# PARAKRAM

## JEE MAIN

CURATED BY EXPERT FACULTY OF PW

# CHEMISTRY

**1500+**

**Selected MCQs**
**to Boost your Confidence**

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## BOOK FEATURES

- Topic wise **MCQs** and Integer type questions
- Strictly as per the latest **NTA** syllabus
- Assertion Reason, Matrix match & Statement based questions also included in exercises.

# CONTENTS


**1.** Stoichiometry and Redox Reactions ........ 1-07
**2.** Structure of Atom ........ 8-15
**3.** Classification of Elements and Periodicity in Properties ........ 16-22
**4.** Chemical Bonding ........ 23-29
**5.** Thermodynamics ........ 30-37
**6.** Chemical Equilibrium ........ 38-46
**7.** Ionic Equilibrium ........ 47-53
**8.** Organic Chemistry- Some Basic Principles & Techniques ........ 54-62
**9.** Hydrocarbons ........ 63-71
**10.** Solutions and Colligative Properties ........ 72-79
**11.** Electrochemistry ........ 80-88
**12.** Chemical Kinetics ........ 89-98
**13.** The p-Block Elements (Group 13 to 18) ........ 99-105
**14.** The d- and f- Block Elements & Qualitative Analysis ........ 106-112
**15.** Coordination Compounds ........ 113-119
**16.** Haloalkanes and Haloarenes ........ 120-128
**17.** Alcohols, Phenols and Ethers ........ 129-140
**18.** Aldehydes, Ketones and Carboxylic Acids ........ 141-151
**19.** Amines ........ 152-161
**20.** Biomolecules ........ 162-168
❖ *ANSWER KEY* ........ 169-178
❖ *HINTS & SOLUTIONS* ........ 179-312

CHAPTER 01

# STOICHIOMETRY AND REDOX REACTIONS

## Single Option Correct Type Questions (01 to 60)

**1.** A partially dried clay mineral contains 8% water. The original sample contains 12% water and 45% silica. The % of silica in the partially dried sample is nearly.

(1) 50% (2) 49%
(3) 55% (4) 47%

**2.** The vapour density of a mixture containing equal number of moles of methane and ethane at STP is

(1) 11.5 (2) 11.0
(3) 23 (4) 12.0

**3.** 6 g of a hydrocarbon on combustion with 22.4 gm of oxygen produces 17.6 g of $CO_2$ and 10.8 g of $H_2O$. The data illustrates the law of:

(1) conservation of mass
(2) multiple proportions
(3) constant proportions
(4) reciprocal proportions

**4.** Which of the following contains the greatest number of atoms?

(1) 1.0 g of butane ($C_4H_{10}$)
(2) 1.0 g of nitrogen ($N_2$)
(3) 1.0 g of silver (Ag)
(4) 1.0 g of water ($H_2O$)

**5.** 4.4 g of an unknown gas occupies 2.24 litres of volume at STP, the gas may be:

(1) $N_2O$ (2) CO
(3) $CO_2$ (4) 1 & 3 Both

**6.** If $N_A$ is Avogadro's number then number of valence electrons in 4.2 g of nitride ions ($N^{3-}$)

(1) 2.4 $N_A$ (2) 4.2 $N_A$
(3) 1.6 $N_A$ (4) 3.2 $N_A$

**7.** The empirical formula of a compound of molecular mass 120 is $CH_2O$. The molecular formula of the compound is:

(1) $C_2H_4O_2$ (2) $C_4H_8O_4$
(3) $C_3H_6O_3$ (4) All of these

**8.** The percentage of nitrogen in urea is about

(1) 46 (2) 85
(3) 18 (4) 28

**9.** 500 ml of a gaseous hydrocarbon when burnt in excess of $O_2$ gave 2.5 litre of $CO_2$ and 3.0 litre of water vapours under standard conditions. Molecular formula of the hydrocarbon is:

(1) $C_4H_8$ (2) $C_4H_{10}$
(3) $C_5H_{10}$ (4) $C_5H_{12}$

**10.** Butane $C_4H_{10}$, burns with the oxygen in air to give carbon dioxide and water.

What is the amount (in moles) of carbon dioxide produced from 0.15 mol $C_4H_{10}$?

$C_4H_{10}(g) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$ (not balanced)

(1) 0.15 mol $CO_2$ (2) 0.30 mol $CO_2$
(3) 0.45 mol $CO_2$ (4) 0.60 mol $CO_2$

**11.** For the reaction:

$A + 2B \rightarrow C$

5 mole of A and 8 mole of B will produce:

(1) 5 mole of C
(2) 4 mole of C
(3) 8 mole of C
(4) 12 mole of C

**12.** Zinc and hydrochloric acid react according to the reaction.

$Zn(s) + 2HCl(aq.) \longrightarrow ZnCl_2(aq.) + H_2(g)$

If 0.30 mole of Zn are added to hydrochloric acid containing 0.52 mole HCl, how many moles of $H_2$ are produced?

(1) 0.26 (2) 1.04
(3) 0.52 (4) 0.13

**13.** The volume of water that must be added to a mixture of 250 ml of 0.6 M HCl and 750 ml of 0.2 M HCl to obtain 0.25 M solution of HCl is:

(1) 750 ml (2) 100 ml
(3) 200 ml (4) 300 ml

**14.** 15 gram of methyl alcohol is dissolved in 35 gram of water. What is the mass percentage of methyl alcohol in solution?

(1) 30% (2) 50%
(3) 70% (4) 75%

**15.** The oxidation number of Phosphorus in $Mg_2P_2O_7$ is:

(1) + 3 (2) + 2
(3) + 5 (4) – 3

**16.** Consider the following reaction:

$3Br_2 + 6CO_3^{2-} + 3H_2O \longrightarrow 5Br^- + BrO_3^- + 6HCO_3^-$

Which of the following statements is true regarding this reaction:

(1) Bromine is oxidized and the carbonate radical is reduced.
(2) Bromine is reduced and the carbonate radical is oxidized.
(3) Bromine is neither reduced nor oxidized.
(4) Bromine is both reduced and oxidized.

**17.** Which reaction does not represent auto redox or disproportionation reaction:

(1) $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^- + H_2O$
(2) $2H_2O_2 \longrightarrow H_2O + O_2$
(3) $2Cu^+ \longrightarrow Cu^{2+} + Cu$
(4) $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$

**18.** The compound that can work both as an oxidising as well as a reducing agent is:

(1) $KMnO_4$ (2) $H_2O_2$
(3) $Fe_2(SO_4)_3$ (4) $K_2Cr_2O_7$

**19.** The molar ratio of $Fe^{2+}$ to $Fe^{3+}$ in a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ having equal number of sulphate ion in both ferrous and ferric sulphate is

(1) 1 : 2
(2) 3 : 2
(3) 2 : 3
(4) Can't be determined

**20.** A sample of ammonium phosphate $(NH_4)_3PO_4$ contains 3.18 mol of H atoms. The number of moles of O atoms in the sample is:

(1) 0.265 (2) 0.795
(3) 1.06 (4) 3.18

**21.** If LPG cylinder contains mixture of butane and isobutane, then the amount of oxygen that would be required for combustion of 1 kg of it will be:

(1) 1.8 kg (2) 2.7 kg
(3) 4.5 kg (4) 3.58 kg

**22.** Calculate the weight of FeO produced from 6.7 g VO & 4.8 g $Fe_2O_3$

$2VO + Fe_2O_3 \longrightarrow 2FeO + V_2O_5$

(At. wt. of V = 51, At. wt. of Fe = 56)

(1) 4.32 (2) 7.755
(3) 2.585 (4) 0.0718

**23.** Decreasing order of mass of pure NaOH in each of the aqueous solution.

(I) 50 g of 40% (W/W) NaOH
(II) 50 ml of 50% (W/V) NaOH ($d_{sol}$ = 1.2 g/ml).
(III) 50 g of 15 M NaOH ($d_{sol}$ = 1 g/ml).

(1) I, II, III (2) III, II, I
(3) II, III, I (4) III = II = I.

**24.** What is the quantity of water that should be added to 16 g methanol to make the mole fraction of methanol as 0.25:

(1) 27 g (2) 12 g
(3) 18 g (4) 36 g

**25.** The number of electrons required to balance the following equation,

$NO_3^- + 4H^+ + e^- \longrightarrow 2H_2O + NO$ is

(1) 5 (2) 4
(3) 3 (4) 2

**26.** In an organic compound of molar mass 108 g $mol^{-1}$, C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular formula can be:

(1) $C_6H_8N_2$ (2) $C_7H_{10}N$
(3) $C_5H_6N_3$ (4) $C_4H_{18}N_3$

**27.** When $KMnO_4$ acts as an oxidizing agent and ultimately forms $MnO_4^{2-}$, $MnO_2$, $Mn_2O_3$ and $Mn^{2+}$, then the number of electrons transferred in each case is:

(1) 4, 3, 1, 5 (2) 1, 5, 3, 7
(3) 1, 3, 4, 5 (4) 3, 5, 7, 1

**28.** $6.02 \times 10^{20}$ molecules of urea are present in 100 ml of its solution. The concentration of urea solution is-

(1) 0.001 M (2) 0.01 M
(3) 0.02 M (4) 0.1 M

**29.** Two solutions of a substance (non-electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 ml of 1.2 M second solution. What is the molarity of the final mixture?

(1) 2.70 M (2) 1.344 M
(3) 1.50 M (4) 1.20 M

**30.** How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms?

(1) 0.02 (2) $3.125 \times 10^{-2}$
(3) $1.25 \times 10^{-2}$ (4) $2.5 \times 10^{-2}$

**31.** Density of a 2.05M solution of acetic acid in water is 1.02 g/ml. The molality of the solution is:

(1) 1.14 mol $kg^{-1}$ (2) 3.28 mol $kg^{-1}$
(3) 2.28 mol $kg^{-1}$ (4) 0.44 mol $kg^{-1}$

**32.** In the reaction

$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^-_{(aq)} + 3H_2\,(g)$

Which of the following statement is correct.

(1) 6 L $HCl_{(aq)}$ is consumed for every 3 L $H_2$ produced.

(2) 33.6 L $H_{2(g)}$ is produced regardless temperature and pressure for every moles that reacts.

(3) 67.2 L $H_{2(g)}$ at STP is produced for every mole of Al that reacts.

(4) 11.2 L $H_{2(g)}$ at STP is produced for every mole of $HCl_{(aq)}$ consumed

**33.** The density (in g $mL^{-1}$) of a 3.60 M sulphuric acid solution that is 29% ($H_2SO_4$ molar mass = 98 g $mol^{-1}$) by mass will be:

(1) 1.22 (2) 1.45
(3) 1.64 (4) 1.88

**34.** A 5.2 molal aqueous solution of methyl alcohol ($CH_3OH$) is supplied. What is the mole fraction of methyl alcohol in the solution?

(1) 0.100 (2) 0.190
(3) 0.086 (4) 0.050

**35.** The density of a solution prepared by dissolving 120 g of urea (mol. mass = 60 u) in 1000 g of water is 1.15 g/mL. The molarity of this solution is:

(1) 0.50 M (2) 1.78 M
(3) 1.02 M (4) 2.05 M

**36.** Consider the following reaction:

$$xMnO_4^- + yC_2O_4^{2-} + zH^+ \rightarrow xMn^{2+} + 2yCO_2 + \frac{z}{2}H_2O$$

The values of x, y and z in the reaction are, respectively:

(1) 5, 2 and 16 (2) 2, 5 and 8
(3) 2, 5 and 16 (4) 5, 2 and 8

**37.** In which of the following reactions $H_2O_2$ acts as a reducing agent?

(a) $H_2O_2 + 2H^+ + 2e^- \longrightarrow 2H_2O$

(b) $H_2O_2 - 2e^- \longrightarrow O_2 + 2H^+$

(c) $H_2O_2 + 2e^- \longrightarrow 2OH^-$

(d) $H_2O_2 + 2OH^- - 2e^- \longrightarrow O_2 + 2H_2O$

(1) (a) & (b) only (2) (c) & (d) only

(3) (a) & (c) only (4) (b) & (d) only

**38.** The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is:

(1) 1 : 4 (2) 7 : 32

(3) 1 : 8 (4) 3 : 16

**39.** The most abundant elements by mass in the body of a healthy human adult are: Oxygen (61.4%), Carbon (22.9%), Hydrogen (10.0%) and Nitrogen (2.6%). The weight which a 75 kg person would gain if all $^1H$ atoms are replaced by $^2H$ atoms is:

(1) 37.5 kg (2) 7.5 kg

(3) 10 kg (4) 15 kg

**40.** $A + 2B + 3C \rightleftharpoons AB_2C_3$

Reaction of 6.0 g of A, $6.0 \times 10^{23}$ atoms of B, and 0.036 mol of C yields 4.8 g of compound $AB_2C_3$. If the atomic mass of A and C are 60 and 80 amu, respectively, the atomic mass of B is (Avogadro no. = $6 \times 10^{23}$) :

(1) 50 amu (2) 60 amu

(3) 70 amu (4) 40 amu

**41.** 5 L of an alkane requires 25 L of oxygen for its complete combustion. If all volumes are measured at constant temperature and pressure, the alkane is;

(1) Butane (2) Isobutane

(3) Ethane (4) Propane

**42.** An organic compound contains C, H and S. The minimum molecular weight of the compound containing 8% sulphur is: (atomic weight of S = 32 amu)

(1) 300 g $mol^{-1}$ (2) 400 g $mol^{-1}$

(3) 200 g $mol^{-1}$ (4) 600 g $mol^{-1}$

**43.** The pair of compounds having metals in their highest oxidation state is:

(1) $MnO_2$ and $CrO_2Cl_2$

(2) $[FeCl_4]^-$ and $Co_2O_3$

(3) $MnO_4^-$ and $[Cu(CN)_4]^{2-}$

(4) $[NiCl_4]^{2-}$ and $[CoCl_4]^{2-}$

**44.** The sodium salt of methyl orange has 7% sodium. What is the minimum molecular weight of the compound?

(1) 420 (2) 375

(3) 328.57 (4) 294.46

**45.** Common salt obtained from sea - water contains 96% NaCl by mass. The approximate number of molecules of NaCl present in 10.0 g of the common salt is: (At. wt. Na = 23 amu)

(1) $10^{21}$ (2) $10^{22}$

(3) $10^{23}$ (4) $10^{24}$

**46.** Consider the following statements:

1. If all the reactants are not taken in their stoichiometric ratio, then at least one reactant will be left behind.
2. 2 moles of $H_2(g)$ and 3 moles of $O_2(g)$ produce 2 moles of water.
3. equal weight of carbon and oxygen are taken to produce $CO_2$ then $O_2$ is limiting reagent.

The above statements 1, 2, 3 respectively are (T = True, F = False)

(1) T T T (2) F T F

(3) F F F (4) T F T

**47.** Which of the following equations is a balanced one:

(1) $5BiO_3^- + 22H^+ + Mn^{2+} \longrightarrow 5Bi^{3+} + 7H_2O + MnO_4^-$

(2) $5BiO_3^- + 14H^+ + 2Mn^{2+} \longrightarrow 5Bi^{3+} + 7H_2O + 2MnO_4^-$

(3) $2BiO_3^- + 4H^+ + Mn^{2+} \longrightarrow 2Bi^{3+} + 2H_2O + MnO_4^-$

(4) $6BiO_3^- + 12H^+ + 3Mn^{2+} \longrightarrow 6Bi^{3+} + 6H_2O + 3MnO_4^-$

**48.** How much $NaNO_3$ must be weighed out to make 50 ml of an aqueous solution containing 70 mg of $Na^+$ per mL?

(1) 11.394 g (2) 1.29 g
(3) 10.934 g (4) 12.934 g

**49.** The temperature at which molarity of pure water is equal to its molality is:

(1) 273 K (2) 298 K
(3) 277 K (4) None of these

**50.** 5.85 g of NaCl is dissolved in 1 L of pure water. The number of ions in 1 mL of this solution is

(1) $6.02 \times 10^{19}$ (2) $1.2 \times 10^{22}$
(3) $1.2 \times 10^{20}$ (4) $6.02 \times 10^{20}$

**51.** The correct expression relating molality (m), molarity (M), density of solution (d) and molar mass ($M_2$) of solute is:

(1) $m = \dfrac{M}{d + MM_2} \times 1000$

(2) $m = \dfrac{M}{1000d - MM_2} \times 1000$

(3) $m = \dfrac{d + MM_2}{M} \times 1000$

(4) $m = \dfrac{1000d - MM_2}{M} \times 1000$

**52.** Calculate the volume of $O_2$ needed for combustion of 1 kg of carbon at STP. $C + O_2 \xrightarrow{\Delta} CO_2$.

(1) 1866.67 L
(2) 3733.33 L
(3) 933.33 L
(4) 4666.67 L

**53.** A 1 g sample of $KClO_3$ was heated under such conditions that a part of it decomposed according to the equation.

(i) $2KClO_3 \longrightarrow 2KCl + 3O_2$
and the remaining underwent change according to the equation
(ii) $4KClO_3 \longrightarrow 3KClO_4 + KCl$
If the amount of $O_2$ evolved was 146.8 mL at NTP, calculate the percentage by weight of $KClO_4$ in the residue.

(1) 29.3 % (2) 49.8 %
(3) 62.5 % (4) 87.1 %

**54.** 64 g of a mixture of NaCl and KCl were treated with concentrated sulphuric acid. The total mass of metal sulphates obtained was found to be 76 g. What are the mass percent of NaCl in the mixture. The reactions are,
$2\,NaCl + H_2SO_4 \longrightarrow Na_2SO_4 + 2\,HCl$ ; $2\,KCl + H_2SO_4 \longrightarrow K_2SO_4 + 2\,HCl$

(1) 42.96 % (2) 84.9 %
(3) 31.5 % (4) 63.1 %

**55.** 100 ml of 0.15 M solution of $Al_2(SO_4)_3$ , the density of the solution is 1.5 g/ml. Report the no. of $Al^{3+}$ ions in this weight.

(1) $1.8 \times 10^{25}$ ions (2) $6 \times 10^{22}$ ions
(3) $1.8 \times 10^{23}$ ions (4) $1.8 \times 10^{22}$ ions

**56.** A person adds 1.71 gram of sugar ($C_{12}H_{22}O_{11}$) in order to sweeten his tea. The number of carbon atoms added are (mol. mass of sugar = 342 g $mol^{-1}$)

(1) $3.6 \times 10^{22}$ (2) $7.2 \times 10^{21}$
(3) 0.05 (4) $6.6 \times 10^{22}$

**57.** **Assertion:** A substance which gets reduced can act as an oxidizing agent.
**Reason:** In the reaction, $3ClO^- \longrightarrow ClO_3^- + 2Cl^-$, Cl atom is oxidized as well as reduced.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**58.** **Assertion:** $Fe_3O_4$ contains iron atoms in two different oxidation numbers.
**Reason:** $Fe^{2+}$ ions decolourize $KMnO_4$ solution.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**59.** Starting with 2 moles of A and 1 mole of B, the following reaction
$2A + 3B \longrightarrow X + 2Y$
is made to take place. Assume the reaction to go to completion. Match the number of moles listed in List II with various species listed in List I.

| List- I | | List- II | |
|---|---|---|---|
| I | A | P | 1/3 |
| II | B | Q | 2/3 |
| III | X | R | 0.0 |
| IV | Y | S | 4/3 |
| | | T | 1/6 |

(1) I-S ; II-R ; III-P ; IV-Q
(2) I-P ; II-Q ; III-R ; IV-S
(3) I-T ; II-S ; III-R ; IV-P
(4) I-Q ; II-R ; III-S ; IV-T

**60.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | 50 mL of 3M HCl solution + 150 mL of 1M $FeCl_3$ solution | P | 4.17 m |
| II | An aqueous solution of NaCl with mole fraction of NaCl as 0.1 | Q | $[Cl^-] = 3$ M |
| III | 20% (w/w) propanol ($C_3H_7OH$) solution | R | $[H^+] = 2.75$ M |
| IV | 10.95% (w/v) HCl solution | S | 6.17 m |

(1) I-R ; II-S ; III-P ; IV-Q
(2) I-Q ; II-S ; III-R ; IV-Q
(3) I-Q ; II-S ; III-P ; IV-Q
(4) I-Q ; II-R ; III-P ; IV-S

## *Integer Type Questions (61 to 75)*

**61.** The weight of a molecule of the compound $C_6H_{12}O_6$ is x × $10^{-22}$ g. Find the value of x. ($N_A = 6 \times 10^{23}$)

**62.** 1.520 g of the hydroxide of a metal on ignition gave 0.995 g of oxide. The equivalent weight of metal is?

(Round off to nearest integer)

**63.** Caffeine has a molecular weight of 194. It contains 28.9% nitrogen by mass. Find the number of atoms of nitrogen in one molecule of it.

**64.** Vapour density of a gas if its density is 0.178 g/L at NTP is: (Round off to nearest integer)

**65.** A gas is found to have the formula $(CO)_x$. It's VD is 70. The value of x must be:

**66.** The volume of oxygen required for complete combustion of 20 ml of ethene is

**67.** If 500 ml of 1 M solution of glucose is mixed with 500 ml of 1 M solution of glucose, final molarity of solution will be:

**68.** 300 ml of 3.0 M NaCl is added to 200 ml of 4.0 M $BaCl_2$ solution. The concentration of $Cl^-$ ions in the resulting solution is

**69.** The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is:

**70.** The molarity of a solution obtained by mixing 750 mL of 0.5 M HCl with 250 mL of 2 M HCl is 'x'. Then find the value of '1000x'.

**71.** At room temperature, the density of water is 1.0 g/ml and the density of ethanol is 0.789 g/ml. What volume (in ml) of ethanol contains the same number of molecules as are present in 175 ml of water? (Nearest Integer)

**72.** What volume (in mL) of 0.10 M $H_2SO_4$ must be added to 50 mL of a 0.10 M NaOH solution to make a solution in which the molarity of the $H_2SO_4$ is 0.050 M?

**73.** If 1/2 moles of oxygen combine with aluminium to form $Al_2O_3$, then weight of aluminium metal (in g) used in the reaction is:

**74.** What volume (in ml) of HCl solution of density 1.2 g/cm$^3$ and containing 36.5% by weight HCl, must be allowed to react with zinc (Zn) in order to liberate 4.0 g of hydrogen? (Nearest integer)

**75.** $Ca_3(PO_4)_2(s)$ and $H_3PO_3(s)$ contains same number of 'P' atom then the ratio of oxygen atom in the two compounds respectively is $\frac{a}{b}$.

Find the value of (a + b). [Take lowest possible integral values of a & b]

CHAPTER

02

# STRUCTURE OF ATOM

## Single Option Correct Type Questions (01 to 60)

**1.** If $10^{-17}$J of light energy is needed by the interior of human eye to see an object. The number of photons of green light ($\lambda$ = 550 nm) needed to see the object are: (h = $6.6 \times 10^{-34}$ J-s)

(1) 27 (2) 28

(3) 29 (4) 30

**2.** Light of wavelength $\lambda$ falls on metal having work function $hc/\lambda_0$. Photoelectric effect will take place only if:

(1) $\lambda > \lambda_0$ (2) $\lambda > 2\lambda_0$

(3) $\lambda < \lambda_0$ (4) $\lambda < 3\lambda_0$

**3.** A bulb of 40 W is producing a light of wavelength 620 nm with 80% of efficiency then the number of photons emitted by the bulb in 20 seconds are (1eV = $1.6 \times 10^{-19}$ J, hc = 12400 eV Å)

(1) $2 \times 10^{18}$ (2) $10^{18}$

(3) $10^{21}$ (4) $2 \times 10^{21}$

**4.** The ionization energy of $He^+$ is $19.6 \times 10^{-18}$ J atom$^{-1}$. The energy of the first stationary state of $Li^{+2}$ will be:

(1) $84.2 \times 10^{-18}$ J/atom

(2) $44.10 \times 10^{-18}$ J/atom

(3) $63.2 \times 10^{-18}$ J/atom

(4) $21.2 \times 10^{-18}$ J/atom

**5.** Energy required to pull out an electron from 1st orbit of hydrogen atom to infinity is 100 units. The amount of energy needed to pull out the electron from 2nd orbit to infinity is:

(1) 50 units (2) 100 units

(3) 25 units (4) Zero

**6.** The ionization energy of H-atom is 13.6 eV. The ionization energy of $Li^{+2}$ ion will be:

(1) 54.4 eV (2) 122.4 eV

(3) 13.6 eV (4) 27.2 eV

**7.** If the wavelength of series limit of the Lyman series for the hydrogen atoms is 912 Å, then the wavelength of series limit for the Balmer series of the hydrogen atom is:

(1) 912 Å (2) 912 × 2 Å

(3) 912 × 4 Å (4) 912/2 Å

**8.** According to Bohr's theory, the angular momentum for an electron in 5th orbit is:

(1) 2.5 h/π (2) 5 h/π

(3) 25 h/π (4) 5π /2h

**9.** Calculate wavelength of 3rd line of Brackett series in hydrogen spectrum

(1) $\frac{784}{33R}$ (2) $\frac{33R}{784}$

(3) $\frac{784R}{33}$ (4) $\frac{33}{784R}$

**10.** Calculate the wavelength of 1st line of Balmer series in Hydrogen spectrum.

(1) 6656 Å

(2) 6266 Å

(3) 6626 Å

(4) 6566 Å

**11.** When an electron in an excited hydrogen atom jumps from an energy level for which n = 5 to a lower level for which n = 2, the spectral line is observed in the ..........region and in .............series of the hydrogen spectrum
(1) Visible, Balmer
(2) Visible, lyman
(3) Infrared, lyman
(4) Infrared, Balmer

**12.** The speed of a proton is one hundredth of the speed of light in vacuum. What is its de-Broglie wavelength? Assume that one mole of protons has a mass equal to one gram. [$h = 6.626 \times 10^{-27}$ erg sec]:
(1) $13.31 \times 10^{-7}$ Å (2) $1.33 \times 10^{-3}$ Å
(3) $13.13 \times 10^{-5}$ Å (4) $1.31 \times 10^{-2}$ Å

**13.** The Uncertainty in the momentum of an electron is $1.0 \times 10^{-5}$ kg m $s^{-1}$. The Uncertainty in its position will be:
($h = 6.626 \times 10^{-34}$ Js)
(1) $1.05 \times 10^{-28}$ m (2) $1.05 \times 10^{-26}$ m
(3) $5.27 \times 10^{-30}$ m (4) $5.25 \times 10^{-28}$ m

**14.** A helium atom is moving with a velocity of $2.40 \times 10^2$ $ms^{-1}$ at 300 K. The de-Broglie wave length is about
(1) 0.416 nm (2) 0.83 nm
(3) 803 Å (4) 8000 Å

**15.** The wavelength of a charged particle ________the square root of the potential difference through which it is accelerated:
(1) is inversely proportional to
(2) is directly proportional to
(3) is independent of
(4) is unrelated with

**16.** Calculate the Uncertainty in velocity of a cricket ball of mass 150 g if the Uncertainty in its position is of the order of 1 Å ($h = 6.6 \times 10^{-34}$ Kg $m^2$ $s^{-1}$)
(1) $3.499 \times 10^{-24}$ $ms^{-1}$
(2) $3.499 \times 10^{-21}$ $ms^{-1}$
(3) $3.499 \times 10^{-20}$ $ms^{-1}$
(4) $3.499 \times 10^{-30}$ $ms^{-1}$

**17.** Which of the following set of quantum numbers are permitted
(1) n = 3, l = 2, m = – 2, s = +1/2
(2) n = 3, l = 2, m = – 1, s = 0
(3) n = 2, l = 2, m = +1, s = – 1/2
(4) n = 2, l = 2, m = +3, s = – 1/2

**18.** For the energy levels in an atom which one of the following statements is correct:
(1) The 4s sub-energy level is at a higher energy than the 3d sub-energy level
(2) The second principal energy level can have five orbitals and contain a maximum of 10 electrons
(3) The M-energy level can have maximum of 18 electrons
(4) None of these

**19.** Which of the following represents the correct set of quantum numbers of a 4d electron?
(1) $4, 3, 2, +\frac{1}{2}$ (2) 4, 2, 1, 0
(3) $4, 3, -2, +\frac{1}{2}$ (4) $4, 2, 1, -\frac{1}{2}$

**20.** Magnetic moment of $X^{n+}$ (Z = 26) is $\sqrt{24}$ B.M. Hence number of unpaired electrons and value of n respectively are:
(1) 4, 2 (2) 2, 4
(3) 3, 1 (4) 0, 2

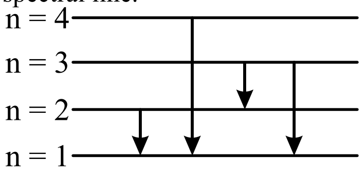
**21.** For $\ell = 1$, n = 3 the corresponding orbitals are -
(1) s, $p_x$ , $p_y$ (2) s, $p_z$ , $p_y$
(3) s , $p_x$ , $d_{xy}$ (4) $p_x$ , $p_y$, $p_z$

**22.** The difference between the wave number of 1st line of Balmer series and last line of paschen series for $Li^{2+}$ ion is:
(1) $\frac{R}{36}$ (2) $\frac{5R}{36}$
(3) 4R (4) $\frac{R}{4}$

**23.** The wave number of electromagnetic radiation emitted during the transition of electron in between two levels of $Li^{2+}$ ion whose principal quantum numbers sum is 4 and difference is 2 is:
(1) 3.5 $R_H$ (2) 4 $R_H$
(3) 8 $R_H$ (4) $\frac{8}{9}R_H$

**24.** If the shortest wave length of Lyman series of H atom is x, then the wave length of the first line of Balmer series of H atom will be -
(1) 9x/5 (2) 36x/5
(3) 5x/9 (4) 5x/36

**25.** Suppose that a hypothetical atom gives a red, green, blue and violet line spectrum. Which jump according to figure would give off the red spectral line.




(1) $3 \to 1$ (2) $2 \to 1$
(3) $4 \to 1$ (4) $3 \to 2$

**26.** Uncertainty in position is twice the Uncertainty in momentum. Uncertainty in velocity is:
(1) $\sqrt{\frac{h}{\pi}}$ (2) $\frac{1}{2m}\sqrt{\frac{h}{\pi}}$
(3) $\frac{1}{2m}\sqrt{\hbar}$ (4) $\frac{h}{4\pi}$

**27.** Which of the above statement (s) is/are false.
I. Orbital angular momentum of the electron having n = 5 and having value of the azimuthal quantum number as lowest for this principal quantum number is $\frac{h}{\pi}$.
II. If n = 3, $\ell$ = 0, m = 0, for the last valence shell electron, then the possible atomic number may be 12 or 13.
III. Total spin of electrons for the atom $_{25}Mn$ is $\pm\frac{7}{2}$.
IV. Spin only magnetic moment of inert gas is 0
(1) I, II and III
(2) II and III only
(3) I and IV only
(4) None of these

**28.** Which of the following ions has the maximum magnetic moment?
(1) $Mn^{2+}$ (2) $Fe^{2+}$
(3) $Ti^{2+}$ (4) $Cr^{2+}$

**29.** The de-Broglie wavelength of a tennis ball of mass 60 g moving with a velocity of 10 m/s is approximately. (planck's constant, h = 6.63 × $10^{-34}$ J-s)
(1) $10^{-33}$ m (2) $10^{-31}$ m
(3) $10^{-16}$ m (4) $10^{-25}$ m

**30.** Which of the following set of quantum numbers is correct for an electron in 4f orbital?
(1) n = 4, l = 3, m = +4, s = +1/2
(2) n = 4, l = 4, m = –4, s = –1/2
(3) n = 4, l = 3, m = +1, s = +1/2
(4) n = 3, l=2, m =–2, s = +1/2

**31.** Which of the following statements in relation to the hydrogen atom is correct?
(1) 3s, 3p and 3d orbitals all have the same energy
(2) 3s and 3p orbitals are of lower energy than 3d orbital
(3) 3p orbital is lower in energy than 3d orbital
(4) 3s orbital is lower in energy than 3p orbital

**32.** In a multi-electron atom, which of the following orbitals described by the three quantum numbers will have the same energy in the absence of magnetic and electric field?
(i) n = 1, l = 0, m = 0
(ii) n = 2, l = 0, m = 0
(iii) n = 2, l = 1, m = 1
(iv) n = 3, l = 2, m =1
(v) n = 3, l = 2, m = 0
(1) (iv) and (v) only
(2) (iii) and (iv) only
(3) (ii) and (iii) only
(4) (i) and (ii) only

**33.** Uncertainty in the position of an electron (mass = $9.1 \times 10^{-31}$ Kg) moving with a velocity 300 m.sec$^{-1}$, Accurate upto 0.001%, will be : (h = $6.63 \times 10^{-34}$ J-s)

(1) $19.2 \times 10^{-2}$ m (2) $5.76 \times 10^{-2}$ m
(3) $1.92 \times 10^{-2}$ m (4) $3.84 \times 10^{-2}$ m

**34.** The ionisation enthalpy of hydrogen atom is $1.312 \times 10^{6}$ J mol$^{-1}$. The energy required to excite the electron in the atom from n = 1 to n = 2 is

(1) $8.51 \times 10^{5}$ J mol$^{-1}$
(2) $6.56 \times 10^{5}$ J mol$^{-1}$
(3) $7.56 \times 10^{5}$ J mol$^{-1}$
(4) $9.84 \times 10^{5}$ J mol$^{-1}$

**35.** Calculate the wavelength (in nanometer) associated with a proton moving at $1.0 \times 10^{3}$ m s$^{-1}$ (Mass of proton = $1.67 \times 10^{-27}$ kg and h = $6.63 \times 10^{-34}$ J-s):

(1) 0.40 nm (2) 2.5 nm
(3) 14.0 nm (4) 0.032 nm

**36.** In an atom, an electron is moving with a speed of 600 m/s with an accuracy of 0.005%. Certainty with which the position of the electron can be located is (h = $6.6 \times 10^{-34}$ kg m$^2$ s$^{-1}$, mass of electron, $e_m = 9.1 \times 10^{-31}$ kg):

(1) $5.10 \times 10^{-3}$ m (2) $1.92 \times 10^{-3}$ m
(3) $3.83 \times 10^{-3}$ m (4) $1.52 \times 10^{-4}$ m

**37.** The energy required to break one mole of Cl–Cl bonds in $Cl_2$ is 242 kJ mol$^{-1}$. The longest wavelength of light capable of breaking a single Cl–Cl bond is : (c = $3 \times 10^{8}$ m s$^{-1}$ and $N_A = 6.02 \times 10^{23}$ mol$^{-1}$)

(1) 594 nm (2) 640 nm
(3) 700 nm (4) 494 nm

**38.** Ionisation energy of H is $2.18 \times 10^{-18}$ J atom$^{-1}$. The energy of the first stationary state (n = 1) of $He^+$ is:

(1) $4.41 \times 10^{-16}$ J atom$^{-1}$
(2) $-1.96 \times 10^{-17}$ J atom$^{-1}$
(3) $-2.2 \times 10^{-15}$ J atom$^{-1}$
(4) $8.82 \times 10^{-17}$ J atom$^{-1}$

**39.** The electrons identified by quantum numbers n and $\ell$ :

(1) n = 4, $\ell$ = 1 (2) n = 4, $\ell$ = 0
(3) n = 3, $\ell$ = 2 (4) n = 3, $\ell$ = 1

can be placed in order of increasing energy as: (for multielectron species)

(1) (3) < (4) < (2) < (1)
(2) (4) < (2) < (3) < (1)
(3) (2) < (4) < (1) < (3)
(4) (1) < (3) < (2) < (4)

**40.** If $\lambda_0$ and $\lambda$ be the threshold wavelength and wavelength of incident light, the velocity of photoelectron (having mass = m) ejected from the metal surface is :

(1) $\sqrt{\frac{2h}{m}(\lambda_0 - \lambda)}$ (2) $\sqrt{\frac{2hc}{m}(\lambda_0 - \lambda)}$

(3) $\sqrt{\frac{2hc}{m}\left(\frac{\lambda_0 - \lambda}{\lambda\lambda_0}\right)}$ (4) $\sqrt{\frac{2h}{m}\left(\frac{1}{\lambda_0} - \frac{1}{\lambda}\right)}$

**41.** The total number of orbitals associated with the principal quantum number (n) = 5 is:

(1) 5 (2) 20
(3) 25 (4) 10

**42.** If the shortest wavelength in Lyman series of hydrogen atom is A, then the longest wavelength in Paschen series of $He^+$ is:

(1) $\frac{36A}{5}$ (2) $\frac{9A}{5}$

(3) $\frac{5A}{9}$ (4) $\frac{36A}{7}$

**43.** The electron in the hydrogen atom undergoes transition from higher orbit to orbit of radius 211.6 pm. This transition is associated with:

(1) Paschen series (2) Brackett series
(3) Lyman series (4) Balmer series

**44.** If nitrogen atom had electronic configuration $1s^7$, it would have energy lower than that of the normal ground state configuration $1s^2\ 2s^2\ 2p^3$, because the electrons would be close to nucleus, yet $1s^7$ is not observed because it violates :
(1) Heisenberg uncertainty principle
(2) Hund's rule
(3) Pauli's exclusion principle
(4) Bohr's postulate of stationary orbits.

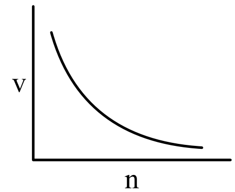
**45.** Match the following
(I) Energy of ground state of $He^+$
(P) + 6.04 eV
(II) Potential energy of I orbit of H-atom
(Q) –27.2 eV
(III) Kinetic energy of II excited state of $He^+$
(R) 54.4 V
(IV) Ionisation potential of $He^+$
(S) – 54.4 eV
(1) I – (P), II – (Q), III – (R), IV – (S)
(2) I – (S), II – (R), III – (Q), IV – (P)
(3) I – (S), II – (Q), III – (P), IV – (R)
(4) I – (Q), II – (R), III – (P), IV – (S)

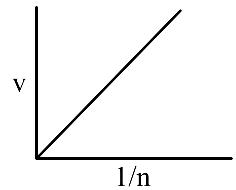
**46.** A 5g orbital has
(1) Zero angular node and zero radial node
(2) Zero radial node and two angular nodes
(3) 4 radial nodes and 4 angular nodes
(4) Zero radial node and 4 angular nodes

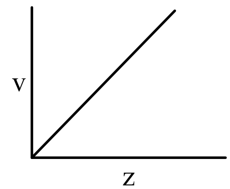
**47.** The threshold wavelength ($\lambda_0$) of sodium metal is 6500Å. If UV light of wavelength 360Å is used, what will be kinetic energy of the photoelectron in ergs?
(1) $55.175 \times 10^{-12}$ (2) $3.056 \times 10^{-12}$
(3) $52.119 \times 10^{-12}$ (4) $48.66 \times 10^{-10}$

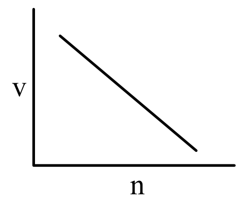
**48.** An electron in an atom jumps from one Bohr orbit to another in such a way that its kinetic energy changes from x to $\frac{x}{4}$. The change in potential energy will be:
(1) $+\frac{3}{2}x$ (2) $-\frac{3}{8}x$
(3) $+\frac{3}{4}x$ (4) $-\frac{3}{4}x$

**49.** Select the incorrect graph for velocity of $e^-$ in a Bohr orbit VS. Z, $\frac{1}{n}$ and n:

(1) 


(2) 


(3) 


(4) 


**50.** An excited state of H-atom emits a photon of wavelength λ and returns to the ground state, the principal quantum number of excited state is given by :
(1) $\sqrt{\lambda R(\lambda R - 1)}$
(2) $\sqrt{\frac{\lambda R}{(\lambda R - 1)}}$
(3) $\sqrt{\lambda R(\lambda R - 1)}$
(4) $\sqrt{\frac{(\lambda R - 1)}{\lambda R}}$

**51.** The energy of a I, II and III energy levels of a certain atom are E, $\frac{4E}{3}$ and 2E respectively. A photon of wavelength λ is emitted during a transition from III to I. What will be the wavelength of emission for transition II to I?

(1) $\frac{\lambda}{2}$ (2) λ
(3) 2λ (4) 3λ

**52.** Calculate the minimum and maximum number of electrons which may have magnetic quantum number,

m = +1 and spin quantum number, s = $-\frac{1}{2}$ in chromium (Cr):

(1) 0, 1 (2) 1, 2
(3) 4, 6 (4) 2, 3

**53.** Electromagnetic radiations of wavelength 242 nm is just sufficient to ionise sodium atom. Calculate the ionisation energy of sodium in kJ $mol^{-1}$.

(1) 495 kJ/mol (2) 821 kJ/mol
(3) 136 kJ/mol (4) None

**54.** Which set of quantum numbers is possible for the last electron of $Mg^+$ ion -

(1) n = 3 , ℓ = 2 , m = 0 , s = +1/2
(2) n = 2 , ℓ = 3 , m = 0 , s = +1/2
(3) n = 1 , ℓ = 0 , m = 0 , s = +1/2
(4) n = 3 , ℓ = 0 , m = 0 , s = +1/2

**55.** According to Bohr's atomic theory, which of the following is correct?

(1) Potential energy of electron $\propto \frac{Z^2}{n}$
(2) The product of velocity of electron and principle quantum number (n) $\propto Z^2$
(3) Frequency of revolution of electron in an orbit $\propto \frac{Z^2}{n^3}$
(4) Coulombic force of attraction on the electron $\propto \frac{Z^2}{n^2}$

**56.** Match List-I with List-II and select the correct answer using the codes given below the lists (ℓ and m are respectively the azimuthal and magnetic quantum no.)

| | List-I | | List-II |
|---|---|---|---|
| (I) | Number of values of ℓ for an energy level | (P) | 0, 1, 2, ............ (n - 1) |
| (II) | Value of ℓ for a particular type of orbital | (Q) | +ℓ to –ℓ through zero |
| (III) | Number of values of m for ℓ = 2 | (R) | 5 |
| (IV) | Value of 'm' for a particular type of orbital | (S) | N |

(1) I-S ; II- P ; III-Q ; IV-R
(2) I-S ; II- P ; III-R ; IV-Q
(3) I-P ; II- S ; III-Q ; IV-R
(4) I-P ; II- S ; III-R ; IV-Q

**57.** Match List I with List II and select the correct answer using the code given below the lists:

$E_n$ = total energy $\ell_n$ = angular momentum
$K_n$ = K.E. , $V_n$ = P.E.
$T_n$ = time period, $r_n$ = radius of $n^{th}$ orbit, for hydrogen- like species.

| | List (I) | | List (II) |
|---|---|---|---|
| (I) | $\frac{V_n}{K_n}$ | (P) | $\frac{1}{2}$ |
| (II) | $\ell_n \propto n^x$, then x is: | (Q) | –2 |
| (III) | $\frac{E_n}{V_n}$ | (R) | – 4 |
| (IV) | $T_n \propto z^t n^3$, then t is: | (S) | 1 |

(1) I-Q ; II- S ; III-P ; IV-Q
(2) I-R ; II- S ; III-P ; IV-Q
(3) I-S ; II- S ; III-Q ; IV-P
(4) I-S ; II- R ; III-P ; IV-Q

**58.** Match List I with List II and select the correct answer using the code given below the lists:

| | List (I) | | List (II) |
|---|---|---|---|
| (I) | Binding energy of $5^{th}$ excited state of $Li^{2+}$ sample | (P) | 10.2 V |
| (II) | $I^{st}$ excitation potential of H-atom | (Q) | 3.4 eV |
| (III) | $2^{nd}$ excitation potential of $He^{+}$ ion | (R) | 13.6 eV |
| (IV) | I.E. of H-atom | (S) | 48.4 V |

(1) I-R ; II- P ; III-S ; IV-Q
(2) I-S ; II- P ; III-Q ; IV-R
(3) I-Q ; II- R ; III-S ; IV-P
(4) I-Q ; II- P ; III-S ; IV-R

**59.** **Assertion:** Hydrogen has one electron in its orbit but it produces several spectral lines.

**Reason:** There are many excited energy levels available.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**60.** **Assertion:** The energy of an electron is largely determined by its principal quantum number.

**Reason:** The principal quantum number (n) is a measure of the most probable distance of finding the electron around the nucleus.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

## *Integer Type Questions (61 to 75)*

**61.** The shortest wavelength (in Å) in H spectrum of Lyman series when $R_H = 109678\ cm^{-1}$ is?

**62.** In a sample of H-atom electrons make transition from $5^{th}$ excited state to ground state, producing all possible types of photons, then number of lines in infrared region are?

**63.** The Uncertainty in position and velocity of a particle are $10^{-11}$ m and $5.27 \times 10^{-24}\ ms^{-1}$ respectively. Calculate the mass (in Kg) of the particle ($h = 6.625 \times 10^{-34}$ Joule sec.).

**64.** The maximum number of 3d-electrons having spin quantum number s = +1/2 are?

**65.** A photon of wavelength 300 nm is absorbed by a gas and then emits two photons. One photon has a wavelength 496 nm then the wavelength of second photon in nm is? (nearest integer)

**66.** If the energy of an electron in hydrogen atom is given by expression, $-1312/n^2\ kJ\ mol^{-1}$, then the energy (in KJ/mol) required to excite the electron from ground state to second orbit is?

**67.** No. of different visible lines obtained when electrons return from 5th orbit to ground state in H spectrum?

**68.** The numbers of d-electrons retained in $Fe^{2+}$ (atomic number of Fe = 26) ion is

**69.** The wavelength (in nm) of the radiation emitted, when in a hydrogen atom electron falls from infinity to first stationary state would be (Rydberg constant = $1.097 \times 10^7 \text{ m}^{-1}$) [Nearest integer].

**70.** The 'spin-only' magnetic moment [in units of Bohr magneton ($\mu_\beta$)] of $Ni^{2+}$ in aqueous solution is $\sqrt{x}$. The value of x would be? (Atomic number of Ni = 28)

**71.** The uncertainty in the position of a moving bullet of mass 10 gm is $10^{-5}$. The uncertainty in its velocity is $X \times 10^{-29}$ m/sec. Find X to the nearest integer. ($h = 6.625 \times 10^{-34}$ Joule sec.).

**72.** The wavelength ($\lambda$) of monochromatic light coming from some light sources is listed below. How many of these sources will be able to exhibit photoelectric effect if incident upon surface of Li metal (work function, $\phi = 2.4$ eV).

| **Light Source** | A | B | C | D | E | F | G | H | I |
|---|---|---|---|---|---|---|---|---|---|
| **λ (nm)** | 100 | 200 | 300 | 400 | 500 | 600 | 700 | 800 | 900 |

**73.** For sodium atom, the number of electrons with m = 0, will be:

**74.** Number of radial nodes in 3s and 2p orbitals are x and y respectively. Calculate the value of (x + y).

**75.** A bulb emits light of wavelength 4500 Å. The bulb is rated as 150 watt and 8 percent of the energy is emitted as light. The number of photons emitted by the bulb per second is $n \times 10^{18}$. Find n to the nearest integer value.

# CHAPTER 03

# CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

*Single Option Correct Type Questions (01 to 60)*

**1.** The first ionization energy of Al is smaller than that of Mg because:

(1) The atomic number of Al is greater than that of Mg.

(2) The atomic size of Al is less than that of Mg.

(3) Penetration of s-subshell electrons in case of Mg is greater than that of p-subshell in Al

(4) Mg has incompletely filled s-orbital.

**2.** Fluorine has the highest electronegativity among the $ns^2\ np^5$ group on the Pauling scale, but the electron affinity of fluorine is less than that of chlorine because:

(1) The atomic number of fluorine is less than that of chlorine.

(2) Fluorine being the first member of the family behaves in an unusual manner.

(3) Chlorine can accommodate an electron better than fluorine by utilising its vacant 3d–orbital.

(4) Small size, high electron density and an increased electron repulsion makes addition of an electron to fluorine less favourable than that in the case of chlorine in isolated stage.

**3.** Select correct statement about radius of an atom.

(1) Values of Van der Waal's radii are larger than those of covalent radii because the Van der Waal's forces are much weaker than the forces operating between atoms in a covalently bonded molecule.

(2) The metallic radii are smaller than the van der Waal's radii, since the bonding forces in the metallic crystal lattice are much stronger than the van der Waal's forces.

(3) Both (1) & (2) are correct.

(4) None is correct.

**4.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | $SO_2, NO_3^-, CO_3^{2-}$ | P | Semi-metals |
| II | B, Si, Ge, As, Sb | Q | Isoelectronic species |
| III | He, Ne, Ar, Kr, Xe | R | Van der waal's radii |
| IV | $M(g) + energy \rightarrow M^+(g) + e^-$ | S | Ionization energy |

(1) I-Q ; II-P ; III-R ; IV-S

(2) I-P ; II-Q ; III-R ; IV-S

(3) I-Q ; II-P ; III-S ; IV-R

(4) I-R ; II-P ; III-Q ; IV-S

**5.** Which of the following is/are generally true regarding effective nuclear charge ($Z_{eff}$):

(1) It increases on moving left to right in a period.

(2) It remains almost constant on moving top to bottom in a group.

(3) For isoelectronic species, as Z increases, $Z_{eff}$ decreases.

(4) Both (1) and (2).

**6.** Thallium is more stable in '+1' oxidation state than '+3' oxidation state because:
(1) of its high reactivity
(2) of inert pair effect
(3) of its amphoteric nature
(4) its is a transition metal

**7.** Which of the following has the largest ionic radius?
(1) $Na^+$ (2) $Cs^+$
(3) $Ca^+$ (4) $Mg^+$

**8.** Atomic radii of F & Ne (in Angstrom) are respectively given by:
(1) 0.72, 1.60 (2) 1.60,1.6
(3) 0.72, 0.72 (4) 1.60, 0.72

**9.** The first ionization energy is smallest for the atom with electronic configuration:
(1) $ns^2\ np^6$ (2) $ns^2np^4$ (3) $ns^2\ np^5$ (4) $ns^2\ np^3$

**10.** Which of the following orders are correct for the ionization energies?
(i) Ba < Sr < Ca (ii) $S^{-2} < S < S^{2+}$
(iii) C < O < N (iv) Mg < Al < Si
(1) i, ii and iv (2) i, iii and iv
(3) i, ii and iii (4) i, ii, iii and iv

**11.** For electron affinity of halogens which of the following is correct?
(1) Br > F (2) F > Cl
(3) Br < Cl (4) $F^- > I$

**12.** Which of the following pair of atoms will have the most negative electron gain enthalpy and which the least negative?
(1) F, Cl (2) Cl, F
(3) S, Cl (4) Cl, P

**13.** The electronegativity of the following elements increases in the order:
(1) C < N < Si < P (2) N < Si < C < P
(3) Si < P < C < N (4) P < Si < N < C

**14.** Which of the following is affected by the stable electron configuration of an atom?
(i) Electronegativity
(ii) Ionisation energy
(iii) Electron affinity
Correct answer is:
(1) (i) only (2) (ii) only
(3) (i) and (ii) both (4) (i),(ii) and(iii)

**15.** Which of the following pairs of elements belongs to representative group of elements in the periodic table?
(1) Aluminium and Magnesium
(2) Chromium and Zinc
(3) Argentum and Astatine
(4) Lanthanum and Thorium

**16.** Element with electronic configuration as $[Ar]^{18}\ 3d^5\ 4s^1$ is placed in:
(1) I A, s-block (2) VI A, s-bloc
(3) VI B, s-block (4) VI B, d-block

**17.** The statement that is not correct for the periodic classification of elements is:
(1) In d-block elements, the last electron enters in (n – 1)d sub-shell.
(2) Non–metallic elements are lesser in number than metallic elements.
(3) The third period contains 8 elements and not 18 as 4th period contains.
(4) For transition elements, the d–subshells are filled with electrons monotonically with increase in atomic number.

**18.** Which series of elements should have nearly the same atomic radii?
(1) Na, K, Rb (2) Fe, Co, Ni
(3) Li, Be, B (4) F, Cl, Br

**19.** Which of the following statement is incorrect for the isoelectronic species?
(1) They have same number of electrons.
(2) Their ionic radii decrease with increase in nuclear charge.
(3) They have different number of protons.
(4) None of these

**20.** The first ionization energy of 'O' is less than that of 'N' because:
(1) The former is more electronegative than later one.
(2) The former has partially filled electron configuration while later one has half-filled electron configuration.
(3) The former is bigger than that of later one.
(4) The former has less electron affinity than that of later one.

**21.** The successive ionization energies for an unknown element are:

$IE_1$ =899 kJ/mol    $IE_2$= 1757 kJ/mol.

$IE_3$ =14,847 kJ/mol.    $IE_4$= 17,948 kJ/mol.

To which family in the periodic table does the unknown element most likely belong?

(1) Carbon family
(2) Boron family
(3) Alkaline earth metal family
(4) Nitrogen family

**22.** The order of first electron affinity of O, S and Se is:

(1) O > S > Se    (2) S > Se > O
(3) Se > O > S    (4) S > O > Se

**23.** Which of the following orders is incorrect?

(1) F > N > C > Si > Ga – non-metallic character.
(2) F > Cl > O > N – oxidising property.
(3) C < Si > P > N – electron affinity value.
(4) None of these.

**24.** The elements having very high ionization enthalpy but zero electron gain enthalpy is:

(1) H    (2) F
(3) He    (4) Be

**25.** Arrange $Ce^{+3}$, $La^{+3}$, $Pm^{+3}$ and $Yb^{+3}$ in increasing order of their ionic radii.

(1) $Yb^{+3} < Pm^{+3} < Ce^{+3} < La^{+3}$
(2) $Ce^{+3} < Yb^{+3} < Pm^{+3} < La^{+3}$
(3) $Yb^{+3} < Pm^{+3} < La^{+3} < Ce^{+3}$
(4) $Pm^{+3} < La^{+3} < Ce^{+3} < Yb^{+3}$.

**26.** According to the periodic law of elements, the variation in properties of elements is related to their:

(1) Atomic masses
(2) Nuclear masses
(3) Atomic numbers
(4) Nuclear neutron-proton number

**27.** Which one of the following groupings represents a collection of isoelectronic species?

(1) $Na^+$, $Ca^{2+}$, $Mg^{2+}$    (2) $N^{3-}$, $F^-$, Na
(3) Be, $Al^{3+}$, $Cl^-$    (4) $Ca^{2+}$ , $Cs^+$, Br.

**28.** Which one of the following ions has the highest value of ionic radius?

(1) $Li^+$    (2) $B^{3+}$
(3) $O^{2-}$    (4) $F^-$

**29.** The formation of the oxide ion $O^{2-}_{(g)}$ requires first an exothermic step and then an endothermic step as shown below:

$O_{(g)} + e^- \rightarrow O^-_{(g)}$ ; $\Delta H° = – 142\ kJmol^{-1}$

$O^-_{(g)} + e^- \rightarrow O^{2-}_{(g)}$ ; $\Delta H° = 844\ kJmol^{-1}$

This is because:

(1) oxygen is more electronegative.
(2) oxygen has high electron affinity.
(3) $O^-$ ion will tend to resist the addition of another electron.
(4) $O^-$ ion has comparatively larger size than oxygen atom.

**30.** In which of the following arrangements the order is NOT according to the property indicated against it?

(1) $Al^{3+} < Mg^{2+} < Na^+ < F^-$ – increasing ionic size
(2) B < C < N < O – increasing first ionization enthalpy
(3) I < Br < F < Cl – increasing electron gain enthalpy (with negative sign)
(4) Li < Na < K < Rb – increasing metallic radius

**31.** Which of the following factors may be regarded as the main cause of lanthanide contraction?

(1) Greater shielding of 5d electrons by 4f electrons.
(2) Poorer shielding of 5d electron by 4f electrons.
(3) Effective shielding of one of 4f electrons by another in the sub-shell.
(4) Poor shielding of one of 4f electron by another in the sub-shell.

**32.** The lanthanide contraction is responsible for the fact that:
(1) Zr and Y have about the same radius
(2) Zr and Nb have similar oxidation state
(3) Zr and Hf have about the same radius
(4) Zr and Zn have same oxidation state.

**33.** The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is:
(1) F < S < P < B (2) P < S < B < F
(3) B < P < S < F (4) B < S < P < F

**34.** The set representing the correct order of ionic radius is:
(1) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$
(2) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$
(3) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$
(4) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$

**35.** The correct sequence which shows decreasing order of the ionic radii of the elements is:
(1) $Al^{3+} > Mg^{2+} > Na^+ > F^- > O^{2-}$
(2) $Na^+ > Mg^{2+} > Al^{3+} > O^{2-} > F^-$
(3) $Na^+ > F^- > Mg^{2+} > O^{2-} > Al^{3+}$
(4) $O^{2-} > F^- > Na^+ > Mg^{2+} > Al^{3+}$

**36.** The correct order of electron gain enthalpy with negative sign of F, Cl, Br and I, having atomic number 9, 17, 35 and 53 respectively, is:
(1) F > Cl > Br > I (2) Cl >F > Br > I
(3) Br > Cl > I > F (4) I > Br > Cl > F

**37.** The increasing order of the ionic radii of the given isoelectronic species is
(1) $Cl^-$, $Ca^{2+}$, $K^+$, $S^{2-}$
(2) $S^{2-}$, $Cl^-$, $Ca^{2+}$, $K^+$
(3) $Ca^{2+}$, $K^+$, $Cl^-$, $S^{2-}$
(4) $K^+$, $S^{2-}$, $Ca^{2+}$, $Cl^-$

**38.** Which of the following represents the correct order of increasing first ionization enthalpy for Ca, Ba, S, Se and Ar?
(1) Ca < S < Ba < Se < Ar
(2) S < Se < Ca < Ba < Ar
(3) Ba < Ca < Se < S < Ar
(4) Ca < Ba < S < Se < Ar

**39.** The ionic radii (in Å) of $N^{3-}$, $O^{2-}$ and $F^-$ are respectively:
(1) 1.36, 1.40 and 1.71
(2) 1.36, 1.71 and 1.40
(3) 1.71, 1.40 and 1.36
(4) 1.71, 1.36 and 1.40

**40.** Which of the following atoms has the highest first ionization energy?
(1) Na (2) K
(3) Sc (4) Rb

**41.** The following statements concern elements in the periodic table. Which of the following is true?
(1) The Group 13 elements are all metals.
(2) All the elements in Group 17 are gases.
(3) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.
(4) For Group 15 elements, the stability of +5 oxidation state increases down the group.

**42.** Identify the least stable ion amongst the following
(1) $Li^-$ (2) $Be^-$
(3) $B^-$ (4) $C^-$

**43.** The elements which exhibit both vertical and horizontal similarities are:
(1) Inert gas elements
(2) Representative elements
(3) Transition elements
(4) None of these

**44.** Match List I (atomic number of the element) with List II (position in the periodic table) and select the correct answer using the codes given below the lists -

| List- I | | List- II | |
|---|---|---|---|
| I | 52 | P | s-block |
| II | 56 | Q | p-block |
| III | 57 | R | d-block |
| IV | 60 | S | f-block |

(1) I-Q ; II-P ; III-R ; IV-S
(2) I-Q ; II-P ; III-S ; IV-R
(3) I-P ; II-Q ; III-R ; IV-S
(4) I-P ; II-Q ; III-S ; IV-R

**45.** In a given energy level, the order of penetration effect of different orbitals is:

(1) $f < p < d < s$ (2) $s < p < d < f$
(3) $f < d < p < s$ (4) $s = p = d = f$

**46.** Which of the following elements can have negative oxidation states.

(1) Al (2) Ca
(3) Fe (4) B

**47.** Which of the following order of radii is correct:

(1) Li < Be < Mg
(2) $H^+ < Li^+ < H^-$
(3) O < F < Ne
(4) Li < Na < K < Cs < Rb

**48.** Which of the following statement is correct with respect to the property of elements in the carbon family with an increase in atomic number, their:

(1) Atomic size increases
(2) Ionization energy increases
(3) Metallic character decreases
(4) Stability of + 4 oxidation state increases

**49.** The second ionization enthalpies of elements are always higher than their first ionization enthalpies because:

(1) Cation formed always have stable half-filled or completely filled valence shell electron configuration.
(2) It is easier to remove electron from cation.
(3) Ionization is an endothermic process.
(4) The cation is smaller than its parent atom.

**50.** The ionization enthalpy will be highest when the electron is to be removed from ............. if other factors are equal:

(1) s-orbital (2) p-orbital
(3) d-orbital (4) f-orbital

**51.** With reference to $1^{st}$ IP which of the following options are correct.

(a) Li < C (b) O < N
(c) Be < N < Ne
(1) a & b only (2) b & c only
(3) a & c only (4) a, b & c

**52.** Which one of the following statements is correct?

(1) The elements having large negative values of electron gain enthalpy generally act as strong oxidising agents.
(2) The elements having low values of ionisation enthalpies act as strong reducing agents.
(3) The formation of $S^{2-}(g)$ from S(g) is an endothermic process.
(4) All of these.

**53.** **Assertion:** F atom has a less negative electron affinity than Cl atom.

**Reason:** Additional electrons are repelled more effectively by 3p electrons in Cl atom than by 2p electrons in F atom.

(1) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Assertion is false but Reason is true.

**54.** **Assertion:** The first ionization energy of Be is greater than that of B.

**Reason:** 2p orbital is lower in energy than 2s.

(1) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Assertion is false but Reason is true.

**55.** The correct set of decreasing order of electronegativity is:

(1) Li, H, Na (2) Na, H, Li
(3) H, Li, Na (4) Li, Na, H

**56.** The correct order of radii is:

(1) N < Be < B (2) $Mg^{2+}<Li^+<N^{3-}$
(3) Na < Li < K (4) $Fe^{+3}<Fe^{2+}<Fe^{4+}$

**57.** Which of the following element has maximum, first ionisation potential?
(1) V (2) Ti
(3) Cr (4) Mn

**58.** Minimum first ionisation energy is shown by which electronic configuration:
(1) $1s^2, 2s^2, 2p^5$
(2) $1s^2, 2s^2, 2p^6, 3s^2, 3p^2$
(3) $1s^2, 2s^2, 2p^6, 3s^1$
(4) $1s^2, 2s^2, 2p^6$

**59.** The high oxidising power of fluorine is due to:
(1) High electron affinity
(2) High ionization energy
(3) Both (1) and (2)
(4) None of these

**60.** Which of the following pair of elements shows diagonal relationship?
(1) Li and Mg (2) Na and Mg
(3) K and Mg (4) Al and Mg

## *Integer Type Questions (61 to 75)*

**61.** The number of elements present in fifth period of periodic table is

**62.** Atomic weight of Cl = 35.5 and of I = 127. According to Dobereiner's triads rule, atomic weight of Br will be approximately?

**63.** An element has atomic number 37. The Sum of period number and group number of this element is?

**64.** The number of element which cannot show the oxidation state of +3 among the following is/are?
Na, Zn, Fe, Mn, F, Mg, Al, Li

**65.** The sum of atomic numbers of the metallic and non-metallic elements which are liquid at room temperature respectively is

**66.** Atomic number of the element from the following that can show +7 oxidation state is-
$$\left(\underset{21}{Sc}, \underset{22}{Ti}, \underset{24}{Cr}, \underset{25}{Mn}, \underset{26}{Fe}, \underset{27}{Co}, \underset{28}{Ni}, \underset{30}{Zn}\right)$$

**67.** The Atomic number of the element unnilennium is?

**68.** The first ionisation potential of Metal M is 15 eV. If the value of electron gain enthalpy of $M^+$ (in eV) is –x eV. Then x is

**69.** The sum of group number, numbers of valence electrons and valency of an element with atomic number 15 is?

**70.** IE1 and IE2 of Mg are 178 and 348 Kcal $mol^{-1}$. The enthalpy required for the reaction $Mg \rightarrow Mg^{2+} + 2e^-$ is
(in Kcal $mol^{-1}$)

**71.** How many of the following statements related to the modern periodic table is/are **correct**?
(i) The p-block has 6 columns, because a maximum of 6 electrons can occupy all the orbitals in a p-subshell.
(ii) The d-block has 8 columns, because a maximum of 8 electrons can occupy all the orbitals in a d-subshell.
(iii) Each block contains a number of columns equal to the number of electrons that can occupy that subshell.
(iv) The block indicates value of azimuthal quantum number (l) for the last subshell that received electrons in building up the electronic configuration.

**72.** How many of the following are the wrong statements?
(i) All the actinide elements are radioactive.
(ii) Alkali and alkaline earth metals are s-block elements.
(iii) Pnictogens and halogens are p-block elements.
(iv) The first member of the lanthanide series is lanthanum.

**73.** How many of the following statements are correct?
(i) Generally, the radius trend and the ionization energy trend across a period are exact opposites.
(ii) Electron gain enthalpy values of elements may be exothermic (negative) or endothermic (positive).
(iii) The first ionization energy of sulphur is higher than that of phosphorus.
(iv) $Te^{2-} > I^- > Cs^+ > Ba^{2+}$ represents the correct decreasing order of ionic radii.

**74.** How many of the following statement is/are correct?

(i) Density increases across the period from left to right while decreases down the group.

(ii) Ionization energy depends upon the type of orbital (of same energy level) from which electron is being removed.

(iii) Generally, electron affinity decreases down the group.

(iv) Moving diagonally, the charge to size ratio remains nearly same for $2^{nd}$ & $3^{rd}$ period elements up to $14^{th}$ group.

**75.** The atomic number of the element from the following atomic number given below. That can not be accommodated in the present setup of the long form of the periodic table is

**Atomic Number :** 107, 118, 126, 102

CHAPTER 04

# CHEMICAL BONDING

*Single Option Correct Type Questions (01 to 60)*

**1.** An ionic bond $A^+ B^-$ is most likely to be formed when:
(1) The ionization energy of A is high and the electron affinity of B is low
(2) The ionization energy of A is low and the electron affinity of B is high
(3) Both the ionization energy of A and the electron affinity of B is high
(4) Both the ionization energy of A and the electron affinity of B is low

**2.** Which of the following pair of elements form a compound with maximum ionic character?
(1) Na and F (2) Cs and F
(3) Na and Br (4) Cs and I

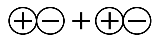
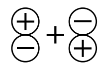
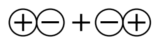
**3.** Among $Na^+$, $Mg^{2+}$ and $Al^{3+}$, the correct order of ease of formation of ionic compounds is:
(1) $Al^{3+} > Mg^{2+} > Na^+$
(2) $Na^+ > Mg^{2+} > Al^{3+}$
(3) $Mg^{2+} > Al^{3+} > Na^+$
(4) $Al^{3+} > Na^+ > Mg^{2+}$

**4.** Which of the following have lowest lattice energy?
(1) Cs – F (2) Cs – Cl
(3) Cs – Br (4) Cs – I

**5.** Which of the following is in order of increasing covalent character?
(1) $CCl_4 < BeCl_2 < BCl_3 < LiCl$
(2) $LiCl < CCl_4 < BeCl_2 < BCl_3$
(3) $LiCl < BeCl_2 < BCl_3 < CCl_4$
(4) $LiCl < BeCl_2 < CCl_4 < BCl_3$

**6.** Which is most ionic according to Fajan's rule?
(1) $AlF_3$ (2) $Al_2O_3$
(3) AlN (4) $Al_4C_3$

**7.** Example of super octet molecule is:
(1) $SF_6$ (2) $PCl_5$
(3) $IF_7$ (4) All of these

**8.** Effective overlapping will be shown by:
(1)  (2) 
(3)  (4) All the above

**9.** Indicate the wrong statement according to Valence bond theory:
(1) A sigma bond is stronger then $\pi$ - bond
(2) p-orbitals always have only sidewise - overlapping
(3) s-orbitals never form $\pi$ - bonds
(4) There can be only one sigma bond between two atoms

**10.** The ion which is not tetrahedral in shape is:
(1) $BF_4^-$ (2) $NH_4^+$
(3) $XeO_4$ (4) $ICl_4^-$

**11.** Choose the molecules in which hybridisation occurs in the ground state?
(a) $BCl_3$ (b) $NH_3$
(c) $PCl_3$ (d) $BeF_2$
The correct answer is:
(1) a, b & d only (2) a, b & c only
(3) b & c only (4) c & d only

**12.** Which of the following compounds have bond angle as 90º?

(1) $CH_4$ (2) $CO_2$

(3) $H_2O$ (4) $SF_6$

**13.** In which of the following pairs hybridisation of the central atom is different?

(1) $ClF_3$ , $ClF_3O$

(2) $ClF_3O$, $ClF_3O_2$

(3) $[ClF_2O]^+$, $[ClF_4O]^-$

(4) $[ClF_4O]^-$, $[XeOF_4]$

**14.** Which has the smallest bond angle (X – S – X) in the given molecules?

(1) $OSF_2$ (2) $OSCl_2$

(3) $OSBr_2$ (4) $OSI_2$ .

**15.** Consider the following iodides:

| $PI_3$ | $AsI_3$ | $SbI_3$ |
|---|---|---|
| 102° | 100.2° | 99° |

The bond angle is maximum in $PI_3$, which is:

(1) Due to small size of phosphorus

(2) Due to more bp–bp repulsion in $PI_3$

(3) Due to less electronegativity of P

(4) None of these

**16.** Electron deficient molecule among the following is:

(1) $I_2Cl_6$ (2) $B_2H_6$

(3) $Al_2Cl_6$ (4) All of these

**17.** For $BF_3$ molecule which of the following is true?

(1) B-atom is $sp^2$ hybridized.

(2) There is a pπ–pπ back bonding in this molecule.

(3) Observed B–F bond length is found to be less than the expected bond length.

(4) All of these

**18.** Which is the true statement about $(SiH_3)_3N$?

(1) It is trigonal planar.

(2) It is trigonal pyramidal.

(3) It is stronger lewis base than that of $(CH_3)_3N$.

(4) It has a total of 9 sigma bonds.

**19.** In which of the following set, the values of bond orders will be 2.5?

(1) $O_2^+$, NO, $NO^{2+}$, CN

(2) CN, $NO^{2+}$, $CN^-$, $F_2$

(3) $O_2^+$ , $NO^{2+}$, $O_2^{2+}$, $CN^-$

(4) $O_2^{2-}$, $O_2^-$, $O_2^+$, $O_2$

**20.** Pick out the incorrect statement.

(1) $N_2$ has greater dissociation energy than $N_2^+$

(2) $O_2$ has lower dissociation energy than $O_2^+$

(3) Bond length in $N_2^+$ is less than $N_2$

(4) Bond length in $NO^+$ is less than in NO.

**21.** Which the following molecules / species have identical bond order and same magnetic properties?

(I) $O_2^+$ ; (II) NO ;

(III) $N_2^+$

(1) (I) and (II) only

(2) (I) and (III) only

(3) (I), (II) and (III)

(4) (II) and (III) only

**22.** Of the following molecules, the one, which has permanent dipole moment, is:

(1) $SiF_4$ (2) $BF_3$

(3) $PF_3$ (4) $PF_5$

**23.** The correct order of dipole moment is:

(1) $CH_4 < NF_3 < NH_3 < H_2O$

(2) $NF_3 < CH_4 < NH_3 < H_2O$

(3) $NH_3 < NF_3 < CH_4 < H_2O$

(4) $H_2O < NH_3 < NF_3 < CH_4$

**24.** Which one of the following molecules shows intramolecular H-bonding?

(1) $H_2O$ (2) o-nitro phenol

(3) HF (4) $CH_3COOH$

**25.** Which of the following compound has maximum number of H-bonds per mole?

(1) HF (2) $PH_3$

(3) $H_2O$ (4) $OF_2$

**26.** **Assertion:** Aluminium chloride in acidified aqueous solution forms octahedral $[Al(H_2O)_6]^{3+}$ ion.

**Reason:** In $[Al(H_2O)_6]^{3+}$ complex ion, the 3d orbitals of Al are involved and the hybridization state of Al is $sp^3d^2$.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both are assertion and reason are incorrect

**27.** The correct order of increasing covalent character of the following is:

(1) $SiCl_4 > AlCl_3 < CaCl_3 < KCl$

(2) $KCl < CaCl_2 < AlCl_3 < SiCl_4$

(3) $AlCl_3 < CaCl_2 < KCl < SiCl_4$

(4) None of these

**28.** Which of the following species is diamagnetic in nature:

(1) NO (2) $NO_2$

(3) $ClO_2$ (4) $N_2O_4$

**29.** Which of the following overlaps is **<u>incorrect</u>** [assuming z-axis to be the internuclear axis]?

(a) $2p_y + 2p_y \rightarrow \pi 2p_y$

(b) $2p_z + 2p_z \rightarrow \sigma 2p_z$

(c) $2p_x + 2p_x \rightarrow \pi 2p_x$

(d) $1s + 2p_y \rightarrow \pi(1s\text{-}2p_y)$

(1) 'a' & 'b' only (2) 'b' & 'd' only

(3) only 'd' (4) None of these

**30.** The type of hybrid orbitals used by chlorine atom in $ClO^-$, $ClO_2^-$, $ClO_3^-$ and $ClO_4^-$ is / are:

(1) sp, $sp^2$, $sp^3$ and $sp^3d$ (2) sp and $sp^3$

(3) only $sp^3$ (4) only sp

**31.** The structure of $IO_2F_2^-$ is analogous to:

(1) $SF_4$ (2) $XeO_2F_2$

(3) $F_2SeO_2$ (4) (1) and (2) both

**32.** Incorrect order about bond angle is/are:

(1) $H_2O > H_2S > H_2Se > H_2Te$

(2) $C_2H_2 > C_2H_4 > CH_4 > NH_3$

(3) $NH_3 < H_2O < OF_2$

(4) $ClO_2 > H_2O > H_2S$

**33.** Which of the following statement is incorrect?

(1) During $N_2^+$ formation, one electron is removed from the bonding molecular orbital of $N_2$.

(2) During $O_2^+$ formation, one electron is removed from the antibonding molecular orbital of $O_2$.

(3) During $O_2^-$ formation, one electron is added to the bonding molecular orbitals of $O_2$.

(4) During $CN^-$ formation, one electron is added to the bonding molecular orbitals of CN.

**34.** According to Molecular orbital theory which of the following is correct?

(1) LUMO level for $C_2$ molecule is $\sigma 2p_x$ orbital

(2) In $C_2$ molecules, both the bonds are $\pi$ bonds

(3) In $C_2^{2-}$ ion there is one $\sigma$ and two $\pi$ bonds

(4) All the above are correct

**35.** Which of the following statements is correct about $N_2$ molecule?

(1) It has a bond order of 3

(2) The number of unpaired electrons present in it is zero and hence it is diamagnetic

(3) The order of filling of MOs is $\pi(2p_x) = \pi(2p_y), \sigma(2p_z)$

(4) All the above three statements are correct

**36.** Which of the following would be expected to have a dipole moment of zero on the basis of symmetry?

(1) $SOCl_2$ (2) $OF_2$

(3) $SeF_6$ (4) $ClF_5$

**37.** The dipole moment of HBr is $2.6 \times 10^{-30}$ Cm and the interatomic spacing is 1.41 Å. The percentage of ionic character in HBr is:

(1) 10.5 (2) 11.5

(3) 12.5 (4) 13.5

**38.** The boiling point of p-nitrophenol is higher than that of o-nitrophenol because:

(1) $NO_2$ group at p-position behaves in a different way from that at o-position

(2) intramolecular hydrogen bonding exists in p-nitrophenol

(3) there is intermolecular hydrogen bonding in p-nitrophenol

(4) p-nitrophenol has a higher molecular weight than o-nitrophenol

**39.** Density of ice is less than that of water because of:

(1) presence of Van der Waal interaction.

(2) crystal modification of ice.

(3) open porous cage like structure of ice due to H-bonding.

(4) different physical states of these.

**40.** Which of the following compounds has the smallest bond angle in its molecule?

(1) $SO_2$ (2) $H_2O$

(3) $H_2S$ (4) $NH_3$

**41.** The pair of species having identical shapes for molecules of both species is:

(1) $CF_4$, $SF_4$ (2) $XeF_2$, $CO_2$

(3) $BF_3$, $PCl_3$ (4) $PF_5$, $IF_5$.

**42.** Which of the following pair of molecules will have permanent dipole moments for both members?

(1) $SiF_4$ and $NO_2$

(2) $NO_2$ and $CO_2$

(3) $NO_2$ and $O_3$

(4) $SiF_4$ and $CO_2$

**43.** The bond order in NO is 2.5 while that in $NO^+$ is 3. Which of the following statements is true for these two species?

(1) bond length in $NO^+$ is greater than in NO

(2) bond length in NO is greater than in $NO^+$

(3) bond length in $NO^+$ is equal to that in NO

(4) bond length is unpredictable

**44.** The states of hybridization of boron and oxygen atoms in boric acid ($H_3BO_3$) are respectively:

(1) $sp^2$ and $sp^2$

(2) $sp^2$ and $sp^3$

(3) $sp^3$ and $sp^2$

(4) $sp^3$ and $sp^3$

**45.** Which one of the following has the regular tetrahedral structure?

(1) $XeF_4$ (2) $SF_4$

(3) $BF_4^-$ (4) $[Ni(CN)_4]^{2-}$

**46.** The molecular shapes of $SF_4$, $CF_4$ and $XeF_4$ are:

(1) The same with 2, 0 and 1 lone pairs of electrons on the central atom, respectively.

(2) The same with 1, 1 and 1 lone pair of electrons on the central atoms, respectively.

(3) Different with 0, 1 and 2 lone pairs of electrons on the central atom, respectively.

(4) Different with 1, 0 and 2 lone pairs of electrons on the central atom, respectively.

**47.** Which one of the following species is diamagnetic in nature?

(1) $He_2^+$ (2) $H_2$

(3) $H_2^+$ (4) $H_2^-$.

**48.** In which of the following molecule/ion, all the bonds are not equal?

(1) $SF_4$ (2) $SiF_4$

(3) $XeF_4$ (4) $BF_4^-$

**49.** The bond dissociation energy of B – F in $BF_3$ is 646 kJ $mol^{-1}$ whereas that of C – F in $CF_4$ is 515 kJ $mol^{-1}$. The correct reason for higher B – F bond dissociation energy as compared to that of C – F is:

(1) Stronger σ bond between B and F in $BF_3$ as compared to that between C and F in $CF_4$.

(2) Significant pπ - pπ interaction between B and F in $BF_3$ whereas there is no possibility of such interaction between C and F in $CF_4$.

(3) Lower degree of pπ - pπ interaction between B and F in $BF_3$ than that between C and F in $CF_4$.

(4) Smaller size of B - atom as compared to that of C - atom.

**50.** The hybridization of orbitals of N atom in $NO_3^-$, $NO_2^+$ and $NH_4^+$ are respectively:

(1) sp, $sp^2$, $sp^3$

(2) $sp^2$, sp, $sp^3$

(3) sp, $sp^3$, $sp^2$

(4) $sp^2$, $sp^3$, sp

**51.** Which of the following has maximum number of lone pairs associated with Xe?

(1) $XeF_4$ (2) $XeF_6$

(3) $XeF_2$ (4) $XeO_3$

**52.** Stability of the species $Li_2$, $Li_2^-$ and $Li_2^+$ increases in the order of:

(1) $Li_2 < Li_2^+ < Li_2^-$

(2) $Li_2^- < Li_2^+ < Li_2$

(3) $Li_2 < Li_2^- < Li_2^+$

(4) $Li_2^- < Li_2 < Li_2^+$

**53.** Which of the following species is not paramagnetic?

(1) CO (2) $O_2$

(3) $B_2$ (4) NO

**54.** Amongst LiCl, RbCl, $BeCl_2$ and $MgCl_2$ the compounds with the greatest and the least ionic character respectively are:

(1) LiCl and RbCl

(2) RbCl and $BeCl_2$

(3) $MgCl_2$ and $BeCl_2$

(4) RbCl and $MgCl_2$

**55.** Match List I with List II and select the correct answer using the codes given below the lists.

| List- I | | List- II (Shape) | |
|---|---|---|---|
| I | $CS_2$ | P | Bent |
| II | $SO_2$ | Q | Linear |
| III | $BF_3$ | R | Trigonal Planar |
| IV | $NH_3$ | S | Tetrahedral |
| | | T | Trigonal pyramidal |

(1) I-Q ; II-P ; III-R ; IV-T

(2) I-P ; II-Q ; III-R ; IV-T

(3) I-Q ; II-P ; III-T ; IV-S

(4) I-P ; II-Q ; III-T ; IV-S

**56.** Identify the correct match.

| List- I | | List - II | |
|---|---|---|---|
| I | $XeF_2$ | P | Central atom has $sp^3$ hybridisation and bent shape. |
| II | $N_3^-$ | Q | Central atom has $sp^3d^2$ hybridisation and octahedral. |
| III | $PCl_5$ (s) anion | R | Central atom has sp hybridisation and linear shape. |
| IV | $I_2Cl_6$ (ℓ) cation | S | Central atom has $sp^3d$ hybridisation and linear shape. |

(1) I-P ; II-Q ; III-R ; IV-S

(2) I-S ; II-Q ; III-S ; IV-R

(3) I-Q ; II-R ; III-P ; IV-S

(4) I-S ; II-R ; III-Q ; IV-P

**57.** Match the species given in List-I with the type of hybridisation given in List-II.

| List- I | | List - II | |
|---|---|---|---|
| I | $IO_2F_2^-$ | P | $sp^3d$ |
| II | $F_2SeO$ | Q | $sp^3$ |
| III | $SO_2$ | R | $sp^2$ |
| IV | $XeF_5^+$ | S | $sp^3d^2$ |

(1) I-P ; II-Q ; III-R ; IV-S
(2) I-P ; II-Q ; III-S ; IV-R
(3) I-P ; II-S ; III-R ; IV-P
(4) I-Q ; II-P ; III-R ; IV-S

**58.** **Assertion:** In the bonding molecular orbital (MO) of $H_2$, electron density is increased between the nuclei.

**Reason:** The bonding MO is $\psi_A + \psi_B$, which shows destructive interference of the combining electron waves.

(1) Assertion is correct, reason is incorrect.
(2) Assertion is incorrect, reason is correct.
(3) Assertion and reason are correct, but reason is not the correct explanation for the assertion.
(4) Assertion and reason are correct and reason is the correct and reason is the correct explanation for the assertion.

**59.** **Assertion:** $NF_3$ has little tendency to act as a donor molecule.

**Reason:** The highly electronegative F atoms attract electrons and these dipole moments partly cancel the dipole moment from the lone pair.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**60.** **Assertion:** Molecules having different hybridisation can have same shape.

**Reason:** The shape of a molecule does not depend on the hybridisation but it depends on the energy factor.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

## *Integer Type Questions (61 to 75)*

**61.** Number of antibonding electrons in $N_2$ is:

**62.** A simplified application of MO theory to the hypothetical molecule 'OF' would give its bond order as 'x'. Then '2x' is:

**63.** The dipole moment of HCl is 1.03 D. If H–Cl bond distance is 1.275 Å, what is the percentage of ionic character in the H–Cl bond. (Nearest integer)

**64.** The number of electrons involved in the bond formation in $N_2$ molecule is:

**65.** The covalency of nitrogen in $HNO_3$ is:

**66.** Average bond order of C–C bond in $C_6H_6$ is 'x'. Then '10x' is:

**67.** In $XeF_2$, $XeF_4$ and $XeF_6$ (g), the number of lone pairs on Xe are x, y and z respectively. Find the value of
$(x + y + z)$

**68.** The bond order of $HeH^+$ is:

**69.** Molecular AB has a bond length of 1.61 Å and a dipole moment of 0.38 D. The fractional charge on each atom (absolute magnitude) is 'x'. Find the value of '100 x'. (Nearest integer) [$e_0 = 4.802 \times 10^{-10}$ esu]

**70.** The number of lone pair(s) of electrons on central atom in $XeOF_4$ is:

**71.** How many of the following species are hypervalent?

(I) $ClO_4^-$ (II) $BF_3$

(III) $SO_4^{2-}$ (IV) $CO_3^{2-}$

**72.** The total number of σ and π bonds in $C_2(CN)_4$ are:

**73.** $CO_2$ is isostructural with how many of the following molecules.

(I) $HgCl_2$ (II) $SnCl_2$

(III) $NO_2$ (IV) $C_2H_2$

**74.** For $B_2H_6$

**S1:** Each boron is $sp^3$ hybridised

**S2:** Four terminal 'H' & two 'B' atom are in same plane but two bridge hydrogen in different plane

**S3:** It has 4 σ bond & 2 bridge bond

**S4:** 8 σ bonds are present in it

How many of these statements are true?

**75.** In $PO4^{3-}$ ion, the formal charge on each oxygen atom and P– O bonds order are x, y respectively. Then find the magnitude of (y – x).

CHAPTER

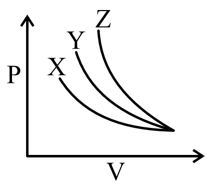
05

# THERMODYNAMICS

## *Single Option Correct Type Questions (01 to 60)*

**1.** P–V plots for three gases (assuming ideal behaviour and similar condition) for reversible adiabatic compression are given in the figure below:

Plots X, Y and Z should correspond to respectively:




(1) $CO_2$, $Cl_2$ and Ne

(2) $SO_2$, $N_2O$ and He

(3) He, $N_2$ and $O_3$

(4) $NH_3$, $H_2S$ and Ar

**2.** A reaction has $\Delta H = -33$ kJ and $\Delta S = -58$ J/K. This reaction would be:

(1) Spontaneous at all temperature

(2) Non-spontaneous at all temperatures

(3) Spontaneous above a certain temperature only

(4) Spontaneous below a certain temperature only

**3.** $\Delta S = \dfrac{q_{rev}}{T}$, so

(1) ΔS is defined only for reversible process.

(2) For irreversible process, ΔS is calculated by considering the irreversible.

(3) For irreversible process, A → B and same process taking place reversible, ΔS is same.

(4) $\Delta S_{sys}$ is always the for irreversible process.

**4.** How many of the given statements are correct:

**I:** Molar entropy of a substance follows the order $(S_m)_{Solid} < (S_m)_{liquid} < (S_m)_{gas}$

**II**: Entropy change of system for the reaction $H_2(g) \longrightarrow 2H(g)$ is +ve.

**III:** Molar entropy of a non-crystalline solid will be zero at absolute zero temperature.

**IV:** If the path of an irreversible process is reversed, then both system and surroundings shall be restored to their original states.

**V**: Refractive index and molarity are intensive properties.

(1) 2 (2) 3

(3) 4 (4) 5

**5.** Among the following, an intensive property is:

(1) Mass

(2) Volume

(3) Surface tension

(4) Enthalpy

**6.** A tightly closed thermos-flask contains some ice cubes. For a short period of time the system behaves as:

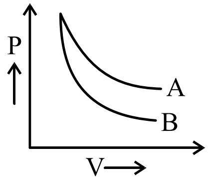
(1) Closed system

(2) Open system

(3) Isolated system

(4) Non-thermodynamic system

**7.** P-V plot for two gases (assuming ideal) during a reversible adiabatic processes are given in the figure. Plot A and plot B should correspond respectively to:




(1) He and $H_2$ (2) $H_2$ and He
(3) He and Ne (4) $H_2$ and $Cl_2$

**8.** The relation of internal energy, enthalpy and work done can be represented (at constant pressure) by:

(1) $\Delta E = \Delta H + W$ (2) $\Delta E = W - \Delta H$
(3) $\Delta H = \Delta E + W$ (4) $W = \Delta E - \Delta H$

**9.** The work done in adiabatic process on ideal gas by a constant external pressure would be:

(1) Zero (2) $\Delta E$
(3) $\Delta H$ (4) $\Delta G$

**10.** Predict which of the following reaction (s) has a positive entropy change?

I. $Ag^+ (aq) + Cl^- (aq) \longrightarrow AgCl (s)$

II. $NH_4Cl (s) \longrightarrow NH_3 (g) + HCl (g)$

III. $2NH_3 (g) \longrightarrow N_2 (g) + 3H_2 (g)$

(1) I and II (2) III
(3) II and III (4) II

**11.** If one mole of an ideal gas $\left(C_{p,m} = \frac{5}{2}R\right)$ is expanded isothermally at 300 K until it's volume is tripled, then change in entropy of gas is:

(1) Zero (2) Infinity
(3) $\frac{5}{2}R \ln 3$ (4) $R \ln 3$

**12.** Which of the following conditions regarding a chemical process ensures its spontaneity at all temperature?

(1) $\Delta H > 0, \Delta G < 0$ (2) $\Delta H < 0, \Delta S > 0$
(3) $\Delta H < 0, \Delta S < 0$ (4) $\Delta H > 0, \Delta S < 0$

**13.** In the exothermic reaction the enthalpy of reaction is always:

(1) Zero (2) Positive
(3) Negative (4) None of these

**14.** Given that the molar heat capacity of ice is more than the molar heat capacity of water vapour. Let x and y be the magnitudes of the enthalpies of sublimation of ice at $T_1$ K and $T_2$ K such that $T_1 < T_2$. Choose the correct options:

(1) $x = y$
(2) $x > y$
(3) $x < y$
(4) Cannot be determined

**15.** The standard heat of combustion of solid boron is equal to-

(1) $\Delta H^\circ_f (B_2O_3)$ (2) $1/2\ \Delta H^\circ_f (B_2O_3)$
(3) $2\Delta H^\circ_f (B_2O_3)$ (4) $1/2\ \Delta H^\circ_f (B_2O_3)$

**16.** If $\Delta G = -\ 177$ K cal for

(1) $2\ Fe(s) + \frac{3}{2} O_2 (g) \longrightarrow Fe_2O_3 (s)$ and $\Delta G = -\ 19$ K cal for

(2) $4\ Fe_2O_3 (s) + Fe(s) \longrightarrow 3\ Fe_3O_4 (s)$

What is the Gibbs free energy of formation of $Fe_3O_4$?

(1) +229.6 kcal/mol (2) –242.3 kcal/mol
(3) – 727 kcal/mol (4) –229.6 kcal/mol

**17.** In the reaction $CS_2 (\ell) + 3O_2 (g) \longrightarrow CO_2 (g) + 2SO_2 (g)$ $\Delta H = -\ 265$ kcal

The enthalpies of formation of $CO_2$ and $SO_2$ are both negative and are in the ratio 4 : 3. The enthalpy of formation of $CS_2$ is +26kcal/mol. Calculate the enthalpy of formation of $SO_2$.

(1) – 90 kcal/mol
(2) – 52 kcal/mol
(3) – 78 kcal/mol
(4) – 71.7 kcal/mol

**18.** One mole of an ideal diatomic gas ($C_v = 5$ cal) was transformed from initial 25°C and 1 L to the state when temperature is 100°C and volume 10 L. The entropy change of the process can be expressed as (R = 2 calories/mol/K)

(1) $3 \ln \frac{298}{373} + 2 \ln 10$

(2) $5 \ln \frac{373}{298} + 2 \ln 10$

(3) $7 \ln \frac{373}{298} + 2 \ln \frac{1}{10}$

(4) $5 \ln \frac{373}{298} + 2 \ln \frac{1}{10}$

**19.** Identify the correct statement regarding a spontaneous process:

(1) Exothermic processes are always spontaneous.

(2) Lowering of energy in the reaction process is the only criterion for spontaneity.

(3) For a spontaneous process in an isolated system, the change in entropy is positive.

(4) Endothermic processes are never spotaneous

**20.** In conversion of lime-stone to lime, $CaCO_3$ (s) $\rightarrow$ CaO(s) + $CO_2$ (g) the values of ΔH° and ΔS° are +179.1 kJ $mol^{-1}$ and 160.2 J/K respectively at 298 K and 1 bar. Assuming that ΔH° and ΔS° do not change with temperature, temperature above which conversion of limestone to lime will be spontaneous is:

(1) 845 K (2) 1118 K

(3) 1008 (4) 1200 K

**21.** Standard entropy of $X_2$, $Y_2$ and $XY_3$ are 60, 40 and 50 $JK^{-1}$ $mol^{-1}$, respectively.

For the reaction, $\frac{1}{2} X_2 + \frac{3}{2} Y_2 \rightarrow XY_3$ $\Delta H = -30$ kJ, to be at equilibrium the temperature will be:

(1) 500 K (2) 750 K

(3) 1000 K (4) 1250 K

**22.** In a fuel cell methanol is used as fuel and oxygen gas is used as an oxidizer. The reaction is

$$CH_3OH (\ell) + \frac{3}{2} O_2 (g) \longrightarrow CO_2(g) + 2H_2O (\ell)$$

At 298 K, standard Gibb's energies of formation for $CH_3OH$ (ℓ), $H_2O$ (ℓ) and $CO_2$ (g) are –166.2, –237.2 and –394.4 kJ $mol^{-1}$ respectively. If standard enthalpy of combustion of methanol is –726kJ $mol^{-1}$, efficiency of the fuel cell will be:

(1) 87% (2) 90%

(3) 97% (4) 80%

**23.** For a particular reversible reaction at temperature T, ΔH and ΔS were found to be both positive. If $T_e$ is the temperature at equilibrium, the reaction would be spontaneous when.

(1) $T_e > T$ (2) $T > T_e$

(3) $T_e$ is 5 times T (4) $T = T_e$

**24.** The entropy change involved in the isothermal reversible expansion of 2 moles of an ideal gas from a volume of 10 $dm^3$ to a volume of 100 $dm^3$ at 27°C is:

(1) 38.3 J $mol^{-1}$ $K^{-1}$ (2) 35.8 J $mol^{-1}$ $K^{-1}$

(3) 32.3 J $mol^{-1}$ $K^{-1}$ (4) 42.3 J $mol^{-1}$ $K^{-1}$

**25.** The value of enthalpy change (ΔH) for the reaction

$$C_2H_5OH_{(l)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(l)}$$

at 27°C is –1366.5 kJ $mol^{-1}$. The value of internal energy change for the above reaction at this temperature will be:

(1) –1369.0 kJ (2) –1364.0 kJ

(3) –1361.5 kJ (4) –1371.5 kJ

**26.** The incorrect expression among the following is:

(1) $\frac{\Delta G_{system}}{\Delta S_{total}} = -T$

(2) In isothermal process, $w_{reversible} = -nRT \ell n \frac{V_f}{V_i}$

(3) $\ln K = \frac{\Delta H^o - T\Delta S^o}{RT}$

(4) $K = e^{-\Delta G^o/RT}$

**27.** A piston filled with 0.04 mol of an ideal gas expands reversibly from 50.0 mL to 375 mL at a constant temperature of 37ºC. As it does so, it absorbs 208 J of heat. The values of q and w for the process will be:
(R = 8.314 J/mol K) (ln 7.5 = 2.01)
(1) q = +208 J, w = – 208 J
(2) q = –208 J, w = – 208 J
(3) q = –208 J, w = + 208 J
(4) q = +208 J, w = + 208 J

**28.** The following reaction is performed at 298 K
$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$
The standard free energy of formation of NO(g) is 86.6 kJ/mol at 298 K. What is the standard free energy of formation of $NO_2(g)$ at 298 K? ($K_P = 1.6 \times 10^{12}$)
(1) R (298) in ($1.6 \times 10^{12}$) – 86600
(2) 86600 + R (298) ln (1.6 x $10^{12}$)
(3) $86600 - \frac{\ln\left(1.6\times10^{12}\right)}{R\left(298\right)}$
(4) 0.5 [2 × 86,600 – R (298) ln ($1.6 \times 10^{12}$)]

**29.** Given, $C_{(graphite)} + O_2(g) \longrightarrow CO_2(g)$ ; $\Delta_rH^o = -393.5$ kJ $mol^{-1}$ ; $H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l)$ ; $\Delta_rH^o = -285.8$ kJ $mol^{-1}$ ; $CO_2(g) + 2H_2O(l) \longrightarrow CH_4(g) + 2O_2(g)$ ; $\Delta_rH^o = +890.3$ kJ $mol^{-1}$
Based on the above thermochemical equations, the value of $\Delta_rH^o$ at 298 K for the reaction:
$C_{(graphite)} + 2H_2(g) \longrightarrow CH_4(g)$ will be:
(1) +144.0 kJ $mol^{-1}$
(2) –74.8 kJ $mol^{-1}$
(3) –144.0 kJ $mol^{-1}$
(4) +74.8 kJ $mol^{-1}$

**30.** The standard enthalpy of formation ($\Delta_fH^o_{298}$) for methane, $CH_4$ is –74.9 kJ $mol^{-1}$. In order to calculate the average energy given out in the formation of a C–H bond from this it is necessary to know which one of the following?
(1) The dissociation energy of the hydrogen molecule, $H_2$ only
(2) The first four ionization energies of carbon.
(3) The dissociation energy of $H_2$ and enthalpy of sublimation of carbon (graphite).
(4) The first four ionization energies of carbon and electron affinity of hydrogen.

**31.** A reaction at 1 bar is non-spontaneous at low temperature but becomes spontaneous at high temperature. Identify the correct statement about the reaction among the following:
(1) Both ΔH and ΔS are positive.
(2) ΔH is negative while ΔS is positive.
(3) ΔH is positive while ΔS is negative.
(4) Both ΔH and ΔS are negative.

**32.** If 100 mole of $H_2O_2$ decompose at 1 bar and 300 K, the work done (kJ) by $O_2(g)$ as it expands against 1 bar pressure is:
$2H_2O_2(l) \rightleftharpoons 2H_2O(l) + O_2(g)$
($R = 8.3$ J $K^{-1}$ $mol^{-1}$)
(1) 498.00
(2) 62.25
(3) 124.50
(4) 249.00

**33.** The enthalpy change on freezing of 1 mol of water at 5ºC to ice at –5ºC is:
(Given $\Delta_{fus}H = 6$ kJ $mol^{-1}$ at 0ºC, $C_p(H_2O, l) = 75.3$ J $mol^{-1}$ $K^{-1}$, $C_p(H_2O,s) = 36.8$ J $mol^{-1}$ $K^{-1}$)
(1) 5.81 kJ $mol^{-1}$
(2) 5.44 kJ $mol^{-1}$
(3) 6.00 kJ $mol^{-1}$
(4) 6.56 kJ $mol^{-1}$

**34.** An ideal gas undergoes isothermal expansion at constant pressure. During the process, its:
(1) Enthalpy increases but entropy decreases.
(2) Enthalpy remains constant but entropy increases.
(3) Enthalpy decreases but entropy increases.
(4) Both enthalpy and entropy remain constant.

**35.** In thermodynamics, a process is called reversible when -

(1) Surroundings and system change into each other

(2) There is no boundary between system and surroundings

(3) The surroundings are always in equilibrium with the system

(4) The system changes into the surroundings spontaneously

**36.** **Statement-1:** For every chemical reaction at equilibrium, standard Gibbs energy of reaction is zero.

**Statement-2:** At constant temperature and pressure, chemical reactions are spontaneous in the direction of decreasing Gibbs energy

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

**37.** **Statement-1:** There is a natural asymmetry between converting work to heat and converting heat to work.

**Statement-2:** No process is possible in which the sole result is the absorption of heat form a reservoir and its complete conversion into work

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

**38.** Which of the following is not a state function

(1) $\Delta S$ (2) $\Delta G$

(3) $\Delta H$ (4) $\Delta Q$

**39.** The molar heat capacities at constant pressure (assumed constant with respect to temperature) at A,B and C are in ratio of 3 : 1.5 : 2.0 The enthalpy change for the exothermic reaction $A + 2B \longrightarrow 3C$ at 300 K and 310 K is $\Delta H_{300}$ and $\Delta H_{310}$ respectively then:

(1) $\Delta H_{300} > \Delta H_{310}$

(2) $\Delta H_{300} < \Delta H_{310}$

(3) $\Delta H_{300} = \Delta H_{310}$

(4) If $T_2 > T_1$ then $\Delta H_{310} > \Delta H_{300}$ and if $T_2 < T_1$ then $\Delta H_{310} < \Delta H_{300}$

**40.** When 1.0 g of oxalic acid ($H_2C_2O_4$) is burned in a bomb calorimeter whose heat capacity is 8.75 kJ/K, the temperature increases by 0.312 K. The enthalpy of combustion of oxalic acid at 27ºC is:

(1) –245.7 kJ/mol

(2) –244.452 kJ/mol

(3) –246.947 kJ/mol

(4) –241.958

**41.** Which statement regarding entropy is correct?

(1) A completely ordered deck of cards has more entropy than a shuffled deck in which cards are arranged randomly.

(2) A perfect ordered crystal of solid nitrous oxide has more entropy than a disordered crystal in which the molecules are oriented randomly.

(3) 1 mole $N_2$ gas at STP has more entropy than 1 mole $N_2$ gas at 273 K in a volume of 11.2 litre.

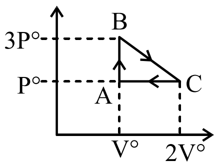
(4) 1 mole $N_2$ gas at STP has more entropy than 1 mole $N_2$ gas at 273 K and 0.25 atm.

**42.** The enthalpy change ($\Delta H$) for the reaction of 50 mL of ethylene with 50.0 mL of $H_2$ at 1.5 atm pressure is –0.31 KJ. What is the change in internal energy ($\Delta E$) in KJ?

(1) – 0.3024 (2) – 0.6048

(3) – 0.1.2 (4) –0.24

**43.** One mole of ideal monoatomic gas is carried through the reversible cyclic process as shown in figure. Calculate net heat absorbed by the gas in the path BC.




(1) $\frac{1}{2}P^\circ V^\circ$ (2) $\frac{7}{2}P^\circ V^\circ$

(3) $2P^\circ V^\circ$ (4) $\frac{5}{2}P^\circ V^\circ$

**44.** $\Delta H^\circ_f$ of water is $-285.8$ kJ mol$^{-1}$. if enthalpy of neutralization of monoacid strong base is $-57.3$ kJ mol$^{-1}$, $\Delta H_f^\circ$ of $OH^-$ ion will be

(1) $-228.5$ kJ mol$^{-1}$ (2) $228.5$ kJ mol$^{-1}$

(3) $114.5$ kJ mol$^{-1}$ (4) $-114.5$ kJ mol$^{-1}$

**45.** One gram sample of oxygen undergoes free expansion from 0.75 L to 3.0 L at 298 K. Find the correct option.

(1) $\Delta S = 0.36$ JK$^{-1}$ (2) $W = 227.97$ J

(3) $q = -227.97$ J (4) $\Delta H = 107.28$ J

**46.** The entropy change in the fusion of one mole of a solid melting at 27°C (latent heat of fusion is 2930 J mol$^{-1}$) is:

(1) 9.77 JK$^{-1}$ mol$^{-1}$ (2) 10.73 JK$^{-1}$ mol$^{-1}$

(3) 2930 JK$^{-1}$ mol$^{-1}$ (4) 108.5 JK$^{-1}$ mol$^{-1}$

**47.** Enthalpy of the reaction,

$CH_4 + \frac{1}{2}O_2 \longrightarrow CH_3OH$ is negative. If the magnitude of enthalpy of combustion of $CH_4$ and $CH_3OH$ are x and y respectively, then which relation is correct?

(1) $x > y$ (2) $x < y$

(3) $x = y$ (4) $x \geq y$

**48.** In a closed insulated container a liquid is stirred with a paddle to increase the temperature, which of the following is true?

(1) $\Delta E = W \neq 0, q = 0$

(2) $\Delta E = W = 0, q \neq 0$

(3) $\Delta E = 0, W = q \neq 0$

(4) $W = 0, \Delta E = q \neq 0$

**49.** The molar heat capacity 'C' of water at constant pressure is 75 JK$^{-1}$ mol$^{-1}$, when 1.0 kJ of heat is supplied to 100 g of water which is free to expand, the increase in temperature of water is:

(1) 4.8 K (2) 6.6 K

(3) 1.2 K (4) 2.4 K

**50.** For the reaction,

$$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O(\ell)$$

at constant temperature, $\Delta H - \Delta E$ is:

(1) $+3RT$ (2) $-RT$

(3) $+RT$ (4) $-3RT$

**51.** If the bond energies of H–H, Br–Br and H–Br are 433, 192 and 364 kJ mol$^{-1}$ respectively, then $\Delta H^\circ$ for the reaction $H_2(g) + Br_2(g) \longrightarrow 2HBr(g)$ is:

(1) $-261$ kJ (2) $+103$ kJ

(3) $+261$ kJ (4) $-103$ kJ

**52.** Considering entropy (S) as a thermodynamic parameter, the criterion for the spontaneity of any process is:

(1) $\Delta S_{system} + \Delta S_{surrounding} > 0$

(2) $\Delta S_{system} - \Delta S_{surrounding} > 0$

(3) $\Delta S_{system} > 0$ only

(4) $\Delta S_{surrounding} > 0$ only

**53.** A reaction occurs spontaneously if:

(1) $T\Delta S < \Delta H$ and both $\Delta H$ and $\Delta S$ are +ve

(2) $T\Delta S > \Delta H$ and both $\Delta H$ and $\Delta S$ are +ve

(3) $T\Delta S = \Delta H$ and both $\Delta H$ and $\Delta S$ are +ve

(4) $T\Delta S > \Delta H$ and $\Delta H$ is + ve and $\Delta S$ is –ve

**54.** The absolute enthalpy of neutralisation of the reaction,

$$MgO(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2O(\ell)$$

will be:

(1) Less than $-57.33$ kJ mol$^{-1}$

(2) $-57.33$ kJ mol$^{-1}$

(3) Greater than $-57.33$ kJ mol$^{-1}$

(4) $57.33$ kJ mol$^{-1}$

**55.** Assume each reaction is carried out in an open container. For which reaction will $\Delta H = \Delta E$?

(1) $H_2(g) + Br_2(g) \longrightarrow 2HBr(g)$

(2) $C(s) + 2H_2O(g) \longrightarrow 2H_2(g) + CO_2(g)$

(3) $PCl_5(g) \longrightarrow PCl_3(g) + Cl_2(g)$

(4) $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$

**56.** List-I and List-II contains four entries each. Entries of List-I are to be matched with some entries of List-II. Select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | Reversible cooling of an ideal gas at constant volume | P | $w = 0$ ; $q < 0$; $\Delta U < 0$ |
| II | Reversible isothermal expansion of an ideal gas | Q | $w < 0$ ; $q > 0$; $\Delta U > 0$ |
| III | Adiabatic expansion of non-ideal gas into vacuum | R | $w = 0$ ; $q = 0$; $\Delta U = 0$ |
| IV | Reversible melting of sulphur at normal melting point | S | $w < 0$; $q > 0$; $\Delta U = 0$ |

(1) I-P ; II-S ; III-R ; IV-Q

(2) I-P ; II-S ; III-S ; IV-Q

(3) I-S ; II-P ; III-R ; IV-Q

(4) I-P ; II-R ; III-R ; IV-Q

**57.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | Adiabatic process | P | $q = 0$ |
| II | Isothermal process | Q | $\Delta H = 0$ |
| III | Isoethalpic process | R | $\Delta T = 0$ |
| IV | Isoentropic process | S | $\Delta S = 0$ |

(1) I-R ; II-R ; III-Q ; IV-S

(2) I-P ; II-R ; III-Q ; IV-Q

(3) I-P ; II-R ; III-Q ; IV-S

(4) I-P ; II-R ; III-S ; IV-S

**58.** **Assertion:** The enthalpy of formation of $H_2O$ ($\ell$) is greater than of $H_2O$ (g) in magnitude.

**Reason:** Enthalpy change is negative for the condensation reaction

$H_2O\,(g) \longrightarrow H_2O\,(\ell)$

(1) Both assertion and reason are correct; and the reason is the correct explanation for the assertion.

(2) Both assertion and reason are correct; but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect, reason is correct.

(4) Both the assertion and reason are incorrect.

**59.** **Assertion:** Entropy change in reversible adiabatic expansion of an ideal gas is zero.

**Reason:** The increase in entropy due to volume increase just compensate the decrease in entropy due to fall in temperature.

(1) Both assertion and reason are correct; and the reason is the correct explanation for the assertion.

(2) Both assertion and reason are correct; but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect, reason is correct.

(4) Both the assertion and reason are incorrect.

**60.** **Assertion:** Increase of free energy during the process under constant temperature and pressure provides a measure of its spontaneity.

**Reason:** A spontaneous change must have + ve sign of $\Delta S_{system}$.

(1) Both assertion and reason are correct; and the reason is the correct explanation for the assertion.

(2) Both assertion and reason are correct; but the reason is not the correct explanation for the assertion.

(3) Assertion is incorrect, reason is correct.

(4) Both the assertion and reason are incorrect.

### *Integer Type Questions (61 to 75)*

**61.** A gas expands isothermally against a constant external pressure of 1 atm from a volume of 10-$dm^3$ to a volume of 20 $dm^3$. It absorbs 800 J of thermal energy from its surroundings. The magnitude of $\Delta U$ (in J) is:

[Given, 1 atm-litre = 101.3 Joules]

**62.** Two molecules of an ideal gas expand spotaneously into vacuum. The work done (in Joule) is:

**63.** AB, $A_2$ and $B_2$ are diatomic molecules. If the bond enthalpies of $A_2$, AB & $B_2$ are in the ratio 1 : 1 : 0.5 and enthalpy of formation of AB from $A_2$ and $B_2$ is – 100 kJ/mol. What is the bond enthalpy of $A_2$ (in KJ/mol).

**64.** Enthalpy of polymerization of ethylene, as represented by the reaction, $nCH_2{=}CH_2 \longrightarrow (-CH_2-CH_2-)_n$is –100 kJ per mole of ethylene. Given bond enthalpy of C=C bond is 600 kJ $mol^{-1}$, magnitude of enthalpy of C–C bond (in kJ $mol^{-1}$) will be:

**65.** Consider the reaction at 300 K

$H_2 (g) + Cl_2 (g) \longrightarrow 2HCl (g)$

$\Delta H^o = -185$ kJ

If 2 moles of $H_2$ completely react with 2 mole of $Cl_2$ to form HCl. What is the magnitude of $\Delta U^o$ (in KJ) for this reaction?

**66.** Assuming that water vapour is an ideal gas, the internal energy change ($\Delta U$) in KJ/mol when 1 mol of water is vapourised at 1 bar pressure and 100°C. (Nearest integer)

(Given: Molar enthalpy of vaporization of water at 1 bar and 373 K = 41 kJ $mol^{-1}$ and R = 8.3 J $mol^{-1}$ $K^{-1}$) will be:

**67.** The standard enthalpy of formation of $NH_3$ is – 46.0 kJ $mol^{-1}$. If the enthalpy of formation of $H_2$ from its atoms is – 436 kJ $mol^{-1}$ and that of $N_2$ is – 712 kJ $mol^{-1}$, the average bond enthalpy of N – H bond in $NH_3$ in KJ/mol is

**68.** One mole of a non-ideal gas undergoes a change of state (2.0 atm, 3.0 L, 95 K) → (4.0 atm, 5.0 L, 245 K) with a change in internal energy, $\Delta U$ = 30.0 L atm. The change in enthalpy ($\Delta H$) of the process in L atm is -

**69.** 2 moles of ideal gas is expanded isothermally & reversibly from 1 litre to 10 litre. Find the enthalpy change in kJ $mol^{-1}$.

**70.** Given that bond energies of H–H and Cl–Cl are 430 KJ $mol^{-1}$ and 240 KJ $mol^{-1}$ respectively and $\Delta H_f$ for HCl is

– 90 KJ $mol^{-1}$. Bond enthalpy of HCl (in KJ $mol^{-1}$) is

**71.** Enthalpy of neutralization of $CH_3COOH$ by NaOH is–50.6 kJ/mol and the heat of neutralization of a strong acid with NaOH is – 55.9 kJ/mol. The value of $\Delta H$ for the ionization of $CH_3COOH$ is x kJ/mol. Find the value of 10x.

**72.** The heats of combustion of carbon and carbon monoxide are –393.5 and –283.5 kJ $mol^{-1}$, respectively. The magnitude of heat of formation (in kJ) of carbon monoxide per mole is:

**73.** For the reaction, A(g)+B(g) → C(g) + D(g), $\Delta H^o$ and $\Delta S^o$ are, respectively, –29.8 kJ $mol^{-1}$ and –0.100 kJ $K^{-1}$ $mol^{-1}$ at 298 K. The equilibrium constant for the reaction at 298 K is:

**74.** For the reaction:

$X_2O_4(l) \rightarrow 2XO_2(g)$

$\Delta U$ = 2.1 k cal, $\Delta s$ = 20 cal $K^{-1}$ at 300 K

Hence, the magnitude of $\Delta G$ (in calories) is:

**75.** The enthalpy of combustion of $H_2$, cyclohexene ($C_6H_{10}$) and cyclohexane ($C_6H_{12}$) are – 241, – 3800 and – 3920 kJ per mol respectively. The magnitude of heat of hydrogenation of cyclohexene (in KJ/mol) is:

CHAPTER

06

# CHEMICAL EQUILIBRIUM

## *Single Option Correct Type Questions (01 to 60)*

**1.** $\log\frac{K_p}{K_c} + \log RT = 0$ is a relationship for the reaction:

(1) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

(2) $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

(3) $H_2(g) + I_2(g) \rightleftharpoons 2HI\ (g)$

(4) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

**2.** In a chemical equilibrium, the rate constant for the backward reaction is $7.5 \times 10^{-4}$ and the equilibrium constant is 1.5 the rate constant for the forward reaction is:

(1) $2 \times 10^{-3}$

(2) $5 \times 10^{-4}$

(3) $1.12 \times 10^{-3}$

(4) $9.0 \times 10^{-4}$

**3.** At 1000 K, the value of $K_p$ for the reaction, $A(g) + 2B(g) \rightleftharpoons 3C(g) + D(g)$ is 0.05 atmosphere. The value of $K_C$ in terms of R would be:

(1) 20000 R

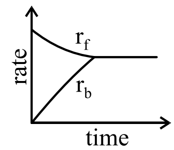
(2) 0.02 R

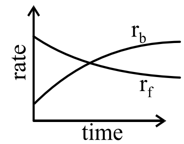
(3) $5 \times 10^{-5}$ R

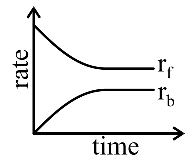
(4) $5 \times 10^{-5} \times R^{-1}$

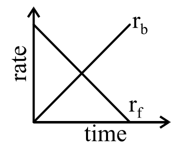
**4.** Rate of reaction curve for equilibrium can be like:

[$r_f$ = forward rate, $r_b$ = backward rate]

(1) 


(2) 


(3) 


(4) 


**5.** The equilibrium constant of the reaction $SO_2(g) + \frac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$ is $4 \times 10^{-3}\ atm^{-1/2}$. The equilibrium constant of the reaction $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ would be:

(1) 250 atm (2) $4 \times 10^3$ atm

(3) $0.25 \times 10^4$ atm (4) $6.25 \times 10^4$ atm

**6.** When alcohol ($C_2H_5OH$) and acetic acid are mixed together in equimolar ratio at 27ºC, 33% is converted into ester. Then the $K_C$ for the equilibrium

$C_2H_5OH(\ell) + CH_3COOH\ (\ell) \rightleftharpoons CH_3COOC_2H_5\ (\ell) + H_2O(\ell)$.

(1) 4 (2) 1/4

(3) 9 (4) 1/9

**7.** 1.50 moles each of hydrogen and iodine were placed in a sealed 10 litre container maintained at 717 K. At equilibrium, 1.25 moles each of hydrogen and iodine were left behind. The equilibrium constant, $K_c$ for the reaction. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ at 717 K is

(1) 0.4 (2) 0.16
(3) 25 (4) 50

**8.** A reaction mixture containing $H_2$, $N_2$ and $NH_3$ has partial pressure 2 atm, 1 atm and 3 atm respectively at 725 K. If the value of $K_P$ for the reaction, $N_2 + 3H_2 \rightleftharpoons 2NH_3$ is $4.28 \times 10^{-5}$ $atm^{-2}$ at 725 K, in which direction the net reaction will go:

(1) Forward
(2) Backward
(3) No net reaction
(4) Direction of reaction cannot be predicted

**9.** For the reaction,

$2A + B \rightleftharpoons 3C$ at 298 K, $K_C = 49$

A 3L vessel contains 2, 1 and 3 moles of A, B and C respectively. The reaction at the same temperature

(1) Must proceed in forward direction
(2) Must proceed in backward direction
(3) Must be equilibrium
(4) Cannot be predicted

**10.** In a container equilibrium $N_2O_4\,(g) \rightleftharpoons 2NO_2\,(g)$ is attained at 25°C. The total equilibrium pressure in container is 380 torr. If equilibrium constant of above equilibrium is 0.667 atm, then degree of dissociation of $N_2O_4$ at this temperature will be

(1) $\frac{1}{3}$ (2) $\frac{1}{2}$
(3) $\frac{2}{3}$ (4) $\frac{1}{4}$

**11.** Consider the reactions

(i) $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$
(ii) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

The addition of an inert gas at constant volume

(1) Will increase the dissociation of $PCl_5$ as well as $N_2O_4$
(2) Will reduce the dissociation of $PCl_5$ as well as $N_2O_4$
(3) Will increase the dissociation of $PCl_5$ and step up the formation of $NO_2$
(4) Will not disturb the equilibrium of the reactions

**12.** Match the following:

| | List- I (Assume only reactant were present initially) | | List- II |
|---|---|---|---|
| I | For the equilibrium $NH_4I(s) \rightleftharpoons NH_3(g) + HI(g)$, if pressure is increased at equilibrium | P | Forward shift |
| II | For the equilibrium $H_2O(g) + CO(g) \rightleftharpoons H_2(g) + CO_2\,(g)$ inert gas is added at constant pressure at equilibrium | Q | No shift in equilibrium |
| III | For the equilibrium $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ $Cl_2$ is removed at equilibrium. | R | Backward shift |

(1) I-R ; II-Q ; III-P
(2) I-Q ; II-R ; III-P
(3) I-P ; II-Q ; III-R
(4) I-P ; II-R ; III-Q

**13.** The dissociation of $CO_2$ can be expressed as $2CO_2 \rightleftharpoons 2CO + O_2$. If the 2 moles of $CO_2$ is taken initially and 40% of the $CO_2$ is dissociated equilibrium then total number of moles at equilibrium:

(1) 2.4 (2) 2.0
(3) 1.2 (4) 5

**14.** In the reaction $2P(g) + Q(g) \rightleftharpoons 3R(g) + S(g)$. If 2 moles each of P and Q taken initially in a 1 litre flask. At equilibrium which is true:

(1) $[P] < [Q]$ (2) $[P] = [Q]$
(3) $[Q] = [R]$ (4) None of these

**15.** For the reaction: $N_2 (g) + 3H_2(g) \rightleftharpoons 2NH_3 (g)$;

equilibrium constant $K_c = \dfrac{[NH_3]^2}{[N_2]\,[H_2]^3}$

Some reactions are written bellow in List I and their equilibrium constants in terms of $K_c$ are written in List II. Match the following reactions with the corresponding equilibrium constant

| List- I (Reaction) | | List- II (Equilibrium Constant) | |
|---|---|---|---|
| I | $2N_2 (g) + 6H_2 (g) \rightleftharpoons 4NH_3 (g)$ | P | $K_c^{\frac{1}{2}}$ |
| II | $2NH_3 (g) \rightleftharpoons N_2(g) + 3H_2(g)$ | Q | $\dfrac{1}{K_c}$ |
| III | $\dfrac{1}{2} N_2(g) + \dfrac{3}{2} H_2(g) \rightleftharpoons NH_3 (g)$ | R | $K_c^2$ |

(1) I-P ; II-R ; III-Q
(2) I-Q ; II-R ; III-P
(3) I-P ; II-Q ; III-R
(4) I-R ; II-Q ; III-P

**16.** $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

In above reaction, at equilibrium condition mole fraction of $PCl_5$ is 0.4 and mole fraction of $Cl_2$ is 0.3. Then find out mole fraction of $PCl_3$

(1) 0.3 (2) 0.7
(3) 0.4 (4) 0.6

**17.** 5 moles of $SO_2$ and 5 moles of $O_2$ are allowed to react to form $SO_3$ in a closed vessel. At the equilibrium stage, 60% $SO_2$ is used up. The total number of moles of $SO_2$, $O_2$ and $SO_3$ in the vessel now is:

(1) 3.9 (2) 10.5
(3) 8.5 (4) 10.0

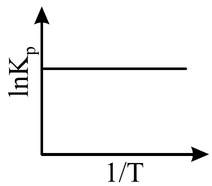
**18.** A mixture of $NO_2$ and $N_2O_4$ has a vapour density of 38.3 at 300 K. What is the number of moles of $NO_2$ in 100 g of the mixture?

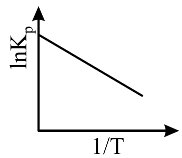
(1) 0.043 (2) 4.4
(3) 3.4 (4) 0.437

**19.** In an equilibrium reaction for which $\Delta G° = 0$, the value of equilibrium constant K =

(1) 0 (2) 1
(3) 2 (4) 10

**20.** An exothermic reaction is represented by the graph:

(1)



(2)
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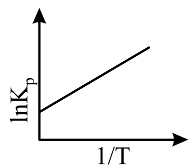



(4) None of these

**21.** A reaction in equilibrium is represented by the following equation–

$2A_{(s)} + 3B_{(g)} \rightleftharpoons 3C_{(g)} + D(g) + O_2(g)$ if the pressure on the system is reduced to half of its original value

(1) The amounts of C and D decreases
(2) The amounts of C and D increases
(3) The amount of B and D decreases
(4) All the amounts remain constant

**22.** In which of the following equilibrium reactions, the equilibrium would shift to right side, if total pressure is decreased:

(1) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

(2) $H_2 + I_2 \rightleftharpoons 2HI$

(3) $N_2O_4 \rightleftharpoons 2NO_2$

(4) $H_2 + Cl_2 \rightleftharpoons 2HCl$

**23.** For an equilibrium $H_2O(s) \rightleftharpoons H_2O(\ell)$ which of the following statements is true.

(1) The pressure changes do not affect the equilibrium

(2) More of ice melts if pressure on the system is increased

(3) More of liquid freezes if pressure on the system is increased

(4) The degree of advancement of the reaction does not depend on pressure.

**24.** In the Haber process for the industrial manufacture of ammonia involving the reaction,

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 200 atm pressure in the presence of a catalyst, a temperature of about 500ºC is used. This is considered as optimum temperature for the process because

(1) Yield is maximum at this temperature

(2) Catalyst is active only at this temperature

(3) Energy needed for the reaction is easily obtained at this temperature

(4) Rate of the catalytic reaction is fast enough while the yield is also appreciable for this exothermic reaction at this temperature.

**25.** $aA + bB \rightleftharpoons cC + dD$

In the above reaction at low pressure and high temperature, conditions are such that reaction is shifted in backward direction. So, correct set:

(1) $(a + b) > (c + d), \Delta H > 0$

(2) $(a + b) < (c + d), \Delta H > 0$

(3) $(a + b) < (c + d), \Delta H < 0$

(4) $(a + b) > (c + d), \Delta H < 0$

**26.** Consider the two gaseous equilibrium involving $SO_2$ and the corresponding equilibrium constant at 299 K

$SO_2(g) + 1/2O_2(g) \rightleftharpoons SO_3(g)$ ; $K_1$

$4SO_3(g) \rightleftharpoons 4SO_2(g) + 2O_2(g)$ ; $K_2$

The value of the equilibrium constant are related by:

(1) $K_2 = \dfrac{1}{(K_1)^4}$ (2) $K_2 = K_1^4$

(3) $K_2 = \left(\dfrac{1}{K_1}\right)^{1/4}$ (4) $K_2 = \dfrac{1}{K_1}$

**27.** Equilibrium constant for the reaction,

$2NO + O_2 \rightleftharpoons 2NO_2$ is $K_{C_1}$;

$NO_2 + SO_2 \rightleftharpoons SO_3 + NO$ is $K_{C_2}$ and

$2SO_3 \rightleftharpoons 2SO_2 + O_2$ is $K_{C_3}$ then correct reaction is:

(1) $K_{C_3} = K_{C_1} \times K_{C_2}$

(2) $K_{C_3} \times K_{C_1} \times K^2_{C_2} = 1$

(3) $K_{C_3} \times K_{C_1} \times K_{C_2} = 1$

(4) $K_{C_3} \times K^2_{C_1} \times K_{C_2} = 1$

**28.** 56 g of nitrogen and 8 g of hydrogen gas are heated in a closed vessel. At equilibrium, 34 g of ammonia are present. The equilibrium number of moles of nitrogen, hydrogen and ammonia are respectively.

(1) 1,2,2 (2) 2,2,1

(3) 1,1,2 (4) 2,1,2

**29.** For the reaction (1) and (2) :

$A \rightleftharpoons B + C$ ....(1)

$D \rightleftharpoons 2E$ ....(2),

Given, $K_{P_1} : K_{P_2} :: 9 : 1$

If the degree dissociation of A and D be same then the total pressure at equilibria (1) and (2) are in the ratio (Assume reaction are started with equal number of moles of A and D).

(1) 3 : 1 (2) 36 : 1

(3) 1 : 1 (4) 0.5 : 1

**30.** The degree of dissociation of $SO_3$ is $\alpha$ at equilibrium pressure $P_0$.
$K_p$ for $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$ is
(1) $[(P_0\alpha^3)/2(1-\alpha)^3]$
(2) $[(P_0\alpha^3)/(2+\alpha)(1-\alpha)^2]$
(3) $[(P_0\alpha^2)/2(1-\alpha)^2]$
(4) $(P_0\alpha^3)/(2+\alpha)^2$

**31.** 2 moles of $PCl_5$ when heated in a closed vessel of 2 litre capacity. At equilibrium, 40% of $PCl_5$ dissociated in $PCl_3$ and $Cl_2$.
The value of the equilibrium constant is:
(1) 2.67 (2) 5.3
(3) 5.33 (4) 0.267

**32.** 1 mole of $N_2$ and 2 moles of $H_2$ are allowed to react in a 1 $dm^3$ vessel. At equilibrium, 0.8 mole of $NH_3$ is formed. The amount of $H_2$ in the vessel at equilibrium is:
(1) 0.6 mole (2) 0.8 mole
(3) 0.2 mole (4) 0.4 mole

**33.** In the given reaction $2X(g) + Y(g) \rightleftharpoons 2Z(g) +$ 80 kcal, which combination of pressure and temperature will give the highest yield of Z at equilibrium?
(1) 1000 atm and 100°C
(2) 500 atm and 500°C
(3) 1000 atm and 200°C
(4) 500 atm and 100°C

**34.** Which reaction will proceed in forward direction on increasing pressure?
(1) $C(s) + O_2(g) \rightleftharpoons CO_2(g)$
(2) $SO_2(g) + 0.5\ O_2(g) \rightleftharpoons SO_3(g)$
(3) $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$
(4) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

**35.** In a given system, water and ice are in equilibrium. If pressure is applied to the above system then:
(1) More of ice is formed
(2) Amount of ice and water will remain same
(3) More of ice is melted
(4) Either (1) or (3)

**36.** The equilibrium, $SO_2Cl_2(g) \rightleftharpoons SO_2(g) + Cl_2(g)$ is attained at 25°C in a closed rigid container and an inert gas, helium, is introduced. Which of the following statement(s) is/are correct.
(1) Concentrations of $SO_2$, $Cl_2$ and $SO_2Cl_2$ are changed
(2) No effect on equilibrium
(3) Concentration of $SO_2$ is reduced
(4) $K_p$ of reaction is increasing

**37.** The following reaction is favourable at:
$H_2O(s) \rightleftharpoons H_2O(\ell)$ $\Delta H = +ve$ ; T = 0ºC
(1) Low pressure & low temperature
(2) High pressure & high temperature
(3) Low pressure & high temperature
(4) High pressure & low temperature

**38.** In which of the following reactions, increase in the volume at constant temperature doesn't effect the number of moles at equilibrium:
(1) $2NH_3 \rightleftharpoons N_2 + 3H_2$
(2) $C(g) + (1/2)\ O_2(g) \rightleftharpoons CO\ (g)$
(3) $H_2\ (g) + O_2\ (g) \rightleftharpoons H_2O_2\ (g)$
(4) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

**39.** For the reaction $CO\ (g) + (1/2)\ O_2\ (g) \rightleftharpoons CO_2$ (g), $K_c/K_p$ is:
(1) RT
(2) $(RT)^{-1}$
(3) $(RT)^{-1/2}$
(4) $(RT)^{1/2}$

**40.** For the reaction equilibrium, $N_2O_4\ (g) \rightleftharpoons 2NO_2$ (g) the concentrations of $N_2O_4$ and $NO_2$ at equilibrium are $4.8 \times 10^{-2}$ and $1.2 \times 10^{-2}$ mol $L^{-1}$ respectively. The value of $K_c$ for the reaction is
(1) $3.3 \times 10^2$ mol $L^{-1}$
(2) $3 \times 10^{-1}$ mol $L^{-1}$
(3) $3 \times 10^{-3}$ mol $L^{-1}$
(4) $3 \times 10^3$ mol $L^{-1}$

**41.** For the reaction, $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$, ($K_C = 1.8 \times 10^{-6}$ at 184°C)
(R = 0.0831 kJ/(mol.K))
When $K_p$ and $K_c$ are compared at 184°C it is found that :
(1) Whether $K_p$ is greater than, less than or equal to $K_c$ depends upon the total gas pressure
(2) $K_p = K_c$
(3) $K_p$ is less than $K_c$
(4) $K_p$ is greater than $K_c$

**42.** An amount of solid $NH_4HS$ is placed in a flask already containing ammonia gas at a certain temperature at 0.50 atm pressure. Ammonium hydrogen sulphide decomposes to yield $NH_3$ and $H_2S$ gases in the flask. When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm? The equilibrium constant for $NH_4HS$ decomposition at this temperature is :
(1) 0.11 (2) 0.17
(3) 0.18 (4) 0.30

**43.** The equilibrium constant for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ at 1000 K is 3.5 $atm^{-1}$. What would be the partial pressure of oxygen gas, if the equilibrium is found to have equal moles of $SO_2$ and $SO_3$ ?
(1) 0.285 atm (2) 3.5 atm
(3) 0.35 atm (4) 1.84 atm

**44.** **Assertion:** For the reaction, $N_2 + O_2 \rightleftharpoons 2NO$, increase in pressure at equilibrium has no effect on the reaction.
**Reason:** $\sum$ moles of gaseous product – $\sum$ moles of gaseous reactant = 0.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**45.** The standard Gibbs energy change at 300 K for the reaction $2A \rightleftharpoons B + C$ is 2494.2 J. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}$, [B] = 2 and $[C] = \frac{1}{2}$. The reaction proceeds in the:
[R = 8.314 J/K/mol, e = 2.718]
(1) Forward direction because $Q > K_C$
(2) Reverse direction because $Q > K_C$
(3) Forward direction because $Q < K_C$
(4) Reverse direction because $Q < K_C$

**46.** The equilibrium constant at 298 K for a reaction $A + B \rightleftharpoons C + D$ is 100. If the initial concentration of all the four species were 1 M each, then equilibrium concentration of D (in mol $L^{-1}$) will be:
(1) 0.818 (2) 1.818
(3) 1.182 (4) 0.182

**47.** The increase of pressure on ice $\rightleftharpoons$ water system at constant temperature will lead to:
(1) A decrease in the entropy of the system
(2) An increase in the Gibbs energy of the system
(3) No effect on the equilibrium
(4) A shift of the equilibrium in the forward direction

**48.** The following reaction occurs in the Blast Furnace where iron ore is reduced to iron metal:
$Fe_2O_3(s) + 3CO(g) \rightleftharpoons 2Fe(\ell) + 3CO_2(g)$
Using the Le Chatelier's principle, predict which one of the following will **not** disturb the equilibrium?
(1) Addition of $Fe_2O_3$
(2) Removal of $CO_2$
(3) Removal of CO
(4) Addition of $CO_2$

**49.** For the reversible reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3$ at 500°C, the value of $K_P$ is $1.44 \times 10^{-5}$ when partial pressure is measured in atmospheres. The corresponding value of $K_C$, with concentration in mole litre$^{-1}$, is

(1) $\frac{1.44\times10^{-5}}{(0.082\times500)^{-2}}$

(2) $\frac{1.44\times10^{-5}}{(8.314\times773)^{-2}}$

(3) $\frac{1.44\times10^{-5}}{(0.082\times773)^{2}}$

(4) $\frac{1.44\times10^{-5}}{(0.082\times773)^{-2}}$

**50.** 2 mole of $N_2$ and 4 moles of $H_2$ are allowed to react in a 1 dm$^3$ vessel. At equilibrium, 1.6 mole of $NH_3$ is formed. The amount of $H_2$ in the vessel at equilibrium is:

(1) 1.2 mole (2) 1.6 mole
(3) 0.4 mole (4) 0.8 mole

**51.** **Assertion:** The reaction quotient, Q has the same form as the equilibrium constant $K_{eq}$, and is evaluated using any given concentrations of the species involved in the reaction, and not necessarily equilibrium concentrations.

**Reason:** If the numerical value of Q is not the same as the value of equilibrium constant, a reaction will occur in ether direction.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**52.** In a 20 litre vessel initially we have 1 mole CO, $H_2O$ & $CO_2$ is present. Then for the equilibrium of $CO + H_2O \rightleftharpoons CO_2 + H_2$ following is true:

(1) $H_2$, more than 1 mole
(2) CO, $H_2O$, $H_2$ less than 1 mole
(3) $CO_2$ & $H_2O$ both more than 1 mole
(4) All of these

**53.** In the following reaction started only with $A_8$, $2A_8(g) \rightleftharpoons 2A_3(g) + 3A_2(g) + A_4(g)$ mole fraction of $A_2$ is found to 0.36 at a total pressure of 100 atm at equilibrium. The mole fraction of $A_8(g)$ at equilibrium is :

(1) 0.28 (2) 0.72
(3) 0.18 (4) None of these

**54.** Two solid compounds X and Y dissociates at a certain temperature as follows $X(s) \rightleftharpoons A(g) + 2B(g)$ ; $K_{p1} = 9 \times 10^{-3}$ atm$^3$ $Y(s) \rightleftharpoons 2B(g) + C(g)$ ; $K_{p2} = 4.5 \times 10^{-3}$ atm$^3$

The total pressure of gases over a mixture of X and Y is:

(1) 4.5 atm
(2) 0.45 atm
(3) 0.6 atm
(4) None of these

**55.** **Assertion:** A catalyst does not influence the values of equilibrium constant.

**Reason:** Catalysts influence the rate of both forward and backward reactions equally.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**56.** Find out $\ln K_{eq}$ for the formation of $NO_2$ from NO and $O_2$ at 298 K:

$NO_{(g)} + \frac{1}{2}O_2 \rightleftharpoons NO_2\ g$

Given, $\Delta G_f^o$ $(NO_2) = 52.0$ KJ/mole

$\Delta G_f^o$ (NO) = 87.0 KJ/mole

$\Delta G_f^o$ $(O_2) = 0$ KJ/mole

(1) $\frac{35\times10^3}{8.314\times298}$

(2) $-\frac{35\times10^3}{8.314\times298}$

(3) $\frac{35\times10^3}{2.303\times8.314\times298}$

(4) $\frac{35\times10^3}{2\times298}$

**57.** The value of $K_p$ for the reaction, $2H_2O(g) + 2Cl_2(g) \rightleftharpoons 4HCl(g) + O_2(g)$ is 0.03 atm at 427° C, when the partial pressure is expressed in atmosphere then the value of $K_C$ for the same reaction is

(1) $5.23 \times 10^{-4}$ (2) $7.34 \times 10^{-4}$
(3) $3.2 \times 10^{-3}$ (4) $5.43 \times 10^{-5}$

**58.** $N_2$ and $H_2$ are taken in 1 : 3 molar ratio in a closed vessel to attain the following equilibrium
$(N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g))$ . Find $K_p$ for reaction at total pressure of 2P if $P_{N_2}$ at equilibrium is $\frac{P}{3}$.

(1) $\frac{1}{3\ P^2}$ (2) $\frac{4}{3\ P^2}$

(3) $\frac{4\ P^2}{3}$ (4) None

**59.** An equilibrium, a mixture in a vessel of capacity 100 litre contains 1 mol $N_2$, 2 mol $O_2$ and 3 mol NO. Number of moles of $O_2$ to be added so that at new equilibrium the concentration of NO is found to be 0.04 mol/lit.:

(1) (101/18)
(2) (101/9)
(3) (202/9)
(4) None of these

**60.** Densities of diamond and graphite are 3.5 and 2.3 g/ml respectively. Increase of pressure on the equilibrium C (diamond) $\rightleftharpoons$ C (graphite)

(1) Favours backward reaction
(2) Favours forward reaction
(3) Has no effect
(4) Increase the reaction rate

## *Integer Type Questions (61 to 75)*

**61.** The equilibrium constant ($K_p$) for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 16. If the volume of the container is reduced to one half its original volume, the value of $K_p$ for the reaction at the same temperature will be :

**62.** The value of $\Delta G^o$ for the phosphorylation of glucose in glycolysis is 15 kJ/mole. The value of $K_c$ at 300 K is $e^{-x}$ then the value of x is (nearest integer)

**63.** 4.5 moles each of hydrogen and iodine heated in a sealed ten litre vessel. At equilibrium 3 moles of HI were formed. The equilibrium constant for $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is:

**64.** In the reaction $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$, the equilibrium pressure is 12 atm. If 50% of $CO_2$ reacts then $K_p$ will be:

**65.** For the reaction
$A_2(g) + 3B_2 \rightleftharpoons 2C_2(g)$

the partial pressure of $A_2$, $B_2$ at equilibrium are 0.80 atm and 0.40 atm respectively. The pressure of the system is 2.80 atm. The equilibrium constant $K_p$ will be?

**66.** For the reaction $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, the degree of dissociation varies inversely as the square root of pressure of the system. Supposing at constant temperature. If the volume is increased 16 times the initial volume, the degree of dissociation for this reaction will become how many times?

**67.** The equilibrium constant for the reaction, $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ at temperature T is $4 \times 10^{-4}$. The value of $K_c$ for the reaction, $NO(g) \rightleftharpoons \frac{1}{2} N_2(g) + \frac{1}{2} O_2(g)$ at the same temperature is:

**68.** The equilibrium constant for the reaction, $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2} O_2(g)$ is $K_C = 5 \times 10^{-2}$. The value of $K_C$ for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ will be?

**69.** The equilibrium constant ($K_c$) for the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ at temperature T is $4 \times 10^{-4}$. The value of $K_c$ for the reaction $PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$ at the same temperature is:

**70.** A solid XY kept in an evacuated sealed container undergoes decomposition to form a mixture of gases X and Y at temperature T. The equilibrium pressure is 10 bar in this vessel. $K_P$ for this reaction is:

**71.** The value of $\log_{10}K$ for a reaction $A \rightleftharpoons B$ is:

(Given: $\Delta_r H^\circ_{298K} = -54.07$ kJ $mol^{-1}$, $\Delta_r S^\circ_{298K} = 10$ $JK^{-1}$ $mol^{-1}$ and R = 8.314 $JK^{-1}$ $mol^{-1}$; $2.303 \times 8.314 \times 298 = 5705$)

**72.** 4 moles of A are mixed with 4 moles of B, when 2 moles of C are formed at equilibrium, according to the reaction, $A + B \rightleftharpoons C + D$. The equilibrium constant is:

**73.** In a 0.25 litre tube dissociation of 4 moles of NO is take place. If its degree of dissociation is 10%. The value of $K_p$ for reaction $2NO \rightleftharpoons N_2 + O_2$ is $x^{-2}$. The value of x is

**74.** A vessel at 1000 K contains $CO_2$ with a pressure of 0.5 atm. Some of the $CO_2$ is converted into CO on the addition of graphite. If the total pressure at equilibrium is 0.8 atm, the value of K is $\frac{x}{20}$, then value of x is

**75.** If the value of $K_C$ for the reaction $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ is y

If the amount are $SO_3$ = 48g, $SO_2$ = 12.8 g and $O_2$ = 9.6 g at equilibrium and the volume of the container is one litre. Then the value of y is

CHAPTER

07

# IONIC EQUILIBRIUM

## *Single Option Correct Type Questions (01 to 60)*

**1.** 100 mL of 0.1 M NaOH solution is titrated with 100 mL of 0.05 M $H_2SO_4$ solution. The pH of the resulting solution is: (For $H_2SO_4$, $K_{a_1} = \infty$, $K_{a_2} = 10^{-2}$)

(1) 7 (2) 7.2
(3) 7.4 (4) 6.8

**2.** When salt $NH_4Cl$ is hydrolysed at 25°C, the pH will be

(1) 7 (2) < 7
(3) > 7 (4) 0

**3.** A weak acid (HA) is titrated with N/100 NaOH. What will be the pH of solution when 50% of titration is completed?
(Given $K_a = 10^{-4}$ & concentration of HA = 0.1 M)

(1) 4 (2) 8
(3) 6.9 (4) 10

**4.** How many moles of NaOH must be removed from 1 litre of are aqueous solution to change its pH from 12 to 11?

(1) 0.009 (2) 0.01
(3) 0.02 (4) 0.1

**5.** Four acids HA, HB, HC and HD form salts with NaOH of pH 7, 8, 9 and 10 respectively. If each solution was 0.1 M, then the strongest acid is:

(1) HA (2) HB
(3) HC (4) HD

**6.** pH of $3\times10^{-3}$ M solution of $H_3X$ will be (assume $\alpha_1 = 1$, $\alpha_2 = 1/3$, $\alpha_3$ = negligible)

(1) 2.40 (2) 3.0
(3) 3.4771 (4) 4.0

**7.** The amount of $(NH_4)_2SO_4$ to be added to 500 mL of 0.01 M $NH_4OH$ solution ($pK_a$ for $NH_4^+$ is 9.26) so as to prepare a buffer of pH 8.26 is:
(Given : $\log_{10}5 = 0.7$, $10^{-1.3} = 0.050$)

(1) 0.05 mol (2) 0.025 mol
(3) 0.10 mol (4) 0.005 mol

**8.** What will be the pH and % α (degree of hydrolysis) respectively for a salt BA of 0.1 M concentration? (Given: $K_a$ for HA = $10^{-6}$ and $K_b$ for BOH = $10^{-6}$)

(1) 5, 1 % (2) 7, 10 %
(3) 9, 0.01% (4) 7, 0.01%

**9.** The solubility product constant ($K_{sp}$) of different sparingly soluble salts is given below:
The correct increasing order of solubility is:

| | Formula Type | Solubility Product ($K_{sp}$) |
|---|---|---|
| (i) | AB | $4.0 \times 10^{-20}$ |
| (ii) | $A_2B$ | $3.2 \times 10^{-11}$ |
| (iii) | $AB_3$ | $2.7 \times 10^{-31}$ |

(1) (i) < (iii) < (ii) (2) (ii) < (i) < (iii)
(3) (i) < (ii) < (iii) (4) (iii) < (i) < (ii)

**10.** What is ΔpH (initial pH – final pH) when 100 ml 0.01 M HCl is added to a solution containing 0.1 m moles of $NaHCO_3$ solution of negligible volume
($K_{a_1} = 10^{-7}$, $K_{a_2} = 10^{-11}$ for $H_2CO_3$)?

(1) 6 + 2 log3 (2) 3 – 2 log3
(3) 3 + 2 log2 (4) 6 – 2 log3

**11.** Match the $pK_a$ values given in list-II correctly for the conjugate acids given in list-I.

| | List- I | | List- II ($pK_a$) |
|---|---|---|---|
| I | $NH_4^+$ | P | 5.82 |
| II | $N_2H_5^+$ | Q | 9.26 |
| III | $NH_3OH^+$ | R | 7.93 |

(1) I-P ; II-R ; III-Q
(2) I-Q ; II-R ; III-P
(3) I-R ; II-Q ; III-P
(4) I-Q ; II-P ; III-R

**12.** In the equilibrium
$CH_3COOH + HF \rightleftharpoons CH_3COOH_2^+ + F^-$
(1) $F^-$ is the conjugate acid of $CH_3COOH$.
(2) $F^-$ is the conjugate base of HF.
(3) $CH_3COOH$ is the conjugate acid of $CH_3COOH_2^+$.
(4) $CH_3COOH_2^+$ is the conjugate base of $CH_3COOH$.

**13.** Which one of the following is the strongest electrolyte?
(1) NaCl (2) $CH_3COOH$
(3) $NH_4OH$ (4) $C_6H_{12}O_6$

**14.** Which of the following ions can act both as bronsted acid as well as bronsted base?
(1) $Cl^-$ (2) $HCO_3^-$
(3) $H_3O^+$ (4) $O^{2-}$

**15.** pH of NaCl solution is 7 at 298 K. If the solution is heated to 320 K, then which one of the following statement is true?
(1) pH will decrease
(2) pOH will increase
(3) pH will increase
(4) pH will decrease and pOH will increase

**16.** A 1.0 M monoprotic acid solution is 0.01% ionised. The dissociation constant of this acid will be:
(1) $1\times10^{-8}$ (2) $1\times10^{-4}$
(3) $1\times10^{-6}$ (4) $1\times10^{-5}$

**17.** The degree of dissociation of a weak electrolyte increases
(1) On increasing dilution
(2) On increasing pressure
(3) On decreasing dilution
(4) None of these

**18.** The pH a of HCl solution is 1. To 10 mL of this acid solution 40 mL of NaOH solution whose pH = 12 is added. The pH of resulting solution is: (log (1.2) = 0.07)
(1) 2.93 (2) 1.93
(3) 3.93 (4) 0.93

**19.** The pH value of $1.0 \times 10^{-8}$ M HCl solution is less than 8 because
(1) HCl is completely ionised at this concentration.
(2) The ionization of water is negligible
(3) The ionization of water cannot be assumed negligible in comparison with this low concentration of HCl .
(4) The pH cannot be calculated at such a low concentration of HCl.

**20.** What will be $[HS^-]$ in a 0.1 M $H_2S$ solution when 0.05 M $H_2SO_4$ is added to it ? ( $K_{a_1}$ & $K_{a_2}$ are dissociation constants of $H_2S$)
(1) $K_{a_1}$ (2) $K_{a_2}$
(3) $K_{a_1} \times K_{a_2}$ (4) $\frac{K_{a_1}}{K_{a_2}}$

**21.** Which one of the following salts undergo anionic hydrolysis?
(1) $Na_3PO_4$ (2) NaCl
(3) $NH_4Cl$ (4) $FeSO_4$

**22.** What is the pH of an aqueous solution of ammonium acetate?
($K_a = K_b = 1.8 \times 10^{-5}$)
(1) > 7.0
(2) 7.0
(3) < 7.0
(4) Zero

**23.** Percentage degree of hydrolysis of 0.1 M $CH_3COONH_4$, when $K_a = K_b = 1.8 \times 10^{-5}$ is:

(1) 0.55
(2) 7.63
(3) $0.55 \times 10^{-2}$
(4) $7.63 \times 10^{-3}$

**24.** The pH of 0.1 M solution of the following salts increases in the order:

(1) $NaCl < NH_4Cl < NaCN < HCl$
(2) $HCl < NH_4Cl < NaCl < NaCN$
(3) $NaCN < NH_4Cl < NaCl < HCl$
(4) $HCl < NaCl < NaCN < NH_4Cl$

**25.** Addition of sodium acetate solution to acetic acid causes which one of the following changes?

(1) pH increases
(2) pH decreases
(3) pH remains unchanged
(4) pH becomes 7

**26.** A buffer solution with pH 9 is to be prepared by mixing $NH_4Cl$ and $NH_4OH$. The number of moles of $NH_4Cl$ that should be added to one litre of 1.0 M $NH_4OH$ is $[K_b = 1.8 \times 10^{-5}, 10^{0.26} = 1.81]$

(1) 3.4
(2) 2.6
(3) 1.5
(4) 1.8

**27.** Which one of the following solutions can act as buffer?

(1) 0.1 molar aq. NaCl
(2) 0.1 molar aq. $CH_3COOH$ + 0.1 molar NaOH
(3) 0.1 molar aq. ammonium acetate
(4) None of these

**28.** 100 mL of 0.02 M benzoic acid ($pK_a = 4.2$) is titrated using 0.02 M NaOH. pH of solution after addition of 50 mL and 100 mL of NaOH respectively will be

(1) 3.50, 7
(2) 4.2, 7
(3) 4.2, 8.1
(4) 4.2, 8.25

**29.** 10 mL of 1 M $H_2SO_4$ will completely neutralise:

(1) 10 mL of 1 M NaOH solution
(2) 10 mL of 2 M NaOH solution
(3) 5 mL of 2 M KOH solution
(4) 5 mL of 1 M $Na_2CO_3$ solution

**30.** The suitable indicator for titration of weak base with strong acid is

(1) Methyl orange
(2) Methyl red
(3) Phenol red
(4) Phenolphthalein

**31.** Why are strong acids generally used as standard solutions in acid-base titrations?

(1) The pH at the equivalence point will always be 7.
(2) They can be used to titrate both strong and weak bases.
(3) Strong acids form more stable solutions than weak acids.
(4) The salts of strong acids do not hydrolysed.

**32.** What is the solubility of $Cd(OH)_2$ in a buffer solution having pH = 8 ? $[K_{sp} (Cd(OH)_2) = 2.5 \times 10^{-14}]$

(1) 2.5 M
(2) 0.25 M
(3) 0.025 M
(4) 0.0025 M

**33.** A solution of 0.02 M $MgCl_2$ is mixed with equal volume of a solution which is 0.01 M in $Na_2C_2O_4$. If $K_{sp}$ of $MgC_2O_4$ is $7 \times 10^{-7}$, then which one of the following is true?

(1) $[Mg^{2+}] = 0.01$ M in final solution
(2) $[Mg^{2+}] = 0$ in final solution
(3) $[Mg^{2+}] = 0.005$ M in final solution
(4) $[C_2O_4^{2-}] = 0.005$ M in final solution

**34.** One litre of water contains $10^{-7}$ mole $H^+$ ions. Degree of ionisation of water is:

(1) $1.8 \times 10^{-7}$ %
(2) $1.8 \times 10^{-9}$ %
(3) $3.6 \times 10^{-7}$ %
(4) $3.6 \times 10^{-9}$ %

**35.** 4.0 g of NaOH and 4.9 g of $H_2SO_4$ are dissolved in water and volume is made upto 250 mL. The pH of this solution is:

(1) 7.0
(2) 1.0
(3) 2.0
(4) 12.0

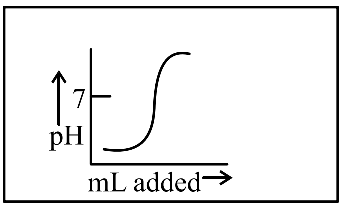
**36.** How many millimoles of NaOH should be added to 1L of 0.1M $FeCl_3$ solution to just start the precipitation of $Fe(OH)_3$? $[K_{sp}[Fe(OH)_3] = 8 \times 10^{-13}]$.

(1) 2 (2) 4
(3) 0.2 (4) 0.4

**37.** A solution contain equal moles of $CH_3COOH$ and $CH_3COONa$. The pH will change significantly if

(1) Small amount of $CH_3$ COONa is added without changing volume.
(2) Small amount of $CH_3COOH$ is added without changing volume.
(3) The solution is diluted
(4) Moles of HCl equal to moles of $CH_3COONa$ are added.

**38.** The following titration curve represents the titration of a _______ acid with a _______ base.




(1) strong, strong (2) weak, strong
(3) strong, weak (4) weak, weak

**39.** 1 M NaCl and 1 M HCl are present in an aqueous solution. The solution is:

(1) Not a buffer solution with pH < 7
(2) Not a buffer solution with pH > 7
(3) A buffer solution with pH < 7
(4) A buffer solution with pH > 7

**40.** Which one of the following statements is not true?

(1) The conjugate base of $H_2PO_4^-$ is $HPO_4^{2-}$
(2) pH + pOH = 14 for all aqueous solutions at 25ºC.
(3) The pH of $1 \times 10^{-8}$ M HCl is 8
(4) The pH of $10^{-2}$ M $H_2SO_4$ is 1.7

**41.** When rain is accompanied by a thunderstorm, the collected rain water will have a pH value

(1) slightly lower than that when the thunderstorm is not there of rain water without thunderstorm
(2) slightly higher than that when the thunderstorm is not there
(3) uninfluenced by occurrence of thunderstorm.
(4) which depends on the amount of dust in the air.

**42.** The molar solubility (in mol $L^{-1}$) of a sparingly soluble salt $MX_4$ is s. The corresponding solubility product constant is $K_{sp}$. s is given in terms of $K_{sp}$ by the relation:

(1) $s = (K_{sp}/128)^{1/4}$
(2) $s = (128K_{sp})^{1/4}$
(3) $s = (256K_{sp})^{1/5}$
(4) $s = (K_{sp}/256)^{1/5}$

**43.** The solubility product constant of a salt having general formula $MX_2$, in water is $4 \times 10^{-12}$. The concentration of $M^{2+}$ ions in the saturated aqueous solution of the salt is:

(1) $2.0 \times 10^{-6}$ M (2) $1.0 \times 10^{-4}$ M
(3) $1.6 \times 10^{-4}$ M (4) $4.0 \times 10^{-10}$ M

**44.** What is the conjugate base of $OH^-$?

(1) $O_2$ (2) $H_2O$
(3) $O^-$ (4) $O^{2-}$

**45.** The $pK_a$ of a weak acid (HA) is 4.5. The pOH of an aqueous buffered solution of HA, in which 50% of the acid is ionized, is:

(1) 9.5 (2) 7.0
(3) 4.5 (4) 2.5

**46.** The $pK_a$ of a weak acid, HA, is 4.80. The $pK_b$ of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be

(1) 4.79 (2) 7.01
(3) 9.22 (4) 9.58

**47.** Solid $Ba(NO_3)_2$ is gradually dissolved in $1.0 \times 10^{-4}$ M $Na_2CO_3$ solution. At what concentration of $Ba^{2+}$ will a precipitate begin to form? ($K_{sp}$ for $BaCO_3 = 5.1 \times 10^{-9}$)

(1) $5.1 \times 10^{-5}$ M (2) $8.1 \times 10^{-8}$ M
(3) $8.1 \times 10^{-7}$ M (4) $4.1 \times 10^{-5}$ M

**48.** Three reactions involving $H_2PO_4^-$ are given below:

(i) $H_3PO_4 + H_2O \rightarrow H_3O^+ + H_2PO_4^-$
(ii) $H_2PO_4^- + H_2O \rightarrow HPO_4^{2-} + H_3O^+$
(iii) $H_2PO_4^- + OH^- \rightarrow H_3PO_4 + O^{2-}$

In which of the above reactions, does $H_2PO_4^-$ act as an acid?

(1) (ii) only (2) (i) and (ii)
(3) (iii) only (4) (i) only

**49.** In an aqueous solution the ionization constants for carbonic acid are $K_1 = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$ respectively. Select the correct statement from the following for a saturated 0.034 M solution of the carbonic acid.

(1) The concentration of $CO_3^{2-}$ is 0.034 M.
(2) The concentration of $CO_3^{2-}$ is greater than that of $HCO_3^-$.
(3) The concentration of $H^+$ and $HCO_3^-$ are approximately equal.
(4) The concentration of $H^+$ is double that of $CO_3^{2-}$.

**50.** Solubility product constantof silver bromide is $5.0 \times 10^{-13}$. The quantity of potassium bromide (molar mass taken as 120 g $mol^{-1}$) to be added to 1 litre of 0.05 M solution of silver nitrate to start the precipitation of AgBr is:

(1) $1.2 \times 10^{-10}$ g (2) $1.2 \times 10^{-9}$ g
(3) $6.2 \times 10^{-5}$ g (4) $5.0 \times 10^{-8}$ g

**51.** $pK_a$ of a weak acid (HA) and $pK_b$ of a weak base (BOH) are 3.2 and 3.4 respectively. The pH of their salt (AB) solution is:

(1) 6.9 (2) 7.0
(3) 1.0 (4) 7.2

**52.** 50 mL of 0.2 M ammonia solution is treated with 25 mL of 0.2 M HCl . If $pK_b$ of ammonia solution is 4.75, the pH of the mixture will be:

(1) 4.75 (2) 3.75
(3) 9.25 (4) 8.25

**53.** **Statement-1:** In the titration of weak a monoacidic base with a strong acid, the pOH at the half equivalent point is $pK_b$.

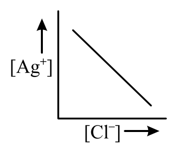
**Statement-2:** At half equivalence point, it will form buffer at its maximum capacity where [base] = [conjugate acid].

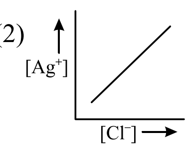
(1) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.
(2) Statement-1 is true, statement-2 is true and statement-2 is not correct explanation for statement-1.
(3) Statement-1 is true, statement-2 is false.
(4) Statement-1 is false, statement-2 is true.

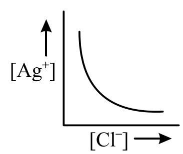
**54.** 10 mL of $\frac{M}{5}$ $CH_3COONa$ solution is titrated with $\frac{M}{5}$ HCl solution. The pH value at equivalence point is: ($pK_a(CH_3COOH) = 4.76$)

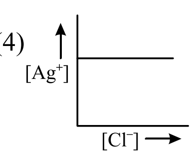
(1) 0.7 (2) 1
(3) 1.88 (4) 2.88

**55.** In a saturated solution of AgCl, NaCl is added gradually. The concentration of $Ag^+$ is plotted against the concentration of $Cl^-$. The graph appears as:

(1)



(2)



(3)



(4)


**56.** **Statement-1:** Solubility of AgCN in KCN (aq) is greater than in pure water.

**Statement-2:** When AgCN dissolve in KCN(aq), complex ion $[Ag(CN)_2]^-$ formation takes place and solubility equilibrium of AgCN shifted in backward direction.

(1) Statement-1 is true, statement-2 is true and statement-2 is correct explanation for statement-1.

(2) Statement-1 is true, statement-2 is true and statement-2 is not correct explanation for statement-1.

(3) Statement-1 is true, Statement-2 is false.

(4) Statement-1 is false, Statement-2 is true.

**57.** Ionization constant of $CH_3COOH$ is 1.7 x $10^{-5}$ and concentration of $H^+$ ions in the solutionis $3.4 \times 10^{-4}$ M. The initial concentration of $CH_3COOH$ is

(1) $3.4 \times 10^{-4}$ M (2) $3.4 \times 10^{-3}$ M

(3) $6.8 \times 10^{-4}$ M (4) $6.8 \times 10^{-3}$ M

**58.** **Assertion:** pH of x M HCl is less than pH of x M $CH_3COOH$.

**Reason:** The degree of ionization of HCl and $CH_3COOH$ are equal at infinite dilution.

(1) Both assertion and reason are correct, and reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but reason is not the correct explanation for the assertion

(3) Assertion is incorrect, but reason is correct.

(4) Both assertion and reason are incorrect.

**59.** Match List I with List II and select the correct answer using the codes given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | pH of 0.1M HA ($pK_a$ = 5) and 0.01 M NaA | P | 4 |
| II | pH of 0.1 M BOH ($pK_b$ = 6) and 0.1 M BCl | Q | 7 |
| III | pH of 0.1 M salt of HA ($pK_a$= 5) and BOH ($pK_b$ = 7) | R | 6 |
| IV | pH of 500 litre of 0.2 M $HNO_3$ and 500 litre 0.2M NaOH | S | 8 |

(1) I-P ; II-S ; III-R ; IV-Q

(2) I-S ; II-P ; III-R ; IV-Q

(3) I-P ; II-R ; III-S ; IV-Q

(4) I-P ; II-S ; III-Q ; IV-R

**60.** Match List I (solutions of salts of ...) with List II (pH of the solution is given by) and select the correct answer using the codes given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | Weak acid and strong base | P | $\frac{1}{2}pK_w$ |
| II | Strong acid and weak base | Q | $\frac{1}{2}(pK_w - pK_b + pK_a)$ |
| III | Weak acid and weak base | R | $\frac{1}{2}(pK_w - pK_b - \log C)$ |
| IV | Strong acid and strong base | S | $\frac{1}{2}(pK_w + pK_a + \log C)$ |

(1) I-P ; II-Q ; III-R ; IV-S

(2) I-S ; II-R ; III-Q ; IV-P

(3) I-S ; II-R ; III-P ; IV-Q

(4) I-R ; II-S ; III-Q ; IV-P

## *Integer Type Questions (61 to 75)*

**61.** How much water must be added to 300 mL of a 0.2 M solution of $CH_3COOH$ for the degree of dissociation of the acid to double? (Assume $K_a$ of acetic acid is of order of $10^{-5}$ M)

**62.** To a 10 mL of $10^{-3}$ N $HNO_3$ solution water has been added to make the total volume to one litre. What would be its pOH value?

**63.** What will be the pH when 0.01 mole of $HNO_3$ is dissolved in 'V' volume of water and $V \to \infty$ ?

**64.** The hydrogen ion concentration in 0.1 M solution of $CH_3COOH$, which is 30% dissociated, is 'x' M. The value ? '100x' is__________.

**65.** The solubility product constant of $Ag_2CrO_4$ is $32 \times 10^{-12}$. If $x \times 10^{-5}$ M is the concentration of $CrO_4^{2-}$ ions in that solution, then find the value of 'x'.

**66.** The first and second dissociation constants of an acid $H_2A$ are $1.0 \times 10^{-5}$ and $5.0 \times 10^{-10}$ respectively. The overall dissociation constant of the acid is represented as $x \times 10^{-16}$ . Find the value of 'x'.

**67.** At 25°C, the solubility product constant of $Mg(OH)_2$ is $1.0 \times 10^{-11}$. At what pH, will $Mg^{2+}$ ions start precipitating in the form of $Mg(OH)_2$ from a solution of 0.001 M $Mg^{2+}$ ions?

**68.** The pH of a 0.1 molar solution of an acid HQ is 3. The value of the $pK_a$ of the acid is___________.

**69.** How many litres of water must be added to 1 litre of an aqueous solution of HCl with a pH = 1 to create an aqueous solution with pH = 2?

**70.** What quantity (in mL) of a 45% acid solution of a monoprotic strong acid must be mixed with a 20% solution of the same acid to produce 800 mL of a 29.875% acid solution?

**71.** The dissociation constant of two acids $HA_1$ and $HA_2$ are $3.14 \times 10^{-4}$ and $1.96 \times 10^{-5}$ respectively. The relative strength of the acids is in the ratio x : 1 The value of x is_______.

**72.** If 0.5 moles of $(NH_4)_2SO_4$ is added to 1L of 0.5 M $NH_4OH$ solution. What will be the pH (nearest integer) of the resultant solution? $[pK_a(NH_4^+) = 9.26]$.

**73.** How many of the following statement(s) are true?

**S1:** pH of water at 30ºC is less than pH at 0ºC.

**S2:** $CN^-$ is a weaker base than $OH^-$ as HCN is a stronger acid than $H_2O$.

**S3:** In the presence of strong base, the degree of dissociation of a weak base increases than in water.

**74.** Addition of sodium hydroxide solution to a weak acid (HA) results in a buffer of pH = 6. If ionisation constant of HA is $10^{-5}$, then ratio of salt to acid concentration in the buffer solution will be______.

**75.** How many of the following statement(s) are true?

**S1:** The pH of solution made by dissolving 1 mole each of HCl, NaOH & $CH_3COONH_4$ in the same beaker is 7, if $pK_a$ $(CH_3COOH) = pK_b$ $(NH_3)$.

**S2:** Methyl orange can be used as an indicator in the titration of $CH_3COOH$ with NaOH.

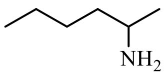
**S3:** Water act as an acid when ammonia is dissolved in water

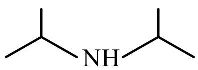
# CHAPTER 08

# ORGANIC CHEMISTRY- SOME BASIC PRINCIPLES & TECHNIQUES

*Single Option Correct Type Questions (01 to 60)*

**1.** Which of the following IUPAC name is incorrect?
(1) 3-Ethylpenta-1, 4-diene
(2) 2-Ethylhex-1-en-4-yne
(3) 2-(2- Chloroethyl) pentanenitrile
(4) 2, 2-Dichlorohexan-4-ol

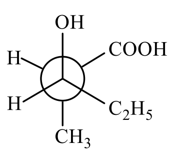
**2.** The given structures are  and

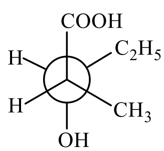


(1) Chain isomers
(2) Position isomers
(3) Functional isomers
(4) Metamers

**3.** Which of the following compound is achiral (optically inactive) ?
(1) 1-Bromo-2-chlorocyclopropane
(2) (Trans)-2-Methyl hex-3-ene
(3) 2-Methyl butanal
(4) 2, 3, 4-Trimethyl hexane

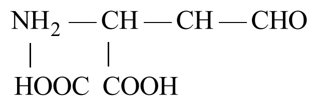
**4.** Identify the compound and find the relation between them.




(1) Conformational isomers or identical
(2) Configurational diastereomer
(3) Configurational enantiomers
(4) Constitutional isomers

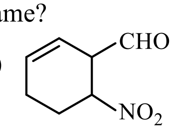
**5.** Correct IUPAC name of the compound is



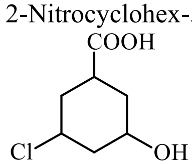

(1) 2-Formyl-3-aminobutane dioic acid
(2) 2-Amino-3-formylbutane-1, 4-dioic acid
(3) 3-Amino-2, 3-dicarboxypropanal
(4) None of the above

**6.** Which of the following statement is **incorrect?**
(1) A meso compound has chiral centres but does not exhibit optical activity.
(2) If a molecule is dissymmetric, it rotate the plane of plane polarized light.
(3) A meso compound is optically inactive because the rotation caused by any molecule is cancelled by an equal and opposite rotation caused by another molecule that is the mirror image of the first.
(4) The two diastereomers have same structure formula but different physical and chemical properties.

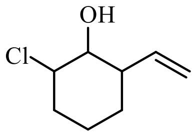
**7.** Which is correctly matched with IUPAC Name?

(1) 

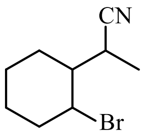

2-Nitrocyclohex-5-ene-1-carbaldehyde

(2) 


5-Chloro-3-hydroxycyclohexane-1-carboxylic acid

(3) 

2-Ethenyl-6-chlorocyclohexanol

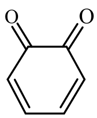
(4) 

2-(2-bromocyclohexyl) propanenitrile

**8.** In which compound D-exchange is possible in presence of $OD^-$ / $D_2O$?

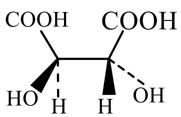
(1) $CH_3-\overset{O}{\overset{||}{C}}-Ph$

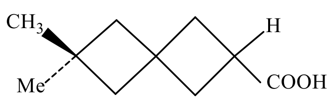
(2) $CH_2=CH-\overset{O}{\overset{||}{C}}-Ph$

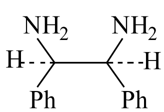
(3) 

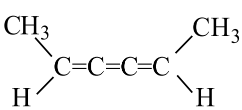
(4) $CH_3-\underset{C_2H_5}{\underset{|}{\overset{Cl}{\overset{|}{C}}}}-CH=CH-CHO$

**9.** Which of the following compound has non superimposable mirror image -

(1) 

(2) 

(3) 

(4) 

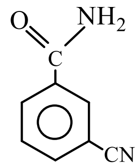
**10.** The enol form of acetone, after treatment with $D_2O$, gives -

(1) $CH_3-\overset{OD}{\overset{|}{C}}=CH_2$

(2) $CD_3-\overset{O}{\overset{||}{C}}=CD_3$

(3) $CH_3-\overset{OH}{\overset{|}{C}}=CHD$

(4) $CH_3-\overset{OD}{\overset{|}{C}}=CD_2$

**11.** 

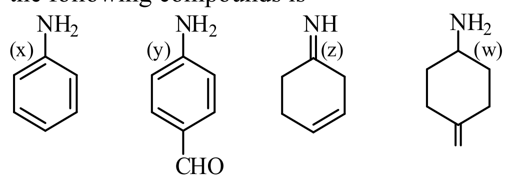
has correct IUPAC name as :

(1) 3-Carbamoylbenzene-1-carbonitrile
(2) 3-Cyanobenzene-1-carboxamide
(3) 3-Cyanobenzamide
(4) 3-Aminocarbonylcyanobenzene

**12.** Glycerol is purified by :

(1) Steam distillation
(2) Distillation under reduced pressure
(3) Fractional distillation
(4) Simple distillation

**13.** The correct order of C—N bond lengths for the following compounds is



(1) w > x > y > z
(2) y > x > w > z
(3) w > y > z > x
(4) x > y > z > w

**14.** In $HCOO^-$, the two carbon-oxygen bonds are found to be of equal length. What is the reason for this ?

(1) The anion is obtained by the removal of a proton from the acid molecule.
(2) Electronic orbitals of carbon atoms are hybridised.
(3) The C=O bond is weaker than C–O bond.
(4) The anion $HCOO^-$ has two equally stable resonating structures.

**15.** Which of the following orders of acidic strength is correct ?

(1) RCOOH > CH≡CH > HOH > ROH

(2) RCOOH > ROH > HOH > CH≡CH

(3) RCOOH > HOH > ROH > CH≡C

(4) RCOOH > HOH > CH≡CH > ROH

**16.** The decreasing order of the stability of the ions

$CH_3-\overset{+}{C}H-CH_3$ **(I)** $\quad CH_3-\overset{+}{C}H-OCH_3$ **(II)**

$CH_3-\overset{+}{C}H-COCH_3$ **(III)**

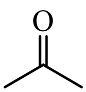
(1) I > II > III

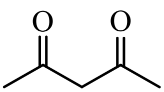
(2) III > II > I

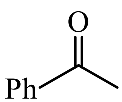
(3) II > III > I

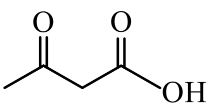
(4) II > I > III

**17.** Maximum enol content is in:

(1) 

(2) 

(3) 


(4) 


**18.** Which of the following is least stable carbanion?

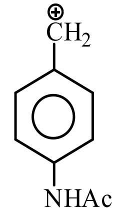
(1) $CH_3-\overset{\overset{O}{||}}{C}-\overset{\ominus}{C}H_2$

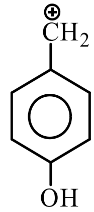
(2) $(C_6H_5)_3\overset{\ominus}{C}$

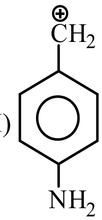
(3) $(CH_3)_3\overset{\ominus}{C}$

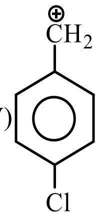
(4) $H-C\equiv\overset{\ominus}{C}$

**19.** Arrange stability of the given carbocations in decreasing order

(I) 


(II) 


(III) 


(IV) 


(1) I > II > III > IV

(2) III > II > I > IV

(3) IV > I > II > III

(4) II > III > I > IV

**20.** The most basic among the following is :

(1) $CH_3O^-$

(2) $C_6H_5O^-$

(3) $(CH_3)_2CHO^-$

(4) $(CH_3)_3CO^-$

**21.** Select false statement from the following?

(1) Formation of dichlorocarbene from $CHCl_3$ is an elimination reaction.

(2) Carbocations and free radicals are planar chemical species.

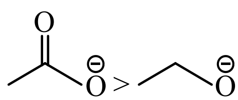
(3) In the rearrangement of carbocation, 1°–carbocation may convert into 2°–carbocation

(4) $CCl_3$ group is o, p-directing because it exhibit hyperconjugation with benzene ring.

**22.** The correct leaving group ability order is :

(1) $\overset{\ominus}{O}H > H_2O$

(2) $\overset{\ominus}{O}H > \overset{\ominus}{S}H$

(3) 


(4) $\overset{\ominus}{Cl} > \overset{\ominus}{I}$

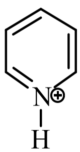
**23.** In Dumas' method for estimation of nitrogen, 0.3 g of an organic compound gave 50 mL of nitrogen collected at 300 K temperature and 715 mm pressure. What will be the percentage composition of nitrogen in the compound. (Aqueous tension at 300 K = 15 mm)

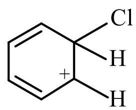
(1) 22.38% (2) 17.46%
(3) 55.11% (4) 82.74%

**24.** Select the correct statement?

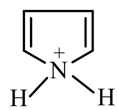
(1) All canonical forms always contribute equally to the resonance hybrid.
(2) In both ethanamine and ethenamine nitrogen is $sp^3$ hybridised.
(3) All 'C–O' bond lengths in carbonate dianion are equal.
(4) $CH_2=C=O$ does not exhibit resonance because it is not a conjugated system.

**25.** Which of the following ion will be aromatic in nature?

(1) 


(2) 


(3) 

(4) 


**26.** In the following sets of resonating structure, label the major contributors towards resonance hybrid.

(P) $\underset{(I)}{CH_3-\overset{\ominus}{C}H-C\equiv N} \longleftrightarrow \underset{(II)}{CH_3-CH=C=\overset{\ominus}{\ddot{N}}:}$

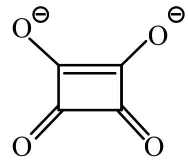
(Q) $\underset{(I)}{CH_3-\overset{O}{\overset{\|}{C}}-\overset{\ominus}{C}H-\overset{O}{\overset{\|}{C}}-CH_3} \longleftrightarrow \underset{(II)}{CH_3-\overset{O^{\ominus}}{\overset{|}{C}}=CH-\overset{O}{\overset{\|}{C}}-CH_3}$

(R) $\underset{(I)}{CH_3-CH_2-\overset{\oplus}{\underset{NH_2}{\underset{|}{C}}}-NH_2} \longleftrightarrow \underset{(II)}{CH_3-CH_2-\underset{NH_2}{\underset{|}{C}}=\overset{\oplus}{N}H_2}$

(S) $\underset{(I)}{CH_3-\overset{\ominus}{C}H-CH=CH-NO_2} \longleftrightarrow \underset{(II)}{CH_3-CH=CH-CH=\overset{\oplus}{\underset{O^{\ominus}}{\underset{|}{N}}}-O^{\ominus}}$

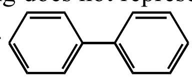
(1) II, II, I, II (2) II, II, II, I
(3) II, II, II, II (4) I, I, II, I

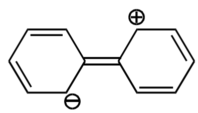
**27.** Which of the following statement is correct regarding dianion of squaric acid

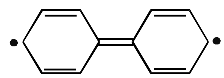


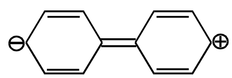

?

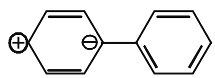
(1) In the dianion, all the C–C bonds are of same length but all C–O bonds are of different length.
(2) In the dianion, all C–C bonds are of same length and also all C–O bonds are of same lengths.
(3) In the dianion, all C–C bond lengths are not of same length.
(4) None of the above.

**28.** Which of the following does not represent the resonating structure of 

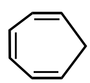
(1) 

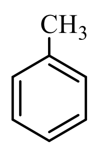
(2) 

(3) 

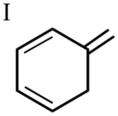
(4) 

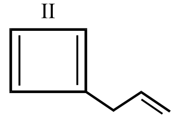
**29.** The correct order of resonance energy of the following compounds would be


I



II


III


IV

(1) I > II > III > IV (2) IV > III > II > I
(3) II > I > III > IV (4) II > III > I > IV

**30.** The Carbocations, carbanions, free radicals and radical cation are reactive carbon intermediates. Their hybrid orbitals respectively are

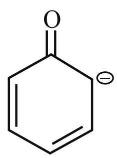
(1) $sp^2$, $sp^2$, $sp^3$, sp

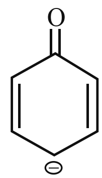
(2) $sp^2$,$sp^2$, sp, $sp^3$

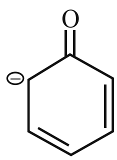
(3) $sp^2$, $sp^3$, $sp^2$, sp

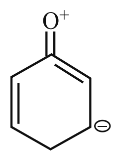
(4) $sp^3$, $sp^2$, sp, $sp^2$

**31.** Which of the following is not a resonating structure for the phenoxide ion?

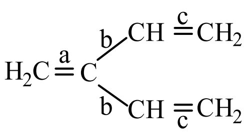
(1) 

(2) 

(3) 

(4) 

**32.** The correct bond order is

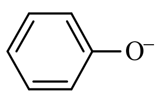


(1) a > b > c (2) b > a > c

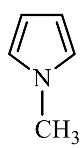
(3) c > a > b (4) c > b > a

**33.** The compound which is not stabilised by resonance :

(1) $CH_2=CH-Cl$

(2) 

(3) $CH_2=CH-CH_2-Cl$

(4) 

**34.** Which statement is correct regarding Inductive effect?

(1) Electron displacement along a carbon chain and develops partial charges on atoms.

(2) Complete transfer of one of the shared pair of electrons to one of the atom joined by a double bond.

(3) Implies transfer of lone pair of electrons from more electronegative atom to the less electronegative atom.

(4) I effect increases with increase in the distance

**35.** The correct stability order of the following resonating structures is

$H_2C=\overset{+}{N}=\overset{-}{N}$ (I)

$H_2\overset{+}{C}-N=\overset{-}{N}$ (II)

$H_2\overset{-}{C}-\overset{+}{N}\equiv N$ (III)

$H_2\overset{-}{C}-N=\overset{+}{N}$ (IV)

(1) (I) > (II) > (IV) > (III)

(2) (I) > (III) > (II) > (IV)

(3) (II) > (I) > (III) > (IV)

(4) (III) > (I) > (IV) > (II)

**36.** Which of the following statement is correct?

(1) +I group stabilises the carbocation.

(2) +I group stabilises the carbon free radical

(3) –I group stabilises the carbanion

(4) All of these

**37.** In which of the following delocalisation of π-electron is possible.

(1) $CH_2=CH-CH_2-CHO$

(2) $CH_2=CH-CH=O$

(3) $CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-CH_3$

(4) $CH_2=CH-CH_2-CH=CH_2$

**38.** In which compound delocalisation is not possible:

(1) 2-Butene

(2) 1, 3-Butadiene

(3) 1, 3, 5-Hexatriene

(4) Benzene

**39.** The least and most stable resonating structure respectively are:

(a) $CH_2=CH-\overset{\ominus}{C}H-\overset{\oplus}{C}H-\underset{\underset{O}{\|}}{C}-CH_3$

(b) $CH_2=CH-\overset{\oplus}{C}H-CH=\underset{\underset{O^{\ominus}}{|}}{C}-CH_3$

(c) $\overset{\oplus}{C}H_2-\overset{\ominus}{C}H-CH=CH-\underset{\underset{O}{\|}}{C}-CH_3$

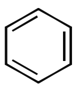
(d) $CH_2=CH-CH=CH-\underset{\underset{O}{\|}}{C}-CH_3$

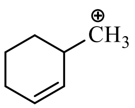
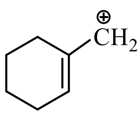
(1) a, d (2) b, c
(3) d, a (4) c, b

**40.** In each of the following pairs, which ion is more stable :

**(x)** **(y)**

(i) $\overset{\oplus}{C}H_2-CH=CH-NH_2$ & $CH_2=CH-CH=\overset{\oplus}{N}H_2$

(ii)  & $CH_2=CH-CH=CH-CH=CH_2$

(iii)  & 

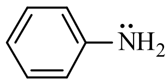
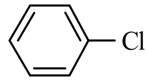
(iv) $CH_2=CH-CH=CH-CH=CH_2$ & $CH_2=CH-\underset{\underset{CH}{\|}}{C}-CH=CH_2$

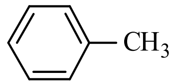
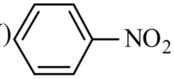
(1) x y y y (2) y x y x
(3) x x x x (4) y x y y

**41.** Arrange the following groups in order of decreasing +M effect.

(i) $-\overset{\ominus}{O}$ (ii) $-NH_2$
(iii) $-OH$ (iv) $-NHCOCH_3$
(1) i > ii > iii > iv (2) iv > iii > ii > i
(3) i > iii > ii > iv (4) i > iv > iii > ii

**42.** Electron density order in the benzene nucleus is

(I)  (II) 

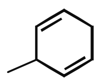
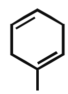
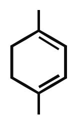
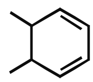
(III)  (IV) 

(1) I > II > III > IV (2) I > III > II > IV
(3) IV > II > III > I (4) I > IV > II > III

**43.** Which of the following group has the maximum hyperconjugation effect?
(1) $CH_3-$ (2) $CH_3CH_2-$
(3) $(CH_3)_2CH-$ (4) $(CH_3)_3C-$

**44.** The C–C bond length in propene is a little shorter (1.49 Å) than the C–C bond length (1.54 Å) in ethane. This is due to
(1) +I effect of $CH_3$
(2) Mesomeric effect
(3) Resonance effect
(4) Hyperconjugation effect

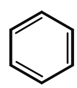
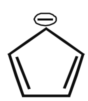
**45.** The order of heat of hydrogenation in following compound is :

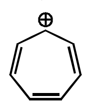
   

(I) (II) (III) (IV)

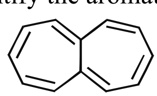
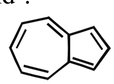
(1) I < II < IV < III (2) III < IV < II < I
(3) II < III < I < IV (4) II < IV < I < III

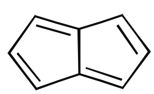
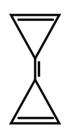
**46.** Which of the following molecules have all C–C bonds are of equal length?

(1)  (2) 

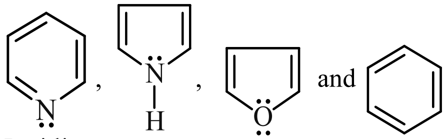
(3)  (4) All of these

**47.** Identify the aromatic compound ?

(1)  (2) 

(3)  (4) 

**48.** Number of π electrons in conjugation for these compounds



Pyridine, Pyrrole, Furan and Benzene will be respectively :

(1) 8, 6, 6, 6 (2) 6, 4, 6, 6

(3) 6, 6, 6, 6 (4) 6, 6, 8, 6

**49.** Which of the following statement is not true about the resonance contributing structures to a resonance hybrid

(1) Contributing structures contribute to the resonance hybrid in proportion of their energies.

(2) Number of unpaired electrons remain same in the resonating structures.

(3) Contributing structures represent hypothetical molecules having no real existence.

(4) Contributing structures are less stable than the resonance hybrid.

**50.** Which of the following series contains atoms/groups having only –M (mesomeric) effect ?

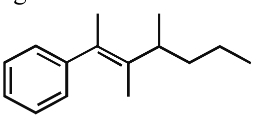
(1) COR, OR, COOR

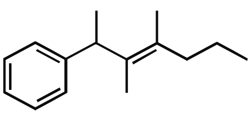
(2) Cl, CHO, $NH_2$

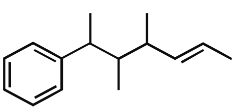
(3) $NO_2$, CN, $SO_3H$

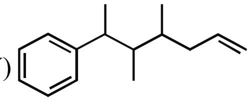
(4) OH, $NR_2$, SR

**51.** Select the correct order of heat of hydrogenation?

(I) 

(II) 

(III) 

(IV) 

(1) I > II > III > IV (2) IV > III > II > I

(3) II > III > IV > I (4) II > III > I > IV

**52.** Carbon-carbon double bond length will be maximum in which of the following compound?

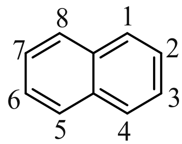
(1) $CH_3-CH=CH_2$

(2) $CH_3-CH=CH-CH_3$

(3) $CH_3-C(CH_3)=C(CH_3)-CH_3$

(4) $CH_2=CH_2$

**53.** Which of the following is correct about the following compound




(Naphthalene)

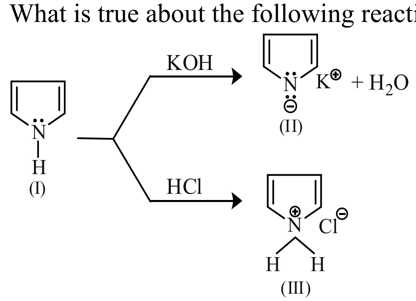
(1) All the C–C bond length are same

(2) $C_1-C_2$ bond length is shorter than $C_2-C_3$ bond length

(3) $C_1-C_2$ bond length is greater than $C_2-C_3$ bond length

(4) All the C–C bond length are equal to C-C bond length of benzene

**54.** What is true about the following reactions




(1) I is nonaromatic

(2) II is nonaromatic

(3) III is antiaromatic

(4) Out of I, II and III, only III compound is nonaromatic

**55.** **Assertion:** The resonating structure of acylium ion, $R-C\equiv\overset{+}{\underset{..}{O}}$ is more stable than $R-\overset{+}{C}=\ddot{O}:$.

**Reason:** The octet of all atoms is complete in $R-C\equiv\overset{+}{\underset{..}{O}}$

(1) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Assertion is false but Reason is true.

**56.** **Assertion:** Heterolytic fission involves the breaking of a covalent bond in such a way that both the electrons of the shared pair are carried away by one of the atoms.

**Reason:** Heterolytic fission occurs readily in polar covalent bonds.

(1) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Assertion is false but Reason is true.

**57.** **Assertion:** Allyl free radical is more stable than simple alkyl free radical.

**Reason:** The allyl free radical is stabilized by resonance.

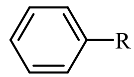
(1) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(2) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
(3) Assertion is true but Reason is false.
(4) Assertion is false but Reason is true.

**58.** Match the contribution of following resonating structures towards their resonance hybrid in Column I with their attributes (properties) mentioned in Column II

| | Column I | | Column II |
|---|---|---|---|
| I | $CH_3CH_2-\overset{O}{\overset{\Vert}{C}}-OCH_2CH_3$ | P | Equal contributor |
| II | $CH_3-\overset{\oplus}{N}(=O)-O^{\ominus}$ | Q | major contributor |
| III | $CH_3-\overset{O}{\overset{\Vert}{C}}-\overset{\ominus}{C}H-\overset{O}{\overset{\Vert}{C}}-CH_3$ | R | minor contributor |

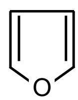
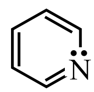
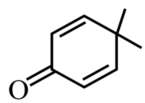
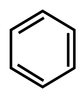
(1) I-Q; II-P; III-R (2) I-R; II-Q; III-P
(3) I-P; II-R; III-Q (4) I-Q; II-R; III-P

**59.** In the following benzyl/allyl system

$R-CH=CH_2$ and 

(R is alkyl group)
Decreasing order of inductive effect is :
(1) $(CH_3)_3C\rightarrow(CH_3)_2CH\rightarrow CH_3CH_2-$
(2) $CH_3CH_2\rightarrow(CH_3)_2CH\rightarrow(CH_3)_3C-$
(3) $(CH_3)_2CH\rightarrow CH_3CH_2\rightarrow(CH_3)_3C-$
(4) $(CH_3)_3C\rightarrow CH_3CH_2\rightarrow(CH_3)_2CH-$

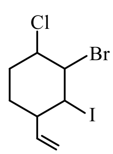
**60.** Which of the following molecules is least resonance stabilized?

(1) 
(2) 
(3) 
(4) 

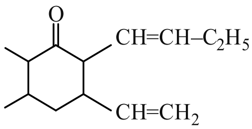
## Integer Type Questions (61 to 75)

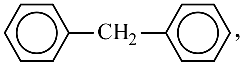
**61.** 0.28 g of a nitrogenous compound was subjected to Kjeldahl's process to produce 0.17 g of $NH_3$. The percentage of nitrogen in the organic compound is :

**62.** Total no. of stereo isomer of



**63.** Total no. of stereo isomer of



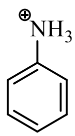
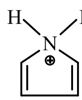
**64.** The molecular formula of diphenyl methane, , is $C_{13}H_{12}$.

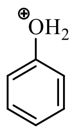
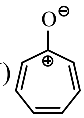
How many structural isomers are possible when one of the hydrogen is replaced by chlorine atom

**65.** How many positional isomers of tetrabromo benzene are possible ?

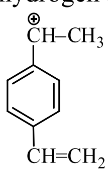
**66.** How many structural isomers of $C_5H_{11}OH$ will be primary alcohols.

**67.** How many structures are there in which delocalisation of positive charge is possible

(I)  (II) 

(III)  (IV) 

**68.** The sum of total number of hyperconjugable hydrogen atoms of following species are

, $CH_3\overset{\oplus}{C}H\,CH_2CH_3$

$(CH_3)_2C{=}CHCH_3$, $H_3CH{=}CHC_2H_5$

**69.** How many following molecules/ions show correct direction of inductive effect.

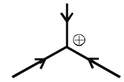
I. $CH_3 \rightarrow CH_2 \rightarrow \underset{\downarrow \atop F}{CH} \rightarrow CH_2 \rightarrow CH_3$

II. $CH_3 \leftarrow \overset{\ominus}{C}H_2$  III. $Cl \rightarrow CH = CH_2$

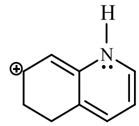
IV. $CH_3 \rightarrow CH = CH_2$  V. $CH_3 \rightarrow Li$

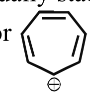
VI. $CH_3 \leftarrow MgBr$  VII. $CH_3 \rightarrow CH_2 \rightarrow OH$

VIII. $CH_3 \leftarrow \overset{\ominus}{O}$  IX. $CH_3 \rightarrow \overset{\oplus}{N}H_3$

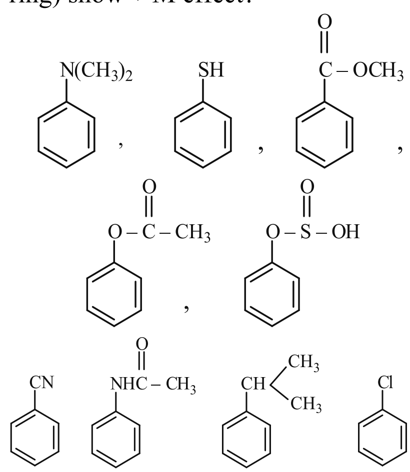
X. 

**70.** Number of delocalised π electrons in the following structure is.

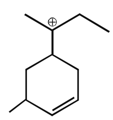


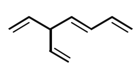
**71.** How many equally stable resonating structures are possible for  (tropylium cation)?

**72.** How many groups (attached with benzene ring) show + M effect?

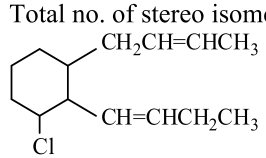


**73.** Observe the following compound and write the number of hydrogen atoms involved in hyperconjugation?



**74.** In  how many π bonds are in resonance?

**75.** Total no. of stereo isomer of



# CHAPTER 09

# HYDROCARBONS

## Single Option Correct Type Questions (01 to 60)

**1.** Which of the following hydrocarbons give same product on hydrogenation.

(1) 2-Methyl hex-1-ene & 3-Methyl hex-3-ene

(2) 3-Ethyl hex-1-en-4-yne & 2-Methylhept-2-en-4-yne

(3) 3-Ethylcycloprop-1-ene & 1,2-Dimethylcycloprop-1-ene

(4) 2-Methylbut-2-ene & 3-Methylbut-1-ene

**2.** Only two isomeric monochloro derivatives are possible for:-

(1) n-Pentane

(2) 2,4-Dimethyl pentane

(3) Toluene

(4) 2,3-Dimethyl butane

**3.** Which of the following alkene gives four monochloro (structural isomers) products after hydrogenation?

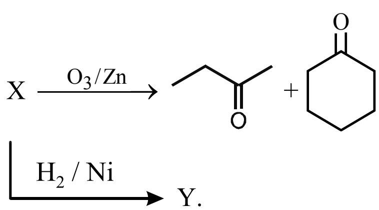
(1) Pent-2-ene

(2) 2-Methylbut-2-ene

(3) 3-Methylhex-2-ene

(4) 2, 3-Dimethylbut-2-ene

**4.**




The IUPAC name of compound Y is:

(1) 2-Cyclohexylbutane

(2) 1-(1-Methylpropyl) cyclohexane

(3) Butylcyclohexane

(4) 1-Cyclohexylbutane

**5.** An alkene give two moles of HCHO, one mole of $CO_2$ and one mole of $CH_3-\underset{\underset{O}{\|}}{C}-CHO$ on ozonolysis.

Its structure could be:

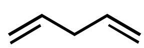
(1) $CH_2=CH-\underset{\underset{CH_3}{|}}{CH}-CH=CH_2$

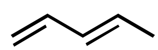
(2) $CH_2=C=CH-\underset{\underset{CH_2}{\|}}{C}-CH_3$

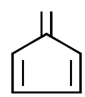
(3) $CH_3-\underset{\underset{CH_3}{|}}{C}=CH-CH=CH_2$

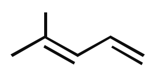
(4) $CH_2=C=CH-\underset{\underset{CH_3}{|}}{CH}-CH=CH_2$

**6.** Which of the following compound on reductive ozonolysis does not give glyoxal as one of the product:

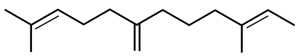
(1) 

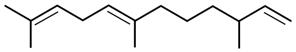
(2) 

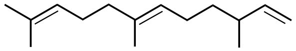
(3) 

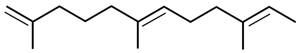
(4) 

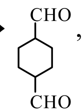
**7.** Farnesene is a compound found in the waxy coating of apples. On hydrogenation it gives 2,6, 10- Trimethyl dodecane. On ozonolysis it gives one mole acetone, one mole of formaldehyde, one mole of 2-Methylpentanedial and one mole of 4-Oxopentanal. The structure proposed for Farnesene may be

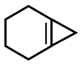
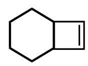
(1) 

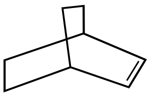
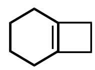
(2) 

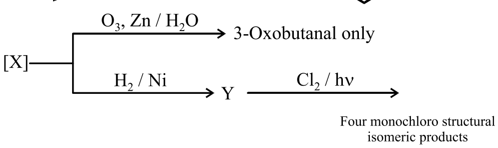
(3) 

(4) 

**8.** An alkene (A) $\xrightarrow{\text{Ozonolysis}}$ , A is:

(1) 
(2) 

(3) 
(4) 

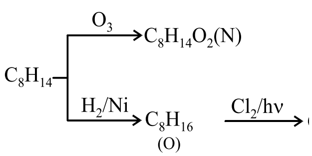
**9.** 


Compound 'X' is:

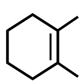
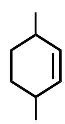
(1) 1-Methylcyclopropene
(2) 1, 4-Dimethylcyclohexa-1,4-diene
(3) 1, 4-Dimethylcyclohexa-1,3-diene
(4) 1, 2-Dimethylcyclohexa-1,4-diene

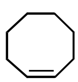
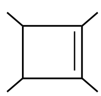
**10.** The chemical reactions of an unsaturated compound 'M' are given below. Determine the possible structural formula of 'M'

(M)




$C_8H_{15}Cl$(P) (Only one monochloro product)

(1) 
(2) 

(3) 
(4) 

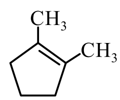
**11.** Ozonolysis of an organic compound 'A' produces acetone and propionaldehyde in equimolar mixture. Identify 'A' from the following compounds:

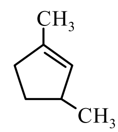
(1) 1-Pentene
(2) 2-Pentene
(3) 2-Methyl-2-pentene
(4) 2-Methyl-1-pentene

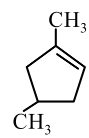
**12.** Which branched chain isomer of the hydrocarbon with molecular mass 72 u gives only one isomer of mono substituted alkyl halide?

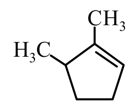
(1) Tertiary butyl chloride
(2) Neopentane
(3) Isohexane
(4) Neohexane

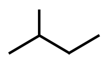
**13.** Which compound would give 5-keto-2-methyl hexanal upon ozonolysis?

(1) 

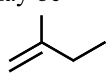
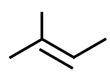
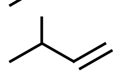

(2) 


(3) 

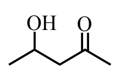

(4) 

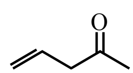

**14.** X $\xrightarrow{H_2/Ni}$ 

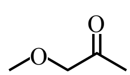
X may be

(1) 
(2) 
(3) 
(4) All of these

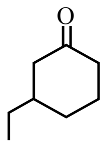
**15.** In which case Clemmensen reduction should be avoided.

(1) 

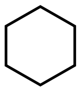
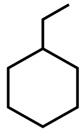
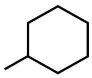
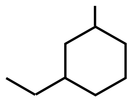

(2) 

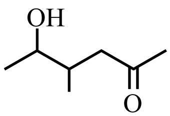

(3) 


(4) All of these

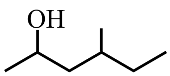
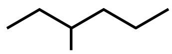
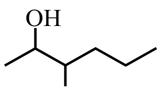
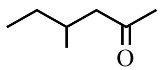
**16.**  $\xrightarrow{NH_2-NH_2/KOH}$ P,

Product P is

(1) 
(2) 
(3) 
(4) 

**17.**  $\xrightarrow{NH_2-NH_2/KOH}$ P

Product P is

(1) 
(2) 
(3) 
(4) 

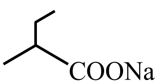
**18.** $CH_3COONa \xrightarrow[\Delta]{\text{reagent}} CH_4$

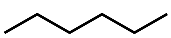
reagent is

(1) $NH_2–NH_2$ / KOH
(2) Zn–Hg / HCl
(3) NaOH + CaO
(4) All of these

**19.** $A \xrightarrow[\Delta]{NaOH\ +\ CaO} CH_3–CH_2–CH_3$

A can be

(1) $CH_3CH_2COONa$
(2) $CH_3CH_2CH_2COONa$
(3) 
(4) $CH_3CH_2CH_2ONa$

**20.** $A \xrightarrow{\text{Na/ Dry ether}}$ 

A may be

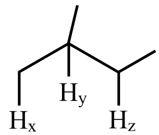
(1) Chloromethane
(2) Chloroethane
(3) 1-Chloropropane
(4) 2-Chloropropane

**21.** $CH_4 + X_2 \xrightarrow[\text{or high temp}]{h\nu} CH_3–X$

Order of reactivity of halogen is

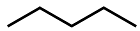
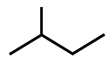
(1) $I_2 > Br_2 > Cl_2 > F_2$
(2) $F_2 > Cl_2 > Br_2 > I_2$
(3) $Br_2 > Cl_2 > I_2 > F_2$
(4) $Cl_2 > Br_2 > F_2 > I_2$

**22.** Reactivity order of Hydrogen for the given reaction is



$+ Br_2 \xrightarrow{h\nu}$

(1) X > Y > Z
(2) Z > X > Y
(3) Y > Z > X
(4) Z > Y > X

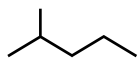
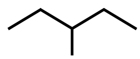
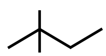
**23.**  $\xrightarrow[HCl]{\text{Anhy. } AlCl_3}$ 

This reaction is known as

(1) Isomerisation of alkane
(2) Polymerisation of alkane
(3) Wurtz reaction
(4) None of these

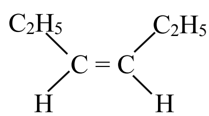
**24.**  $\xrightarrow[HCl]{\text{Anhy. } AlCl_3}$ P

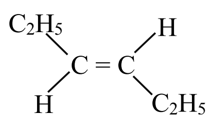
P may be

(1) 
(2) 
(3) 
(4) All of these

**25.** $CH_3–CH_2–C \equiv C–CH_2–CH_3 \xrightarrow{Na/NH_3(\ell)}$

Product:

(1) 

(2) 

(3) Both A & B
(4) None of these

**26.** $CH_3-CH(CH_3)-CH(Br)-CH_2-CH(CH_3)-CH_3 \xrightarrow{KOH(alc)}$ Product

Product is:

(1) $CH_3-C(CH_3)=C=CH-CH(CH_3)-CH_3$

(2) $CH_3-CH(CH_3)-CH=CH-CH(CH_3)-CH_3$

(3) $CH_3-C(CH_3)=CH-CH_2-CH(CH_3)-CH_3$

(4) None of these

**27.** $CH_3-CH(CH_3)-CH(Br)-CH(Br)-CH(CH_3)-CH_3 \xrightarrow{\text{Zn dust, Alcohol } \Delta}$ Product

Product is:

(1) $CH_3-C(CH_3)=C=CH-CH(CH_3)-CH_3$

(2) $CH_3-CH(CH_3)-CH$∟$CH-CH(CH_3)-CH_3$

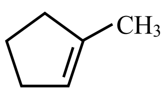
(3) $CH_3-CH(CH_3)-CH_2-CH_2-CH(CH_3)-CH_3$

(4) None of these

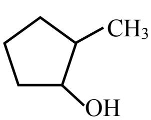
**28.** $Ph-CH=CH_2 + HBr \longrightarrow$ Product:

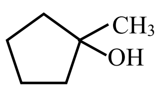
(1) $Ph-CH_2-CH_2(Br)$ (2) $Ph-CH=CH(Br)$

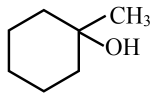
(3) $Ph-CH(Br)-CH_3$ (4) $Ph-CH_2-CHBr_2$

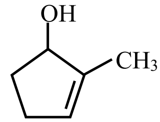
**29.** 

$\xrightarrow[NaBH_4]{Hg(OAc)_2, H_2O}$ Product

(1) 


(2) 


(3) 


(4) 


**30.** $CH_3-CH_2-CH=CH_2 \xrightarrow{A} CH_3-CH_2-CH_2-CH_2(OH)$

Reagent A will be?

(1) $Hg(OAc)_2$, $H_2O$ / $NaBH_4$

(2) $B_2H_6$, $H_2O_2 + OH^-$

(3) Both (A) and (B)

(4) None of these

**31.** $Ph-CH=CH_2 + HBr \xrightarrow{peroxide}$ Product

(1) $Ph-CH(Br)-CH_2(Br)$ (2) $Ph-CH=CH(Br)$

(3) $Ph-CHBr-CH_3$ (4) $Ph-CH_2-CHBr$

**32.** $Ph-CH=CH_2 + HCl \xrightarrow{peroxide}$ Product

(1) $Ph-CH_2-CH_2(Cl)$ (2) $Ph-CH=CH(Cl)$

(3) $Ph-CH(Cl)-CH_3$ (4) $Ph-CH_2-CHCl_2$

**33.** $CH_3-CH_2-C(H)(Br)-C(H)(Br)-CH_2-CH_3 \xrightarrow{2NaNH_2}$ Product

Product is:

(1) $CH_3-C\equiv C-CH_2-CH_2-CH_3$

(2) $CH_3-CH_2-C\equiv C-CH_2-CH_3$

(3) $CH\equiv C-CH_2-CH_2-CH_2-CH_3$

(4) $CH_3-CH=CH-CH_2-CH_2-CH_3$

**34.** $A \xrightarrow{2NaNH_2} Ph-C\equiv C-Ph$

A is:

(1) $CH_3-CH=CH-Ph$ (2) $Ph-C(H)(Br)-C(H)(Br)-Ph$

(3) $CH_3-CH_2-CH_2-CH_3$ (4) None of these

**35.** $2Ph-CCl_3 + Ag \longrightarrow$ Product

Product is:

(1) $Ph-CH=CH-Ph + AgCl$

(2) $Ph-CH_2-CH_2-Ph + AgCl$

(3) $Ph-C\equiv C-Ph + AgCl$

(4) $Ph-C\equiv C-CH_3 + AgCl$

**36.** $C_2H_5-C\equiv C-C_2H_5 + Cl_2 \xrightarrow{CCl_4}$ Product

Final product is:

(1) $C_2H_5-CH(Cl)-CH_2-C_2H_5$

(2) $C_2H_5-CH(Cl)-C_2H_5$

(3) $C_2H_5-CH(Cl)-CH(Cl)-C_2H_5$

(4) $C_2H_5-CCl_2-CCl_2-C_2H_5$

**37.** $CH_3-C\equiv CH + HBr \longrightarrow$ Product

Product is:

(1) $CH_3-CH(Br)-CH_2(Br)$ (i.e. $CH_3-\underset{Br}{CH}-\underset{Br}{CH_3}$)

(2) $CH_3-CH=\underset{Br}{CH}$

(3) $CH_3-CBr_2-CH_3$

(4) $CH_3-\overset{Br}{\underset{Br}{C}}-CH_3$

**38.** $CH_3-C\equiv CH \xrightarrow[H_2O_2/OH^-]{B_2H_6}$ Product

Product is:

(1) $CH_3-\underset{OH}{C}-CH_3$

(2) $CH_3CH_2-CHO$

(3) $CH_3-\underset{O}{\underset{\|}{C}}-CH_3$

(4) $CH_3-CH_2-\underset{OH}{CH_2}$

**39.** $CH_3CH_2C\equiv CCH_2CH_3 + H_2O \xrightarrow{HgSO_4}$ Product

Product is:

(1) $CH_3CH_2\overset{O}{\overset{\|}{C}}CH_2CH_2CH_3$

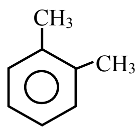
(2) $CH_3CH_2CH_2CH_2CH_2CH_3$

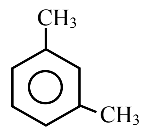
(3) Both A & B

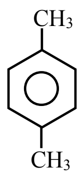
(4) None of these

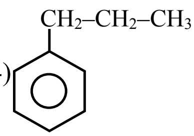
**40.** Which of the following will not form in the following reaction?

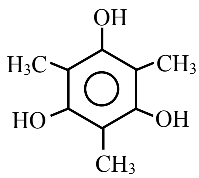
$2CH_3-C\equiv C-H + HC\equiv CH \xrightarrow[Tube]{Red\ hot}$ ?

(1) 

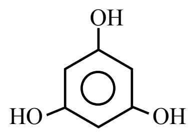

(2) 

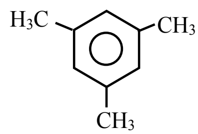

(3) 

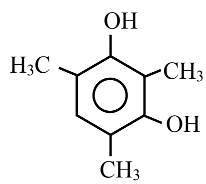

(4) 

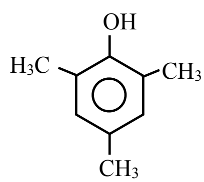

**41.** 

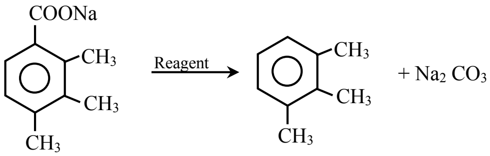
$\xrightarrow[distillation]{Zn\ powder}$ ?

(1) 


(2) 


(3) 


(4) 

**42.** 

Reagent may be -

(1) Soda lime (2) Zinc dust

(3) Red hot tube (4) None of these

**43.** Benzene upon addition with the mixture of conc. $HNO_3$ and conc. $H_2SO_4$ undergoes .....

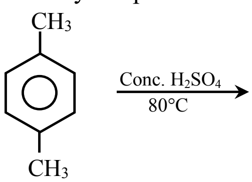
(1) Nitration

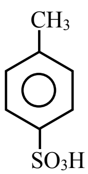
(2) Sulphonation

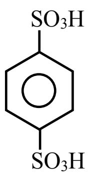
(3) Both nitration and sulphonation

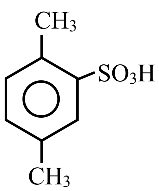
(4) Neither nitration nor sulphonation

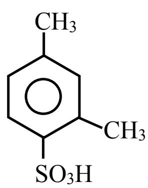
**44.** Identify the product:



(1) 

(2) 

(3) 

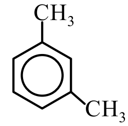
(4) 

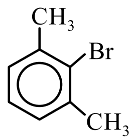
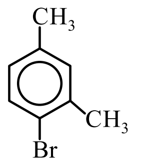
**45.** Structural formula of Lewisite is:

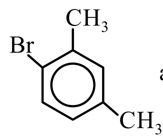
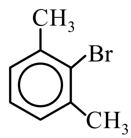
(1) $CHCl{=}CHAsCl_3$ (2) $CHCl{=}CHAsCl$

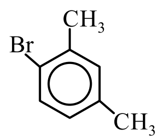
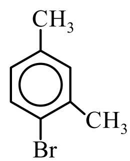
(3) $CHCl{=}CHAsCl_2$ (4) $CH_2{=}CHAsCl_2$

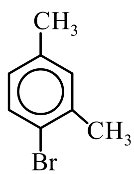
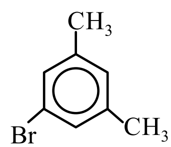
**46.** What product are formed when the following compound is treated with $Br_2$ in the presence of $FeBr_3$?



(1)  and 

(2)  and 

(3)  and 

(4)  and 

**47.** $C_6H_5Cl + CH_3Cl \xrightarrow{\text{Na/dry ether}} C_6H_5CH_3 + 2NaCl$

This reaction is an example of:

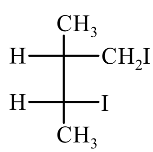
(1) Wurtz reaction

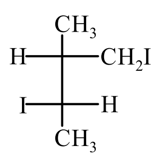
(2) Fittig reaction

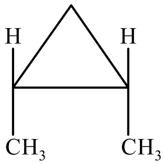
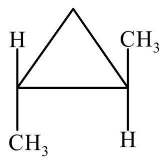
(3) Wurtz-Fittig reaction

(4) Frankland reaction

**48.** $CH_3{-}C{\equiv}C{-}CH_3 \xrightarrow{Na/NH_3(l)} P \xrightarrow{CH_2I_2, Zn, \Delta}$ Product is:

(1) 

(2) 

(3)     (4) 

**49.** In which of the following Hofmann elimination product is more?

(1) $CH_3-C(CH_3)_2-CH(OH)-CH_3 \xrightarrow[\Delta]{\text{Conc. } H_2SO_4}$

(2) $CH_3-C(H)(CH_3)-CH(Br)-CH_3 \xrightarrow{\text{Potassium ethoxide}}$

(3) $CH_3-CH_2-CH_2-CH_2-\overset{\oplus}{N}(CH_3)_3\ I^- \xrightarrow[2.\ \Delta]{1.\ Ag\ OH}$

(4) $CH_3-C(CH_3)_2-CH_2-Cl \xrightarrow[\Delta]{\text{alc. KOH}}$

**50.** Identify Z in the series:

$CH_3CH_2CH_2OH \xrightarrow[160\text{–}180°C]{\text{conc. } H_2SO_4} (X)$

$\xrightarrow{Br_2} (Y) \xrightarrow[NaNH_2/\Delta]{\text{alc. KOH}/\Delta} (Z)$

(1) $CH_3-CH(OH)-CH_2(OH)$

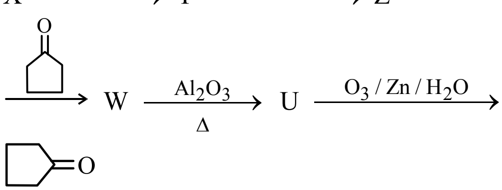
(2) $CH_3CH_2CH(OH)_2$

(3) $CH_3-C(OH)=CH_2$

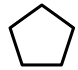
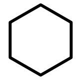
(4) $CH_3-C\equiv CH$

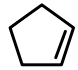
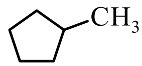
**51.** Observe the following reaction sequence

$X \xrightarrow{Br_2/h\nu} Y \xrightarrow{Mg/Ether} Z$



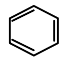

X can be:

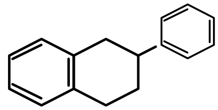
(1)     (2) 

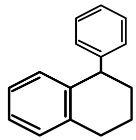
(3)     (4) 

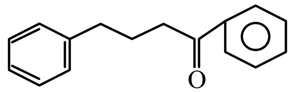
**52.** 

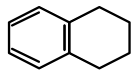

B $\xrightarrow{AlCl_3}$ C. The product C is:



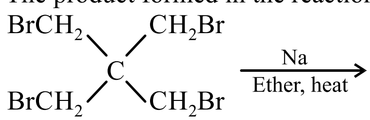
(1) 

(2) 

(3) 

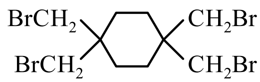
(4) 

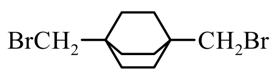
**53.** The product formed in the reaction

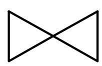



is:

(1) $(BrCH_2)_3CCH_2CH_2C(CH_2Br)_3$

(2) 

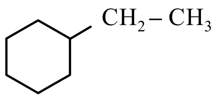
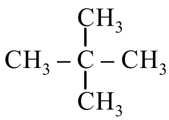
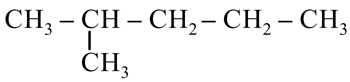

(3) 


(4) 

**54.** Which statement is incorrect:

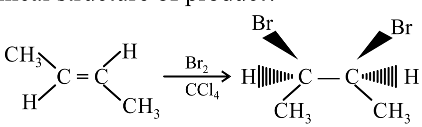
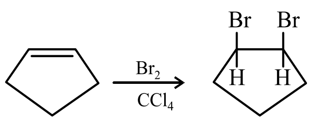
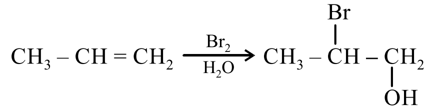
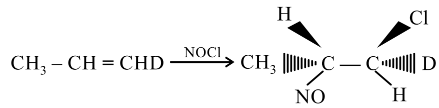
(1) Monobromination of 2-methyl butane produces 3° bromide as major product where as monochlorination of 2-methyl butane produces 1° chloride as major product.

(2) Halogenation of alkane in presence of sunlight, is followed through free radical mechanism.
(3) In the reaction of propene with $H_2O$ & $Br_2$, water act as nucleophile.
(4) Alkenes undergo electrophilic substitution reaction generally.

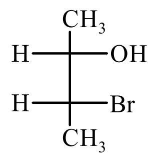
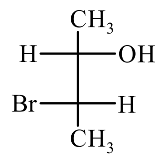
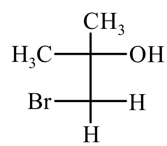
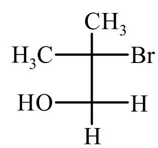
**55.** Using corey-house synthesis we can't prepare..............from ethylbromide.
(1) $CH_3–CH_2–CH_2–CH_3$
(2) 
(3) 
(4) 

**56.** During Kolbe's electrolysis, pH of electrolyte ................. progressively.
(1) Increases
(2) Decreases
(3) Remains same
(4) Cannot be predicted

**57.** In Kolbe's electrolysis sodium propanoate gives:
(1) $CH_3–CH_3$
(2) $CH_2=CH_2$
(3) $CH_3–CH_2–CH_2–CH_3$
(4) A mixture of 1, 2 and 3

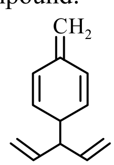
**58.** Which reaction shows the correct stereo chemical structure of product?
(1) 
(2) 
(3) 
(4) 

**59.** Identify the incorrect statement / statements:
(i) Alkynes are more reactive than alkenes towards electrophilic addition reaction
(ii) Alkynes are less reactive than alkenes towards electrophilic addition reaction
(iii) Alkynes decolourise $Br_2$ water
(iv) Addition of HBr to alkenes in presence of peroxide proceeds via Markownikoff's rule
(1) (i) & (ii) only (2) (ii) & (iii) only
(3) (i) & (iv) only (4) (ii) & (iv) only

**60.** cis-2-Butene $\xrightarrow{HOBr}$ P, identify product 'P' is:
(1) 
(2) 
(3) 
(4) 

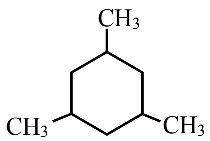
## Integer Type Questions (61 to 75)

**61.** Number of moles of hydrogen required for complete hydrogenation of one mole of following compound:



**62.** The number of possible monochloro derivatives of 2, 2, 3, 3-Tetramethylbutane is -

**63.** How many products (structural isomers only) are formed by monochlorination of given compound.



**64.** How many isomeric alkynes on catalytic hydrogenation gives 3-Ethyl-4-methylheptane?

**65.** How many alkenes, alkynes and alkadienes can be hydrogenated to form Isopentane (Including all structural isomers)

**66.** 'n' number of alkenes yield 2,2,3,4,4-pentamethyl-pentane on catalytic hydrogenation and 'm' number of monochloro structural isomers are possible for this compound.

Report your answer as (n + m).

**67.** How many isomeric structural alkene on catalytic hydrogenation gives 3-Methyl hexane.

**68.** How many terminal alkynes having molecular mass 68 g/mol is possible?

**69.** In the following sequence of reactions, the alkene forms the compound 'B'

$$CH_3CH{=}CHCH_3 \xrightarrow{O_3} A \xrightarrow[Zn]{H_2O} B,$$

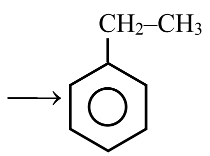
molecular weight of compound B is (in g/mol)

**70.** $CH_3{-}CH_2{-}Cl \xrightarrow{2Li} X \xrightarrow{CuI}$

$Y \xrightarrow{CH_3-Cl} Z$

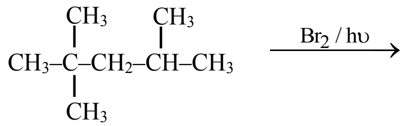
The molecular weight of final product Z is: (in g/mol)

**71.** X $HC{\equiv}CH$ + Y $CH_3{-}CH_2{-}C{\equiv}CH$



Find the value of $\frac{x}{y}$.

**72.** For the given reaction how many monohalo products are optically active (all isomers):



**73.** An isomer of $C_5H_{12}$ gives total six isomeric products on monochlorination. Calculate the percentage yield of the primary monochloride which is chiral. Consider the following relative reactivity of C – H bonds for chlorination.

| Degree of C-H | 1° C – H | 2° C – H | 3° C – H |
|---|---|---|---|
| Relative reactivity for chlorination (RR) | 1 | 3 | 5 |

**74.** How many of the following statements are correct?

(i) Melting point of neo-pentane is greater than that of n-pentane but the boiling point of n-pentane is more than that of neo-pentane.

(ii) Melting point depends upon packing in crystal lattice whereas boiling point depends upon surface area of the molecule.

(iii) Propene is less reactive than ethene towards electrophilic addition reactions.

(iv) Electron density of double bond increases due to hyperconjugation of methyl group.

**75.** During the electrolysis of sodium ethanoate, the molecular weight of gas liberated at cathode is: (in g/mol)

# CHAPTER 10

# SOLUTIONS AND COLLIGATIVE PROPERTIES

*Single Option Correct Type Questions (01 to 60)*

**1.** The plots of $\frac{1}{X_A}$ (on y-axis) vs $\frac{1}{Y_A}$ (on x-axis) (where XA and YA are the mole fractions of liquid A in liquid and vapour phase respectively) is linear with slope and y-intercept respectively.

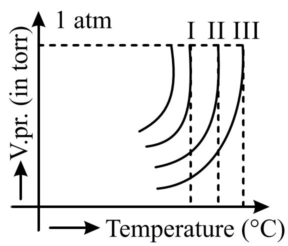
(1) $\frac{P_A^0}{P_B^0}$ and $\frac{\left(P_A^0 - P_B^0\right)}{P_B^0}$

(2) $\frac{P_B^0}{P_A^0}$ and $\frac{\left(P_A^0 - P_B^0\right)}{P_B^0}$

(3) $\frac{P_A^0}{P_B^0}$ and $\frac{\left(P_B^0 - P_A^0\right)}{P_B^0}$

(4) $\frac{P_B^0}{P_A^0}$ and $\frac{\left(P_B^0 - P_A^0\right)}{P_B^0}$

**2.** The vapour pressure curves of the same solute in the same solvent are shown. The curves are parallel to each other and do not intersect. The concentrations of solutions are in order of:




(1) I < II < III  (2) I = II = III

(3) I > II > III  (4) I > III > II

**3.** At higher altitudes, water boils at temperature < 100ºC because

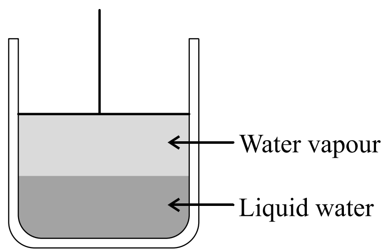
(1) temperature of higher altitudes is low

(2) atmospheric pressure is low

(3) the proportion of heavy water increases

(4) atmospheric pressure becomes more.

**4.** The vapour pressure of water at 20°C is 17.54 mmHg. What will be the vapour pressure of the water in the apparatus shown after the piston is lowered, decreasing the volume of the gas above the liquid to one half of its initial volume (assume temperature constant).




(1) 8.77 mmHg

(2) 17.54 mmHg

(3) 35.08 mmHg

(4) between 8.77 and 17.54 mmHg

**5.** According to Henry's law, the solubility of a gas in a given volume of liquid increases with increase in:

(1) Temperature

(2) Pressure

(3) Both (1) and (2)

(4) None of these

**6.** Which statement about the composition of vapour over an ideal 1:1 molar mixture of benzene and toluene is correct? Assume the temperature is constant at 25°C.

Given, Vapour pressure (25°C) of Pure

Benzene 75 mm Hg

Toluene 22 mm Hg

(1) The vapour will contain higher percentage of benzene

(2) The vapour will contain higher percentage of toluene

(3) The vapour will contain equal amount of benzene and toluene

(4) Not enough information is given to make a prediction

**7.** Which of the following shows negative deviation from Raoult's law?

(1) $CHCl_3$ and acetone

(2) $CHCl_3$ and $C_2H_5OH$

(3) $C_6H_5CH_3$ and $C_6H_6$

(4) $C_6H_6$ and $CCl_4$

**8.** Total vapour pressure of mixture of 1 mol A ($P_A^0$ =150 torr) and 2 mol B ($P_B^0$ =240 torr) is 200 torr. In this case:

(1) There is positive deviation from Raoult's law

(2) There is negative deviation from Raoult's law

(3) There is no deviation from Raoult's law

(4) Molecular masses of A and B are also required for calculating the deviation

**9.** For the given electrolyte $A_xB_y$, the degree of dissociation 'α' can be given as

(1) $\alpha = \frac{i-1}{x+y-1}$

(2) $i = (1-\alpha) + x\alpha + y\alpha$

(3) $\alpha = \frac{1-i}{1-x-y}$

(4) All of these

**10.** The experimental molecular weight of an electrolyte during dissociation will always be less than its calculated value because the value of vant Hoff factor, 'i' is:

(1) Less than 1 (2) Greater than 1

(3) One (4) Zero

**11.** Aluminium phosphate is 100% ionised in 0.01 molal aqueous solution. Hence, $\Delta T_b / K_b$ is:

(1) 0.01 (2) 0.015

(3) 0.0175 (4) 0.02

**12.** A solution containing 28 g of phosphorus in 315 g $CS_2$ (b.p. 46.3ºC) boils at 47.98ºC. If $K_b$ for $CS_2$ is 2.38 K kg $mol^{-1}$. The formula of phosphorus is (at. mass of P = 31).

(1) $P_6$ (2) $P_4$

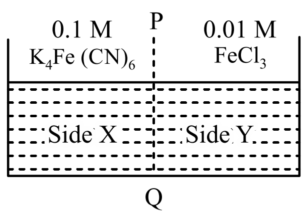
(3) $P_3$ (4) $P_2$.

**13.** The freezing point of a solution containing 0.2 g of acetic acid in 20.0 g benzene is lowered by 0.45ºC. Calculate the degree of association of acetic acid in benzene. Assume acetic acid dimerizes in benzene. $K_f$ for benzene = 5.12 K mol–1 kg.

(1) 49.5 % (2) 94.5%

(3) 85.5% (4) 58.5%

**14.** $FeCl_3$ on reaction with $K_4[Fe(CN)_6]$ in aq. solution gives blue colour. These are separated by a semipermeable membrane PQ as shown. Due to osmosis there is-




(1) Blue colour formation in side X

(2) Blue colour formation in side Y

(3) Blue colour formation in both of the sides X and Y

(4) No blue colour formation

**15.** Osmotic pressure of 30% solution of glucose is 1.20 atm and that of 3.42% solution of cane sugar is 2.5 atm. The osmotic pressure of the mixture containing equal volumes of the two solutions will be

(1) 2.5 atm (2) 3.7 atm
(3) 1.85 atm (4) 1.3 atm.

**16.** A solution of a substance (non-electrolyte) containing 1.05 g per 100 mL. was found to be isotonic with 3%(w/v) glucose solution. The molecular mass of the substance is:

(1) 31.5 (2) 6.3
(3) 630 (4) 63

**17.** Which has maximum osmotic pressure at temperature T:

(1) 100 mL of 1 M urea solution
(2) 300 mL of 1 M glucose solution
(3) Mixture of 100 mL of 1 M urea solution and 300 mL of 1 M glucose solution
(4) All are isotonic

**18.** pH of a 0.1 M monobasic acid is found to be 2. Hence its osmotic pressure at a given temperature T K is-

(1) 0.1 RT (2) 0.11 RT
(3) 1.1 RT (4) 0.01 RT

**19.** Pressure cooker reduces cooking time because

(1) The heat is more evenly distributed inside the cooker
(2) A large flame is used
(3) Boiling point of water is elevated
(4) Whole matter is converted into steam

**20.** Which of the following is not correct for an ideal solution?

(1) $P_A = P_A^0 X_A$ (2) $\Delta H_{mix} = 0$
(3) $\Delta V_{mix} = 0$ (4) $\Delta S_{mix} = 0$

**21.** **Assertion:** If on mixing the two liquids, the solution becomes hot, it implies that it shows negative deviation from Raoult's law.

**Reason:** Solution which show negative deviation are accompanied by decrease in volume.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both assertion and reason are incorrect

**22.** The vapour pressure of the solution of two liquids A($p^o$ = 80 mm) and B($p^o$ = 120 mm) is found to be 100 mm when $x_A = 0.4$. The result shows that

(1) Solution exhibits ideal behaviour
(2) Solution shows positive deviations
(3) Solution shows negative deviations
(4) Solution will show positive deviations for lower concentration and negative deviations for higher concentrations.

**23.** **Assertion:** 0.1 m aqueous solution of glucose has higher depression in the freezing point than 0.1 m aqueous solution of urea.

**Reason:** $K_f$ for both has different values.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**24.** Osmotic pressure of blood is 7.40 atm at 27°C. Number of mol of glucose to be used per L at same temperature for an intravenous injection that is to have the same osmotic pressure as blood is:

(1) 0.3
(2) 0.2
(3) 0.1
(4) 0.4

**25.** **Assertion:** When dried fruits and vegetables are placed in water, they get swelled.

**Reason:** It happens due to the phenomenon of osmosis.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**26.** If 'A' contains 2% NaCl and is separated by a semipermeable membrane from 'B' which contains 10% NaCl, which event will occur?

(1) NaCl will flow from 'A' to 'B'
(2) NaCl will flow from 'B' to 'A'
(3) Water will flow from 'A' to 'B'
(4) Water will flow from 'B' to 'A'

**27.** $6.02 \times 10^{20}$ molecules of urea are present in 100 ml of its solution. The concentration of urea solution is

(1) 0.001 M (2) 0.01 M
(3) 0.02 M (4) 0.1 M.

**28.** Which one of the following aqueous solutions will exhibit highest boiling point?

(1) 0.01 M $Na_2SO_4$ (2) 0.01 M $KNO_3$
(3) 0.015 M urea (4) 0.015 M glucose

**29.** If $\alpha$ is the degree of dissociation of $Na_2SO_4$, the vant Hoff's factor (i) used for calculating the molecular mass is:

(1) $1 + \alpha$ (2) $1 - \alpha$
(3) $1 + 2\alpha$ (4) $1 - 2\alpha$.

**30.** Equimolar solutions in the same solvent have. (Assuming i = 1)

(1) same boiling point but different freezing point
(2) same freezing point but different boiling point
(3) same boiling and same freezing points
(4) different boiling and freezing points

**31.** Two solutions of a substance (non electrolyte) are mixed in the following manner. 480 ml of 1.5 M first solution + 520 mL of 1.2 M second solution. What is the molarity of the final mixture?

(1) 1.20 M (2) 1.50 M
(3) 1.344 M (4) 2.70 M

**32.** Density of a 2.05 M solution of acetic acid in water is 1.02 g/mL. The molality of the solution is

(1) 3.28 mol $Kg^{-1}$ (2) 2.28 mol $Kg^{-1}$
(3) 0.44 mol $Kg^{-1}$ (4) 1.14 mol $Kg^{-1}$

**33.** A binary liquid solution is prepared by mixing n-heptane and ethanol. Which one of the following statement is correct regarding the behaviour of the solution?

(1) The solution is non-ideal, showing +ve deviation from Raoult's Law.
(2) The solution in non-ideal, showing –ve deviation from Raoult's Law.
(3) n-heptane shows +ve deviation while ethanol shows –ve deviation from Raoult's Law.
(4) The solution formed is an ideal solution.

**34.** Two liquids X and Y form an ideal solution. At 300K, vapour pressure of the solution containing 1 mol of X and 3 mol of Y is 550 mmHg. At the same temperature, if 1 mol of Y is further added to this solution, vapour pressure of the solution increases by 10 mmHg. Vapour pressure (in mmHg) of X and Y in their pure states will be, respectively:

(1) 300 and 400 (2) 400 and 600
(3) 500 and 600 (4) 200 and 300

**35.** If sodium sulphate is considered to be completely dissociated into cations and anions in aqueous solution, the change in freezing point of water ($\Delta T_f$), when 0.01 mole of sodium sulphate is dissolved in 1 kg of water, is ($K_f = 1.86$ K kg $mol^{-1}$)

(1) 0.0372 K (2) 0.0558 K
(3) 0.0744 K (4) 0.0186 K

**36.** Consider separate solution of 0.500 M $C_2H_5OH(aq)$, 0.100 M $Mg_3(PO_4)_2(aq)$, 0.250 M KBr(aq) and 0.125 M $Na_3PO_4(aq)$ at 25°C. Which statement is **true** about these solution, assuming all salts to be strong electrolytes? (Assume $Mg_3(PO_4)_3$ to be completely soluble).
(1) They all have the same osmotic pressure.
(2) 0.100 M $Mg_3(PO_4)_2(aq)$ has the highest osmotic pressure.
(3) 0.125 M $Na_3PO_4(aq)$ has the highest osmotic pressure.
(4) 0.500 M $C_2H_5OH(aq)$ has the highest osmotic pressure.

**37.** The vapour pressure of acetone at 20ºC is 185 torr. When 1.2 g of a non-volatile substance was dissolved in 100g of acetone at 20ºC, its vapour pressure was 183 torr. The molar mass (g $mol^{-1}$) of the substance is:
(1) 32 (2) 64
(3) 128 (4) 488

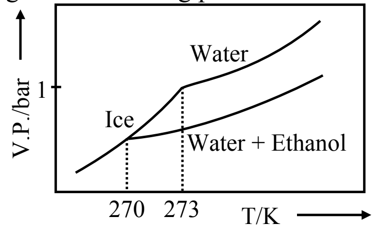
**38.** 18 g glucose ($C_6H_{12}O_6$) is added to 178.2 g water at 760 torr pressure. The vapor pressure of solution (in torr) at boiling point of water is:
(1) 76.0 (2) 752.4
(3) 759.0 (4) 7.6

**39.** The solubility of $N_2$ in water at 300 K and 500 torr partial pressure is 0.01 g $L^{-1}$. The solubility (in g $L^{-1}$) at 750 torr partial pressure is:
(1) 0.02 (2) 0.015
(3) 0.0075 (4) 0.005

**40.** An aqueous solution of a salt $MX_2$ at certain temperature has a van't Hoff factor of 2. The degree of dissociation for this solution of the salt is:
(1) 0.67 (2) 0.33
(3) 0.80 (4) 0.50

**41.** The Henry's law constant for the solubility of $N_2$ gas in water at 298 K is $1.0 \times 10^5$ atm. The mole fraction of $N_2$ in air is 0.8. The number of moles of $N_2$ from air dissolved in 10 moles of water of 298 K and 5 atm pressure is:
(1) $4 \times 10^{-4}$ (2) $4.0 \times 10^{-5}$
(3) $5.0 \times 10^{-4}$ (4) $4.0 \times 10^{-6}$

**42.** Pure water freezes at 273 K and 1 bar. The addition of 34.5 g of ethanol to 500 g of water changes the freezing point of the solution. Use the freezing point depression constant of water as 2 K kg $mol^{-1}$. The figures shown below represent plots of vapour pressure (V.P.) versus temperature (T).
[molecular weight of ethanol is 46 g $mol^{-1}$. Among the following, the option representing change in the freezing point is:

(1)
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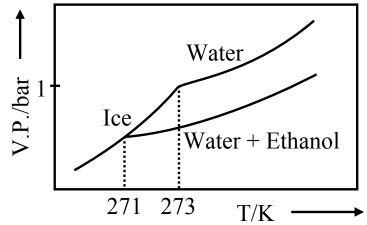
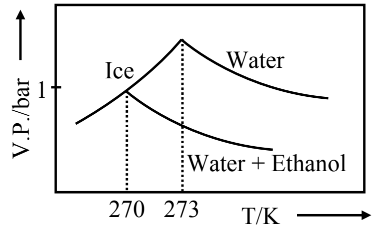



(3)
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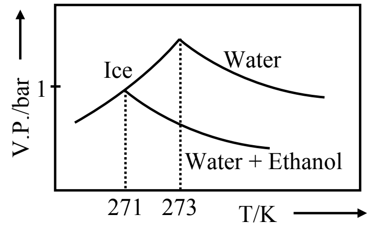



**43.** Select correct statement(s):
(1) When solid $CaCl_2$ is added to liquid water, the boiling temperature rises
(2) When solid $CaCl_2$ is added to ice at 0°C, the freezing temperature falls
(3) Both (1) and (2)
(4) None of the above

**44.** Consider following terms (m = molality):

I: $mK_b$ II: $mK_bi$

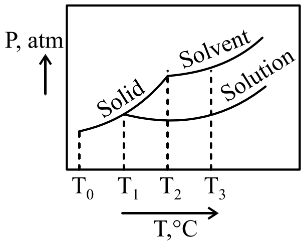
III: $\frac{\Delta T_b}{i}$ IV: $K_b$

Terms which can be expressed in degree (temperature) are

(1) III, IV only (2) I, II only

(3) I, II, IIII only (4) I, III only

**45.** What is the normal freezing point of the solution represented by the phase diagram?




(1) $T_1$ (2) $T_2$

(3) $T_3$ (4) $T_0$

**46.** Total vapour pressure of mixture of 1 mol of volatile component A ($p_A°$ = 100 mmHg) and 3 mol of volatile component B ($p_B°$ = 60 mmHg) is 75 mm. For such case:

(1) There is positive deviation from Raoult's low

(2) Boiling point has been lowered

(3) Force of attraction between A and B is smaller than that between A and A or between B and B

(4) All the above statements are correct

**47.** Select correct statements:

(1) The fundamental cause of all colligative properties is the higher entropy of the solution relative to that of the pure solvent

(2) The freezing point of hydrofluoride solution is larger than that of equimolal hydrogen chloride solution

(3) 1M glucose solution and 0.5 M NaCl solution are isotonic at a given temperature

(4) All are correct statements

**48.** An azeotropic solution of two liquids has a boiling point lower than either of them when it:

(1) shows negative deviation from Raoult's law

(2) shows positive deviation from Raoult's low

(3) shows ideal behaviour

(4) is saturated

**49.** Which of the following azeotropic solutions has the boiling point more than boiling point of the constituents A and B?

(1) $CHCl_3$ and $CH_3COCH_3$

(2) $CS_2$ and $CH_3COCH_3$

(3) $CH_3CH_2OH$ and $CH_3COCH_3$

(4) $CH_3CHO$ and $CS_2$

**50.** Select correct statement?

(1) Heats of vaporisation for a pure solvent and for a solution are similar because similar intermolecular forces between solvent molecules must be overcome in both cases (for ideal solution)

(2) Entropy change between solution and vapour is smaller than the entropy change between its pure solvent and vapour

(3) Boiling point of the solution is larger than that of the pure solvent

(4) All are correct statements

**51.** What will be the molecular weight of NaCl determined experimentally from elevation in the boiling point or depression in freezing point method?

(1) < 58.5 (2) > 58.5

(3) = 58.5 (4) None of these

**52.** Which of the following liquid pairs shows a positive deviation from Raoult's law?

(1) Acetone – chloroform

(2) Benzene – methanol

(3) Water – nitric acid

(4) Water – hydrochloric acid

**53.** A 6.90 M solution of KOH in water has 30% by weight of KOH. Calculate density of solution.

(1) 1.288 g $mL^{-1}$ (2) 12.88 g $mL^{-1}$

(3) 24.88 g $mL^{-1}$ (4) 2.488 g $mL^{-1}$

**54.** The best colligative property used for the determination of molecular masses of polymers is:

(1) Relative lowering in vapour pressure
(2) Osmotic pressure
(3) Elevation in boiling point
(4) depression in freezing point

**55.** Consider equimolal aqueous solutions of $NaHSO_4$ and NaCl with $\Delta T_b$ and $\Delta T'_b$ as their respective boiling point elevations. The value of $\underset{m \to 0}{Lt} \frac{\Delta T_b}{\Delta T'_b}$ will be:

(1) 1 (2) 1.5
(3) 3.5 (4) 2 / 3

**56.** A complex of iron and cyanide ions is 100% ionised at 1m (molal). If its elevation in b.p. is 2.08 K. ($K_b$ = 0.52K $mol^{-1}$ kg), then the complex is:

(1) $K_3[Fe(CN)_6]$ (2) $Fe(CN)_2$
(3) $K_4[Fe(CN)_6]$ (4) $Fe(CN)_4$

**57.** 3.24 g of $Hg(NO_3)_2$ (molar mass = 324) dissolved in 1000 g of water constitutes a solution having a freezing point of – 0.0558ºC while 21.68 g of $HgCl_2$ (molar mass = 271) in 2000 g of water constitutes a solution with a freezing point of – 0.0744ºC. The $K_f$ for water is 1.86 $\frac{K - Kg}{Mol}$. About the state of ionization of these two solids in water it can be inferred that:

(1) $Hg(NO_3)_2$ and $HgCl_2$ both are completely ionized
(2) $Hg(NO_3)_2$ is fully ionized but $HgCl_2$ is fully unionized
(3) $Hg(NO_3)_2$ and $HgCl_2$ both are completely unionized
(4) $Hg(NO_3)_2$ is fully unionized but $HgCl_2$ is fully ionized

**58.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | Relative lowering in vapour pressure | P | Negative deviation from ideal behaviour |
| II | Depression in freezing point | Q | Walker and Ostwald Method |
| III | $\Delta$Hmix < Zero | R | Beckmann thermometer |
| IV | Osmotic pressure | S | Berkeley and Hartley's method |

(1) I-P ; II-Q ; III-R ; IV-S
(2) I-Q ; II-P ; III-S ; IV-R
(3) I-Q ; II-R ; III-P ; IV-S
(4) I-R ; II-S ; III-Q ; IV-P

**59.** Match List I with List II and select the correct answer using the code given below the lists :

| List- I | | List- II | |
|---|---|---|---|
| I | 0.1M NaCl | P | $\pi$ = 0.3 RT |
| II | 0.2 M Na2SO4 | Q | $\pi$ = 0.4 RT |
| III | 0.1M Al(NO3)3 | R | $\pi$ = 0.6 RT |
| IV | 0.1M Ca(NO3)2 | S | $\pi$ = 0.20 RT |

(1) I-S ; II-R ; III-Q ; IV-P
(2) I-S ; II-P ; III-Q ; IV-R
(3) I-P ; II-Q ; III-R ; IV-S
(4) I-P ; II-Q ; III-R ; IV-S

**60.** List-I and List-II contains four entries each. Entries of List-I are to be matched with entries of List-II.

| List- I | | List- II | |
|---|---|---|---|
| I | $AlCl_3$ if $\alpha$ = 0.8 | P | i = 3.4 |
| II | $BaCl_2$ if $\alpha$ = 0.9 | Q | i = 2.8 |
| III | $Na_3PO_4$ if $\alpha$ = 0.9 | R | i = 3.8 |
| IV | $K_4$[Fe(CN)6] if $\alpha$ = 0.7 | S | i = 3.7 |

(1) I-P ; II-Q ; III-S ; IV-R
(2) I-Q ; II-P ; III-S ; IV-R
(3) I-Q ; II-R ; III-P ; IV-S
(4) I-R ; II-S ; III-Q ; IV-P

## Integer Type Questions (61 to 75)

**61.** 15 gram of methyl alcohol is dissolved in 35 gram of water. What is the mass percentage of methyl alcohol in solution?

**62.** At 323 K, the vapour pressure in millimeters of mercury of a methanol-ethanol solution is represented by the equation $p = 120 X_A + 140$, where $X_A$ is the mole fraction of methanol. Then the value of $\lim_{x_A \to 1} \frac{p_A}{X_A}$ is (in millimeters of Hg)

**63.** The van't Hoff factor i for an infinitely dilute solution of $NaHSO_4$ is:

**64.** What weight of solute (non-electrolyte) (molecular weight = 60) is required to dissolve in 180 g of water to reduce the vapour pressure to $\frac{4}{5}$th of pure water? (in g)

**65.** Moles of $K_2SO_4$ to be dissolved in 12 mol water to lower its vapour pressure by 10 mmHg at a temperature at which vapour pressure of pure water is 50 mm is:

**66.** Benzene and toluene form nearly ideal solutions. At 20ºC, the vapour pressure of benzene is 75 torr and that of toluene is 22 torr. The partial vapour pressure of benzene at 20 ºC for a solution containing 78 g of benzene and 46 g of toluene in torr is:

**67.** A mixture of ethyl alcohol and propyl alcohol has a vapour pressure of 290 mm at 300 K. The vapour pressure of propyl alcohol is 200 mm. If the mole fraction of ethyl alcohol is 0.6, its vapour pressure (in mm) at the same temperature will be

**68.** $K_f$ for water is 1.86 K kg $mol^{-1}$. If your automobile radiator holds 1.0 kg of water, how may grams of ethylene glycol ($C_2H_6O_2$) must you add to get the initial freezing point of the solution lowered to –2.8ºC? [Nearest integer]

**69.** 5 g of $Na_2SO_4$ are dissolved in x g of $H_2O$. The change in freezing point was found to be 3.82ºC. If $Na_2SO_4$ is 81.5% ionised, the value of x ($K_f$ for water = 1.86ºC kg $mol^{-1}$) is. (Nearest integer) (molar mass of S= 32 g $mol^{-1}$ and that of Na = 23 g $mol^{-1}$)

**70.** The density of a solution prepared by dissolving 120 g of urea (molar mass = 60) in 1000 g of water is 1.15 g/mL. The molarity of this solution is:

**71.** If relative decrease in vapour pressure is 0.4 for a solution containing 1 mol NaCl in 3 mol $H_2O$, NaCl is .... % ionized.

**72.** A 5.25% solution of a substance is isotonic with a 1.5% solution of urea (molar mass = 60g $mol^{-1}$) in the same solvent. If the densities of both the solutions are assumed to be equal to 1.0 g $cm^{-3}$, molar mass of the substance will be (in gram)

**73.** On mixing, heptane and octane form an ideal solution. At 373 K, the vapour pressures of the two liquid components (heptane and octane) are 105 kPa and 45 kPa respectively. Vapour pressure (in kPa) of the solution obtained by mixing 25.0 g of heptane and 35 g of octane will be. (Molar mass of heptane - 100 g $mol^{-1}$ and of octane = 114 g $mol^{-1}$) [Nearest Integer]

**74.** Insulin $(C_2H_{10}O_5)_n$ is dissolved in a suitable solvent and the osmotic pressure, π of the solution of various concentration, c (in $kg/m^3$) is measured at 20ºC. The slope of a plot of π against c is found to be $8.314 \times 10^{-3}$ (SI units) The molecular weight of the insulin (in kg/mol) is $x \times 10^3$. Find x. [R = 8.314 J/mol/K]

**75.** A solution is prepared by mixing 8.5 g of $CH_2Cl_2$ and 11.95 g of $CHCl_3$. If vapour pressure of $CH_2Cl_2$ and $CHCl_3$ at 298 K are 415 and 200 mmHg respectively, the mole fraction of $CHCl_3$ in vapour form is X.

(Molar mass of Cl = 35.5 g/mol). Find the value of 1000X. (Nearest integer)

CHAPTER 11

# ELECTROCHEMISTRY

### Single Option Correct Type Questions (01 to 60)

**1.** Which of the following statements is true for an electrochemical cell?

Pt, $H_2$(g)1 atm | $H^+$(1M) | | $Cu^{2+}$(1 M) | Cu(s)

(1) $H_2$ is anode and Cu is cathode

(2) $H_2$ is cathode and Cu is anode

(3) Reduction occurs at $H_2$ electrode

(4) Oxidation occurs Cu electrode

**2.** Which is not true for a standard hydrogen electrode?

(1) The hydrogen ion concentration is 1 M

(2) Temperature is 25ºC

(3) Pressure of hydrogen is 1 atmosphere

(4) It contains a metallic conductor which does not absorb hydrogen.

**3.** In the galvanic cell Cu | $Cu^{2+}$(1M) | | $Ag^+$(1M) | Ag, the electrons will travel in the external circuit:

(1) From Ag to Cu

(2) From Cu to Ag

(3) Electrons do not travel in the external circuit

(4) In any direction

**4.** Adding powdered Pb and Fe to a solution containing 1.0 M is each of $Pb^{2+}$ and $Fe^{2+}$ ions would result into the formation of

(Given: $E^\circ_{Pb^{2+}/Pb} = -0.13$ V and $E^\circ_{Fe^{2+}/Fe} = -0.44$ V at 298 K)

(1) More of Pb and $Fe^{2+}$ ions

(2) More of Fe and $Pb^{2+}$ ions

(3) More of Fe and Pb

(4) More of $Fe^{2+}$ and $Pb^{2+}$ ions

**5.** The oxidation potential of Zn, Cu, Ag, $H_2$ and Ni are 0.76, –0.34, –0.80, 0, 0.55 volt respectively. Which of the following reaction will provide maximum voltage?

(1) $Zn + Cu^{2+} \longrightarrow Cu + Zn^{2+}$

(2) $Zn + 2Ag^+ \longrightarrow 2Ag + Zn^{2+}$

(3) $H_2 + Cu^{2+} \longrightarrow 2H^+ + Cu$

(4) $H_2 + Ni^{2+} \longrightarrow 2H^+ + Ni$

**6.** Red hot carbon will remove oxygen from the oxide AO and BO but not from MO, while B will remove oxygen from AO. The activity of metals A, B and M in decreasing order is

(1) A > B > M

(2) B > A > M

(3) M > B > A

(4) M > A > B

**7.** The reduction electrode potential E, of 0.1 M solution of $M^+$ ions ($E^\circ_{RP} = -2.36$ V) is:

(1) – 2.41 V (2) + 2.41 V

(3) – 4.82 V (4) 2.36 V

**8.** The emf of the cell

Ti | $Ti^+$ (0.0001M) || $Cu^{2+}$(0.01M)|Cu is 0.83 V

The emf of this cell will be increased by:

(1) Increasing the concentration of $Cu^{2+}$ ions

(2) Decreasing the concentration of $Ti^+$

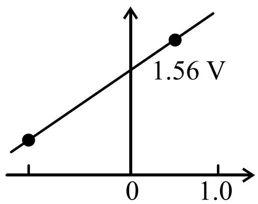
(3) Increasing the concentration of both

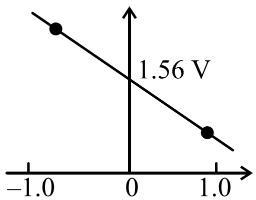
(4) (1) & (2) both

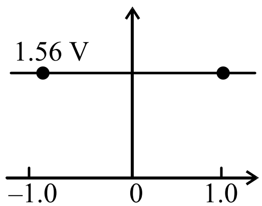
**9.** Which graph correctly correlates $E_{cell}$ as a function of concentrations for the cell

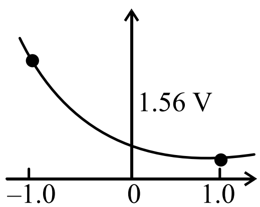
$Zn(s) + 2Ag^{+}(aq) \longrightarrow Zn^{2+}(aq) + 2Ag(s)$, $E^{o}_{cell} = 1.56$ V

Y-axis : $E_{cell}$, X-axis : $\log_{10} \frac{[Zn^{2+}]}{[Ag^{+}]^{2}}$

(1) 


(2) 


(3) 


(4) 


**10.** W g of copper deposited in a copper voltameter when an electric current of 2 ampere is passed for 2 hours. If one ampere of electric current is passed for 4 hours in the same voltameter, copper deposited will be:

(1) W (2) W/2
(3) W/4 (4) 2W

**11.** When the same electric current is passed through the solution of different electrolytes in series, the amounts of elements deposited on the electrodes are in the ratio of their:

(1) atomic number
(2) atomic masses
(3) specific gravities
(4) equivalent masses

**12.** When a lead storage battery is discharged

(1) $PbSO_4$ is formed
(2) Pb is formed
(3) $SO_2$ is consumed
(4) $H_2SO_4$ is formed

**13.** By the electrolysis of aqueous solution of $CuSO_4$ using inert electrodes, the products obtained at both the electrodes are

(1) $O_2$ at anode and $H_2$ at cathode
(2) $H_2$ at anode and Cu at cathode
(3) $O_2$ at anode and Cu at cathode
(4) $H_2S_2O_8$ at anode and $O_2$ at cathode

**14.** A fuel cell is:

(1) The voltaic cells in which continuous supply of fuels are send at anode to give oxidation
(2) The votalic cell in which fuels such as : $CH_4$, $H_2$, CO are used up at anode
(3) It involves the reactions of $H_2 – O_2$ fuel cell such as:

Anode: $2H_2 + 4OH^- \longrightarrow 4H_2O(\ell) + 4e$

Cathode: $O_2 + 2H_2O(\ell) + 4e \longrightarrow 4OH^-$

(4) All of the above

**15.** Which of the following solutions of NaCl will have the highest specific conductance?

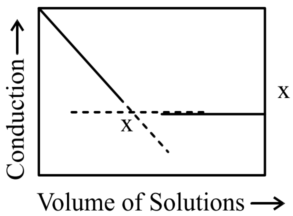
(1) 0.001 N (2) 0.1 N
(3) 0.01 N (4) 1.0 N

**16.** The specific conductivity of a saturated solution of AgCl is $3.40 \times 10^{-6}$ ohm$^{-1}$ cm$^{-1}$ at 25 ºC. If $\lambda_{Ag+} = 62.3$ ohm$^{-1}$ cm$^{2}$ mol$^{-1}$ & $\lambda_{Cl} = 67.7$ ohm$^{-1}$ cm$^{2}$ mol$^{-1}$, the solubility of AgCl at 25 ºC is:

(1) $2.6 \times 10^{-5}$ M (2) $4.5 \times 10^{-3}$ M
(3) $3.6 \times 10^{-5}$ M (4) $3.6 \times 10^{-3}$ M

**17.** The specific conductance of a 0.01 M solution of KCl is 0.0014 $ohm^{-1}$ $cm^{-1}$ at 25°C. its equivalent conductance ($cm^2$ $ohm^{-1}$ $equiv^{-1}$) is:
(1) 140 (2) 14
(3) 1.4 (4) 0.14

**18.** Following curve for conductometric titration is obtained when:



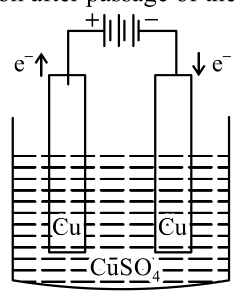

(1) NaOH solution is added in to HCl solution
(2) NaOH solution is added in to $CH_3COOH$ solution
(3) $NH_4OH$ solution is added in to HCl solution
(4) $NH_4OH$ solution is added in to $CH_3COOH$ solution

**19.** Corrosion of iron is essentially an electrochemical phenomenon where the cell reactions are
(1) Fe is oxidised to $Fe^{2+}$ and dissolved oxygen in water is reduced to $OH^-$
(2) Fe is oxidised to $Fe^{3+}$ and $H_2O$ is reduced to $O_2^{2-}$
(3) Fe is oxidised to $Fe^{2+}$ and $H_2O$ is reduced to $O_2^{2-}$
(4) Fe is oxidised to $Fe^{2+}$ and $H_2O$ is reduced to $O_2$

**20.** Given: $E^o(Cu^{2+} | Cu) = 0.337$ V and $E^o(Sn^{2+} | Sn) = -0.136$ V. Which of the following statements is correct?
(1) $Cu^{2+}$ ions can be reduced by $H_2(g)$
(2) Cu can be oxidized by $H^+$
(3) $Sn^{2+}$ ions can be reduced by $H_2(g)$
(4) Cu can reduce $Sn^{2+}$

**21.** How much will the potential of a hydrogen electrode change when its solution initially at pH = 0 is neutralised to pH = 7?
(1) Increase by 0.059 V
(2) Decrease by 0.059 V
(3) Increase by 0.41 V
(4) Decrease by 0.41 V

**22.** In the adjacent diagram the electrolytic cell contains 1 L of an aqueous 1 M Copper (II) sulphate solution. If 0.4 mole of electrons are passed through cell, the concentration of copper ion after passage of the charge will be




(1) 0.4 M (2) 0.8 M
(3) 1.0 M (4) 1.2 M

**23.** A solution containing one mole per litre of each $Cu(NO_3)_2$; $AgNO_3$; $Hg_2(NO_3)_2$; is being electrolysed by using inert electrodes. The values of standard electrode potentials in volts (reduction potentials) are:
$Ag/Ag^+ = -0.80$ V, $Hg/Hg_2^{++} = -0.79$ V, $Cu/Cu^{++} = -0.34$ V, $Mg/Mg^{++} = +2.37$ V
With increasing voltage, the sequence of deposition of metals on the cathode will be:
(1) Ag, Hg, Cu, Mg
(2) Mg, Cu, Hg, Ag
(3) Ag, Hg, Cu
(4) Cu, Hg, Ag

**24.** In $H_2 - O_2$ fuel cell the reaction occurring at cathode is:
(1) $2H_2O + O_2 + 4e^- \longrightarrow 4OH^-$
(2) $2H_2 + O_2 \longrightarrow 2H_2O\,(l)$
(3) $H^+ + OH^- \longrightarrow H_2O$
(4) $H^+ + e^- \longrightarrow \frac{1}{2} H_2$ .

**25.** Which process involves corrosion?
(1) Brown deposits on iron articles
(2) Green deposits on battery terminals
(3) Black deposits on silver coin
(4) All of the above

**26.** The corrosion of iron object is favoured by:
(1) Presence of $H^+$ ion
(2) Presence of moisture in air
(3) Presence of impurities in iron object
(4) All of the above

**27.** A hydrogen electrode placed in a buffer solution of $CH_3COONa$ and $CH_3COOH$ in the ratios of x : y and y : x has electrode potential values $E_1$ volts and $E_2$ volts, respectively at 25ºC. The $pK_a$ values of acetic acid is ($E_1$ and $E_2$ are oxidation potentials)
(1) $\frac{E_1 + E_2}{0.118}$ (2) $\frac{E_2 - E_1}{0.118}$
(3) $-\frac{E_1 + E_2}{0.118}$ (4) $\frac{E_1 - E_2}{0.118}$

**28.** If $E^o_{Fe^{2+}/Fe} = -0.441$ V and $E^o_{Fe^{3+}Fe^{2+}} = 0.771$ V, the standard EMF of the reaction
$Fe + 2Fe^{3+} \longrightarrow 3Fe^{2+}$
will be:
(1) 1.212 V (2) 0.111 V
(3) 0.330 V (4) 1.653 V

**29.** In a salt bridge, KCl is used because:
(1) It is an electrolyte
(2) It is good conductor of electricity
(3) The transport number of $K^+$ and $Cl^-$ ions are nearly same or both have same ionic mobility
(4) It is ionic compound

**30.** By how much will the potential of half-cell $Cu^{2+}$ / Cu change if the solution is diluted to 100 times at 298K
(1) Increases by 59 mV
(2) Decreases by 59 mV
(3) Increases by 29.5 mV
(4) Decreases by 29.5 mV

**31.** A 1 M solution of $H_2SO_4$ is electrolyzed. Select right statement with products at anode and cathode respectively
Given: $2SO_4^{2-} \longrightarrow S_2O_8^{2-} + 2e^-$ ;
$E^o = -2.01$ V
$H_2O(\ell) \longrightarrow 2H^+ (aq) + 1/2O_2(g) + 2e^-$ ;
$E^o = -1.23$ V
(1) concentration of $H_2SO_4$ remain constant ; $H_2$, $O_2$
(2) concentration of $H_2SO_4$ increases ; $O_2$, $H_2$
(3) concentration of $H_2SO_4$ decreases ; $O_2$, $H_2$
(4) concentration of $H_2SO_4$ remains constant ; $S_2O_8^{2-}$ , $H_2$

**32.** A solution of sodium sulphate in water is electrolyzed using inert electrodes. The products at the cathode and anode are respectively
(1) $H_2$, $O_2$ (2) $O_2$, $H_2$
(3) $O_2$, Na (4) $O_2$, $SO_2$

**33.** Electrolysis of a solution of $MnSO_4$ in aqueous sulphuric acid is a method for the preparation of $MnO_2$. Passing a current of 27A for 24 hours gives 1kg of $MnO_2$. The current efficiency in this process is:
(1) 100% (2) 95.185%
(3) 80% (4) 82.951%

**34.** **Assertion:** $E^o_{cell} = 0$ for a chloride ion concentration cell.
**Reason:** For this concentration cell,
$$E_{cell} = \frac{RT}{nF} \ln \frac{[Cl^-]_{LHS}}{[Cl^-]_{RHS}}$$
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**35.** **Assertion:** Conductivity always increases with the decrease in concentration of both the weak and strong electrolytes.

**Reason:** No. of ions per unit volume linearly decreases in both electrolytes.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**36.** **Assertion:** If SRP of substance is –0.5 V then reduction of substance is possible in basic medium.

**Reason:** SRP of water is –0.8274 V and reduction potential is zero at pH = 7.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is correct, but the reason is incorrect
(4) Both are assertion and reason are incorrect

**37.** For the following cell with hydrogen electrodes at two different pressure $p_1$ and $p_2$,

$Pt \mid H_2(g) \mid H^+(aq) \mid H_2(g) \mid Pt$

$p_1$ 1M $p_2$

emf is given by:

(1) $\frac{RT}{F}\log_e\frac{p_1}{p_2}$ (2) $\frac{RT}{2F}\log_e\frac{p_1}{p_2}$

(3) $\frac{RT}{F}\log_e\frac{p_2}{p_1}$ (4) $\frac{RT}{2F}\log_e\frac{p_2}{p_1}$

**38.** For a cell given below:

$Ag \mid Ag^+ \parallel Cu^{2+} \mid Cu$

– +

$Ag^+ + e^- \longrightarrow Ag$ $E^o = x$

$Cu^{2+} + 2e^- \longrightarrow Cu,$ $E^o = y$

The value of $E^o_{cell}$ is:

(1) x + 2y (2) 2x + y
(3) y –x (4) y – 2x

**39.** For a cell reaction involving a two-electron change, the standard emf of the cell is found to be 0.295 V at 25°C. The equilibrium constant of the reaction at 25°C will be:

(1) $1 \times 10^{-10}$ (2) $29.5 \times 10^{-2}$
(3) 10 (4) $1 \times 10^{10}$

**40.** Consider the following $E^0$ values:

$E^0_{Fe^{3+}/Fe^{2+}} = +0.77$ V ; $E^0_{Sn^{2+}/Sn} = -0.14$ V

Under standard conditions, the cell potential for the reaction given below is:

$Sn_{(s)} + 2Fe^{3+}_{(aq)} \rightarrow 2Fe^{2+}_{(aq)} + Sn^{2+}_{(aq)}$

(1) 1.68 V (2) 1.40 V
(3) 0.91 V (4) 0.63 V

**41.** In a cell that utilizes the reaction

$Pb_{(s)} + 2H^+_{(aq)} \rightarrow Pb^{2+}_{(aq)} + H_{2(g)}$,

addition of HCl to cathode compartment will:

(1) lower the E and shift equilibrium to the left.
(2) lower the E and shift the equilibrium to the right.
(3) increase the E and shift the equilibrium to the right.
(4) increase the E and shift the equilibrium to the left.

**42.** The $E^0_{M^{3+}/M^{2+}}$ values for Cr, Mn, Fe and Co are – 0.41, + 1.57, + 0.77 and + 1.97 V respectively. For which one of these metals, the change in oxidation state from +2 to +3 is easiest:

(1) Cr (2) Mn
(3) Fe (4) Co

**43.** The molar conductivities $\Lambda^0_{NaOAc}$ and $\Lambda^0_{HCl}$ at infinite dilution in water at 25°C are 91.0 and 426.2 $Scm^2/mol$ respectively. To calculate $\Lambda^0_{HOAc}$, the additional value required is:

(1) $\Lambda^0_{H_2O}$ (2) $\Lambda^0_{KCl}$
(3) $\Lambda^0_{NaOH}$ (4) $\Lambda^0_{NaCl}$

**44.** Given data is at 25°C:

$Ag + I^- \rightarrow AgI + e^-$ ; E° = 0.152 V

$Ag \rightarrow Ag^+ + e^-$ ; E° = – 0.800 V

What is the value of log $K_{sp}$ for AgI: (Take $\frac{0.474}{0.059} = 8.065$)

(1) – 8.12 (2) + 8.612

(3) – 37.83 (4) – 16.13

45. In a cell that utilises the reaction: $Zn(s) + 2H^+ (0.1M) \longrightarrow Zn^{2+}(aq) + H_2(g)$ addition of 0.1 M $H_2SO_4$ to cathode compartment will:

(1) Increase the cell emf and shift equilibrium to the left.

(2) Lower the cell emf and shift equilibrium to the right.

(3) Increase the cell emf and shift equilibrium to the right.

(4) Lower the cell emf and shift equilibrium to the left.

**46.** The cell $Zn | Zn^{2+}(1M) || Cu^{2+}(1M) | Cu$ : (E°cell = 1.10V) was allowed to completely discharge at 298 K. The relative concentration of $Zn^{2+}$ to $Cu^{2+}$ $\left(\frac{[Zn^{2+}]}{[Cu^{2+}]}\right)$ is: (Take $\frac{1.1}{0.059} = 18.65$)

(1) $10^{37.3}$ (2) $9.65 \times 10^4$

(3) antilog (24.08) (4) 37.3

**47.** Given: $E^0_{Cr^{3+}/Cr} = -0.72$, $E^0_{Fe^{2+}/Fe} = -0.42$ V

The potential for the cell $Cr | Cr^{3+}(0.1\ M) || Fe^{2+}(0.01\ M) | Fe$ at 298 K is: (Take $\frac{2.303R(298)}{F} = 0.06$)

(1) 0.339 V

(2) – 0.339 V

(3) – 0.26 V

(4) 0.26 V

**48.** The Gibbs energy for the decomposition of $Al_2O_3$ at 500ºC is as follows:

$\frac{2}{3}Al_2O_3 \rightarrow \frac{4}{3}Al + O_2$ ; $\Delta_rG = +966\ kJ\ mol^{-1}$.

The potential difference needed for electrolytic reduction of $Al_2O_3$ at 500ºC is at least:

(1) 4.5 V (2) 3.0 V

(3) 2.5 V (4) 5.0 V

**49.** The reduction potential of hydrogen half-cell will be negative, if:

(1) $p(H_2)$ = 1 atm and $[H^+]$ = 2.0 M

(2) $p(H_2)$ = 1 atm and $[H^+]$ = 1.0 M

(3) $p(H_2)$ = 2 atm and $[H^+]$ = 1.0 M

(4) $p(H_2)$ = 2 atm and $[H^+]$ = 2.0 M

**50.** Resistance of 0.2 M solution of an electrolyte is 50 Ω. The specific conductance of the solution is 1.4 S $m^{-1}$. The resistance of 0.5 M solution of the same electrolyte is 280 Ω. The molar conductivity of 0.5 M solution of the electrolyte in S $m^2$ $mol^{-1}$ is:

(1) $5 \times 10^{-4}$ (2) $5 \times 10^{-3}$

(3) $5 \times 10^3$ (4) $5 \times 10^2$

**51.** The equivalent conductance of NaCl at concentration C and at infinite dilution are $\Lambda_C$ and $\Lambda_\infty$, respectively. The correct relationship between $\Lambda_C$ and $\Lambda_\infty$ is given as : (where the constant B is positive)

(1) $\Lambda_C = \Lambda_\infty + (B)C$

(2) $\Lambda_C = \Lambda_\infty - (B)C$

(3) $\Lambda_C = \Lambda_\infty - (B)\sqrt{C}$

(4) $\Lambda_C = \Lambda_\infty + (B)\sqrt{C}$

**52.** Given below are the half-cell reactions:

$Mn^{2+} + 2e^- \longrightarrow Mn$ ; E° = –1.18 V

$2(Mn^{3+} + e^- \longrightarrow Mn^{2+})$ ; E° = +1.51 V

The E° for $3Mn^{2+} \longrightarrow Mn + 2Mn^{3+}$ will be:

(1) –2.69 V ; the reaction will not occur

(2) –2.69 V ; the reaction will occur

(3) –0.33 V ; the reaction will not occur

(4) –0.33 V ; the reaction will occur

**53.** How many electrons would be required to deposit 6.35 g of copper at the cathode during the electrolysis of an aqueous solution of copper sulphate? (Atomic mass of copper = 63.5 u, $N_A$ = Avogadro's constant).

(1) $\frac{N_A}{20}$ (2) $\frac{N_A}{10}$

(3) $\frac{N_A}{5}$ (4) $\frac{N_A}{2}$

**54.** At 298 K, the standard reduction potentials are 1.51 V for $MnO_4^-|Mn^{2+}$, 1.36 V for $Cl_2|Cl^-$, 1.07 V for $Br_2|Br$, and 0.54 V for $I_2|I^-$. At pH = 3, permanganate is expected to oxidize: $\left(\frac{RT}{F} = 0.059\,V\right)$

(1) $Cl^-$, $Br^-$ and $I^-$ (2) $Br^-$ and $I^-$

(3) $Cl^-$ and $Br^-$ (4) $I^-$ only

**55.** Consider the following standard electrode potentials (E° in volts) in aqueous solution:

| **Element** | **$M^{3+}$ / M** | **$M^+$ / M** |
|---|---|---|
| Al | –1.66 | + 0.55 |
| Tl | +1.26 | – 0.34 |

Based on these data, which of the following statements is **correct**?

(1) $Al^+$ is more stable than $Al^{3+}$

(2) $Tl^{3+}$ is more stable than $Al^{3+}$

(3) $Tl^+$ is more stable than $Al^{3+}$

(4) $Tl^+$ is more stable than $Al^+$

**56.** To find the standard potential of $M^{3+}$/M electrode, the following cell is constituted:

Pt / M / $M^{3+}$ (0.001 mol $L^{-1}$) / $Ag^+$ (0.01 mol $L^{-1}$)/Ag

The emf of the cell is found to be 0.421 volt at 298 K. The standard potential of half reaction $M^{3+} + 3e^- \longrightarrow M$ at 298 K will be: (Given $E^o_{Ag^+/Ag}$ at 298 K = 0.80 volt)

(1) 0.32 Volt (2) 0.66 Volt

(3) 0.38 Volt (4) 1.28 Volt

**57.** Which is/are correct among the following?

Given, the half-cell emf's

$E^0_{Cu^{+2}|Cu} = 0.337$, $E^0_{Cu^{+1}|Cu} = 0.521$

(1) $Cu^{+1}$ disproportionates

(2) Cu and $Cu^{2+}$ comproportionates.

(3) $E^0_{Cu\,|\,Cu^{+2}} + E^0_{Cu^{+1}\,|\,Cu}$ is positive

(4) (1) and (3) Both

**58.** The E° in the given figure is about:

$$ClO_3^{\ominus} \xrightarrow{0.54\,V} ClO^{\ominus} \xrightarrow{0.45\,V} Cl_2 \xrightarrow{1.07\,V} Cl^{\ominus}$$

($ClO_3^{\ominus} \longrightarrow Cl^{\ominus}$: E°)

(1) 0.5 V

(2) 0.6 V

(3) 0.7 V

(4) 0.8 V

**59.** The standard reduction potential for $Zn^{+2}$/Zn; $Ni^{+2}$/Ni; and $Fe^{+2}$/Fe are –0.76 V, –0.23 V, –0.44 V respectively. The reaction $X + Y^{+2} \longrightarrow X^{+2} + Y$ will be non-spontaneous when:

| | X | Y |
|---|---|---|
| (I) | Ni | Fe |
| (II) | Ni | Zn |
| (III) | Fe | Zn |
| (VI) | Zn | Ni |

(1) I, II, IV only (2) I, II, III only

(3) II, III, IV only (4) All of these

**60.** How much will the reduction potential of a hydrogen electrode change when its solution initially at pH = 0 is increased to pH = 14 at 25° C?

(1) Increases by 0.059 V

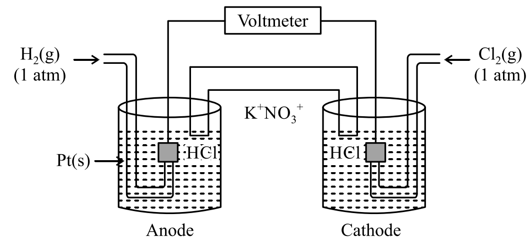
(2) Decreases by 0.082 V

(3) Increases by 0.41 V

(4) Decreases by 0.82 V

*Integer Type Questions (61 to 75)*

**61.** Consider the following Galvanic cell as shown in figure. If value the cell voltage change is $-\frac{x}{1000}$ when concentration of ions in anodic and cathodic compartments are both increased by factor of 10 at 298 K then the value of x is $\left(\text{Let } \frac{2.303RT}{F} = 0.06\right)$




**62.** During electrolysis of conc. $H_2SO_4$, perdisulphuric acid ($H_2S_2O_8$) and $O_2$ are formed in equimolar amount which is one moles each. The moles of $H_2$ that will be produced simultaneously will be y. Find y

**63.** The cell Pt, $H_2$(g) (1 atm) $|H^+, pH = \frac{x}{10}|$

Normal calomel electrode has emf of 0.67 V at 25°C. The oxidation potential of calomel electrode on H-scale is −0.28 V. The value of x is $\left(\text{Let } \frac{2.303RT}{F} = 0.06\right)$

**64.** For the cell, Pt | $H_2$ (g) | $H^+$ (aq) || $Cu^{2+}$ (aq) | Cu (s)

$E^o_{Cu/Cu^{2+}} = -0.34$ V

Then calculate approximate value of $K_{eq}$ is $2 \times 10^x$. The value of x

**65.** The standard electrode potential for the reaction

$Ag^+ (aq) + e^- \longrightarrow Ag(s)$

$Sn^{2+}(aq) + 2e^- \longrightarrow Sn(s)$

at 25°C are 0.80 volt and – 0.14 volt, respectively. The emf of the cell

($Sn|Sn^{+2}||Ag^+|Ag$) is $\frac{x}{100}$V,

the value of x will be

Sn | $Sn^{2+}$(1M) | | $Ag^+$(1M) | Ag is:

**66.** The standard electrode potentials of the two half-cell are given below:

$Ni^{2+} + 2e^- \rightarrow Ni$ ; E° = – 0.25 V

$Zn^{2+} + 2e^- \rightarrow Zn$ ; E° = – 0.77 V

The emf of cell formed by combining the two half cells is $\frac{y}{50}$ volt, the value of y will be

**67.** Electrolysis can be used to determine atomic masses. A current of 0.550 A deposits 0.55 g of a certain metal in 100 minutes. If the atomic mass of the metal (n factor = 3) is $\frac{z}{4}$, the value of z is (nearest integer)

**68.** How many minutes will it take to plate out 5.0 g of Cr from a $Cr_2(SO_4)_3$ solution using a current of 15 A ? (Atomic weight: Cr = 52.0) (nearest integer)

**69.** How many coulomb of electricity are consumed when 100 mA current is passed through a solution of $AgNO_3$ for 30 minutes during an electrolysis experiment:

**70.** A certain current liberated 0.504 g of hydrogen in 2 hours. How many grams of copper can be liberated by the same current flowing for the same time in copper sulphate solution (nearest integer)

**71.** The ionization constant of a weak electrolyte is $25 \times 10^{-6}$ while the equivalent conductance of its 0.01 M solution is 19.6 S $cm^2$ $eq^{-1}$. The equivalent conductance of the electrolyte at infinite dilution (in S $cm^2$ $eq^{-1}$) will be

**72.** Resistance of 0.1 M KCl solution in a conductance cell is 300 ohm and conductivity is 0.013 $Scm^{-1}$. The value of cell constant is $\frac{x}{10} cm^{-1}$, the value of x is

**73.** The equivalent conductivity of 0.1 N $CH_3COOH$ at 25°C is 80 and at infinite dilution 400. The degree of dissociation of $CH_3COOH$ is x %, the value of x is

**74.** The weight of silver (in gm) (eq. wt = 108) displaced by that quantity of current which displaced 5600 ml. of hydrogen at STP is:

**75.** When molten lithium chloride (LiCl) is electrolyzed, lithium metal is formed at the cathode. If current efficiency is 75% . If $\frac{x}{1000}$ grams of lithium are liberated when 1930 C of charge is passed through the cell the value of x is (Atomic weight: Li = 7)

# CHAPTER 12

# CHEMICAL KINETICS

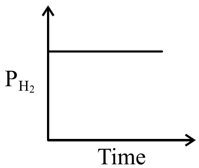
### *Single Option Correct Type Questions (01 to 60)*

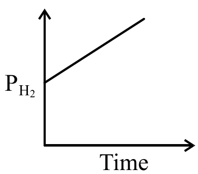
**1.** A reaction, which is second order, has a rate constant of 0.002 L $mol^{-1}$ $s^{-1}$. If the initial conc. of the reactant is 0.2 M. how long will it take for the concentration to become 0.0400 M?

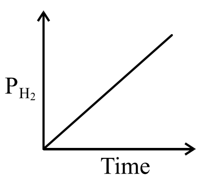
(1) 1000 s (2) 400 s

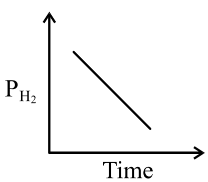
(3) 200 s (4) 10, 000 s

**2.** Decomposition of HI (g) on gold surface is zero order reaction. Initially, few moles of $H_2$ are present in the container then which of the following graph is correct?

(1) 


(2) 


(3) 


(4) 


**3.** Match the order of reaction (in List **I**) with its property (in List **II**) and select the correct answer using the code given below the lists:

| **List- I (Order)** | | **List- II (Property)** | |
|---|---|---|---|
| I | Zero | P | Half-life $\propto \frac{1}{a^2}$ |
| II | First | Q | Half-life $\propto \frac{1}{a}$ |
| III | Second | R | Half-life is doubled on doubling the initial concentration |
| IV | Third | S | 50% reaction takes same time even if concentration is halved or doubled. |

(1) I-S ; II-R ; III-Q ; IV-P

(2) I-R ; II-S ; III-Q ; IV-P

(3) I-Q ; II-S ; III-P ; IV-R

(4) I-R ; II-Q ; III-S ; IV-P

**4.** Half-lives of decomposition of $NH_3$ on the surface of a catalyst for different initial pressure are given as:

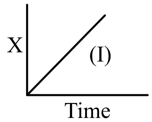
| P(torr) | 200 | 300 | 500 |
|---|---|---|---|
| $t_{1/2}$ | 10 | 15 | 25 |

The order of the reaction is-

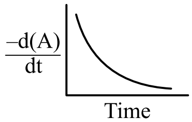
(1) 2 (2) 0

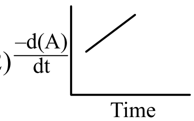
(3) 1 (4) 0.5

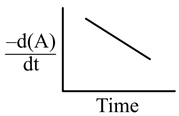
**5.** Variation of concentration of the product (X) with time in the reaction $A \rightarrow X$ is shown in graph (I).

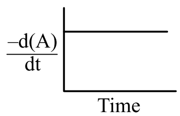



Hence, the graph between $-\frac{d(A)}{dt}$ and time will be of the type:

(1) 


(2) 


(3) 


(4) 


**6.** At 227ºC, the presence of catalyst causes the activation energy of a reaction to decrease by 4.606 K cal. The rate of the reaction will be increased by:

(1) 2 times (2) 10 times
(3) 100 times (4) 1000 times

**7.** Gaseous cyclobutane isomerizes to butadiene following first order process which has half-life of 150.5 minute at certain temperature. How long will take for the process to occur to the extent of 40% at the same temperature?

(1) 103 minutes (2) 121 minutes
(3) 111 minutes (4) 115 minutes

**8.** The rate constant for the reaction $2N_2O_5 \rightarrow 4NO_2 + O_2$ is $3.0 \times 10^{-4}\ s^{-1}$. If start is made with 1.0 mol $L^{-1}$ of $N_2O_5$, calculate the rate of formation of $NO_2$ at the moment of the reaction when concentration of $O_2$ is 0.1 mol $L^{-1}$.

(1) $2.7 \times 10^{-4}$ mol $L^{-1}s^{-1}$
(2) $2.4 \times 10^{-4}$ mol $L^{-1}\ s^{-1}$
(3) $4.8 \times 10^{-4}$ mol $L^{-1}\ s^{-1}$
(4) $9.6 \times 10^{-4}$ mol $L^{-1}\ s^{-1}$

**9.** The rate of a hetrogeneous reaction (as iron (solid) and oxygen gas) does not depend on:

(1) Concentration of reactants
(2) Surface area of reactants
(3) Pressure of reactant gases
(4) Potential energy of reactant

**10.** For the reaction $4A + B \rightarrow 2C + 2D$

The incorrect statement is:

(1) The rate of disappearance of B is one fourth the rate of disappearance of A
(2) The rate of appearance of C is half the rate of disappearance of B
(3) The rate of formation of D is half the rate of consumption of A
(4) The rates of formation of C and D are equal

**11.** The decomposition of azo methane, at certain temperature according to the equation $(CH_3)_2N_2 \rightarrow C_2H_6 + N_2$ is a first order reaction. After 40 minutes from the start, the total pressure developed is found to be 350 mm Hg in place of initial pressure 200 mm Hg of azo methane. The value of rate constant k is -

(1) $2.88\times10^{-4}\ sec^{-1}$ (2) $1.25\times10^{-4} sec^{-1}$
(3) $3.45\times10^{-4}\ sec^{-1}$ (4) None of these

**12.** The decomposition of $N_2O$ into $N_2$ & $O_2$ in presence of gaseous argon follow second order kinetics with

$k = (5.0 \times 10^{11}\ L\ mol^{-1}\ s^{-1})\ e^{-\frac{41570\ K}{T}}$ (K stands for Kelvin units). The energy of activation of the reaction is

(1) $5.0 \times 10^{11}$ J (2) 41570 J
(3) 5000 J (4) 345446.70 J

**13.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I (Graph) | | List- II (Slope) | |
|---|---|---|---|
| I | C Vs t (abscissa) for zero order | P | Unity |
| II | log C Vs t (abscissa) for first order | Q | Zero |
| III | $\left(\frac{-dc}{dt}\right)$ Vs c for zero order | R | –k |

| | | | |
|---|---|---|---|
| IV | $\ln\left(\frac{-dc}{dt}\right)$ Vs $\ell$nc for first order | S | $-\frac{k}{2.303}$ |

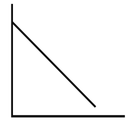
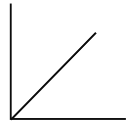
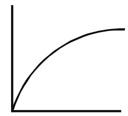
(1) I-R ; II-S ; III-Q ; IV-P
(2) I-S ; II-P ; III-Q ; IV-R
(3) I-Q ; II-S ; III-P ; IV-R
(4) I-R ; II-Q ; III-P ; IV-S

**14.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | If the activation energy is 65 kJ then how much time faster a reaction proceed at 25°C than at 0°C | P | 2 |
| II | Rate constant of a first - order reaction is 0.0693 $min^{-1}$. If we start with 20 mol $L^{-1}$, it is reduced to 2.5 mol $L^{-1}$ in how many minutes | Q | Zero |
| III | Half - lives of first - order and zero order reactions are same. Ratio of rates at the start of reaction is how many times of 0.693. Assume initial concentration to be same for the both. | R | 11 |
| IV | the half-life periods are given,<br>$[A]_0$ (M): 0.0677, 0.136<br>$t_{1/2}$ (sec): 240, 480<br>Order of the reaction is: | S | 30 |

(1) I-R ; II-S ; III-P ; IV-Q
(2) I-S ; II-R ; III-P ; IV-Q
(3) I-R ; II-P ; III-S ; IV-Q
(4) I-R ; II-S ; III-Q ; IV-P

**15.** Match the following for a 1st order reaction A→ products with time on the x axis and select the correct answer using the code given below:

| List- I | | List- II | |
|---|---|---|---|
| I | [A] v/s time | P |  |
| II | $\frac{-d[A]}{dt}$ v/s [A] | Q |  |
| III | $\frac{-d[A]}{dt}$ v/s time | R |  |
| IV | log [A] v/s time | S |  |

(1) I-R ; II-Q ; III-R ; IV-P
(2) I-R ; II-R ; III-Q ; IV-P
(3) I-Q ; II-R ; III-R ; IV-P
(4) I-R ; II-Q ; III-P ; IV-R

**16.** For the reaction, $2NO(g) + 2H_2(g) \longrightarrow N_2(g) + 2H_2O(g)$ the rate expression can be written in the following ways:

$\{dt[N_2]/dt\} = k_1 [NO][H_2]$ ; $\{d[H_2O]/dt\} = k[NO][H_2]$ ; $\{-d[NO]/dt\} = k'_1 [NO][H_2]$ ; $\{-d[H_2]/dt\} = k''_1 [NO][H_2]$

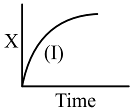
The relationship between k, $k_1$, $k'_1$ and $k''_1$. is:

(1) $k = k_1 = k'_1 = k''_1$
(2) $k = 2k_1 = k'_1 = k''_1$
(3) $k = 2k'_1 = k_1 = k''_1$
(4) $k = k_1 = k'_1 = 2 k''_1$

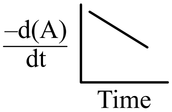
**17.** For a first order reaction, the plot of 't' against log C gives a straight line with slope equal to:

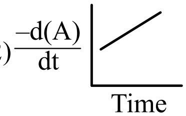
(1) (k / 2.303) (2) (– k / 2.303)
(3) (ln k / 2.303) (4) – k.

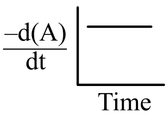
**18.** Graph between concentration of the product and time of the reaction A → B is of the type

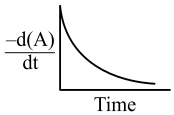



Hence graph between – d[A]/dt and time will be of the type:

(1) 


(2) 


(3) 

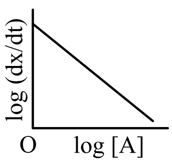

(4) 

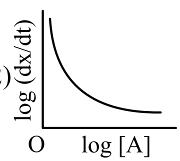

**19.** In the case of zero order reaction, the ratio of time required for 75% completion to 50% completion is:

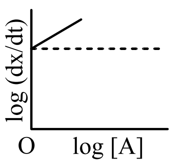
(1) ln 2 (2) 2

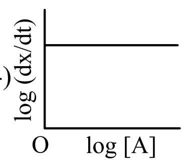
(3) 1.5 (4) None

**20.** A → Product and $\left(\frac{dx}{dt}\right) = k[A]^2$. If log $\left(\frac{dx}{dt}\right)$ is plotted against log [A], then graph is of the type:

(1) 


(2) 


(3) 


(4) 


**21.** Let there be as first-order reaction of the type, A $\longrightarrow$ B + C. Let us assume that only A is gaseous. We are required to calculate the value of rate constant based on the following data.

| Time | 0 | T | ∞ |
|---|---|---|---|
| Partial pressure of A | $P_0$ | $P_t$ | – |

Calculate the expression of rate constant.

(1) $k = \frac{1}{t}\ln\left(\frac{P_0}{P_t}\right)$ (2) $k = \frac{1}{t}\ln\left(\frac{P_t}{P_0}\right)$

(3) $k = \frac{1}{t}\ln\left(\frac{2P_0}{P_t}\right)$ (4) $k = \frac{1}{t}\ln\left(\frac{P_t}{2P_0}\right)$

**22.** For a zero order reaction, which of the following statement is false:

(1) The rate is independent of the temperature of the reaction.

(2) The rate is independent of the concentration of the reactants.

(3) The half-life depends on the concentration of the reactants.

(4) The rate constant has the unit mole litre$^{-1}$ sec$^{-1}$.

**23.** For producing the effective collisions, the colliding molecules must posses:

(1) A certain minimum amount of energy

(2) Energy equal to or greater than threshold energy

(3) Proper orientation

(4) Threshold energy as well as proper orientation of collision.

**24.** The reaction of hydrogen, and iodine monochloride is represented by the equation:

$$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$$

This reaction is first–order in $H_2(g)$ and also first–order in ICl(g). Which of these proposed mechanism can be consistent with the given information about this reaction?

**Mechanism I:**

$$H_2(g) + 2ICl(g) \longrightarrow 2HCl(g) + I_2(g)$$

**Mechanism II:**

$$H_2(g) + ICl(g) \xrightarrow{\text{Slow}} HCl(g) + HI(g)$$

$$HI(g) + ICl(g) \xrightarrow{\text{fast}} HCl(g) + I_2(g)$$

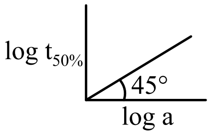
(1) I only

(2) II only

(3) Both I and II

(4) Neither I nor II

**25.** What will be the order of reaction and rate constant for a chemical change having log $t_{50\%}$ vs log concentration of (A) curves as:

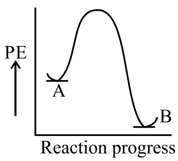


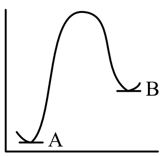

(1) 0, 1/2 (2) 1, 1
(3) 2, 2 (4) 3, 1

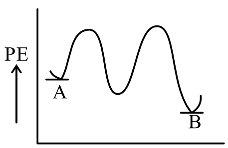
**26.** The rate constant $K_1$ of a reaction is found to be double that of rate constant $K_2$ of another reaction. The relationship between corresponding activation energies of the two reactions at same temperature ($E_1$ and $E_2$) can be represented as:

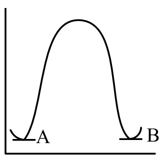
(1) $E_1 > E_2$ (2) $E_1 < E_2$
(3) $E_1 = E_2$ (4) None of these

**27.** For a reaction A → B, $E_a$ = 10 kJ mol$^{-1}$, ΔH = 5 kJ mol$^{-1}$. Thus, potential energy profile for this reaction is:

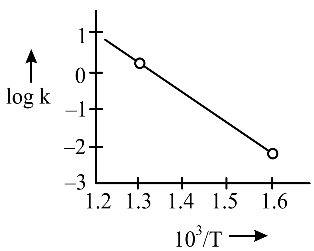
(1)



(2)



(3)



(4)



**28.** For the decomposition of HI the following logarithmic plot is shown: [R = 1.98 cal/mol-K]




The activation energy of the reaction is about

(1) 45600 cal (2) 13500 cal
(3) 24600 cal (4) 32300 cal

**29.** A hypothetical reaction $X_2 + Y_2 \longrightarrow 2XY$ follows the mechanism given below.

$X_2 \rightleftharpoons X + X$ [Fast]

$X + Y_2 \longrightarrow XY + Y$ [Slow]

$X + Y \longrightarrow XY$ [Fast]

The order of overall reaction is

(1) 2 (2) 1
(3) 1.5 (4) Zero

**30.** A radioactive element has a half-life of one day. After three days, the amount of the element left will be:

(1) 1/2 of the original amount
(2) 1/4 of the original amount
(3) 1/8 of the original amount
(4) 1/16 of the original amount

**31.** **Assertion:** The rate of reaction whether exothermic or endothermic, increases with temperature.

**Reason:** The rate of reaction = K [reactant]$^n$ and K increases with temperature.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**32.** **Assertion:** A catalyst always lowers the energy of activation.

**Reason:** The positive catalyst-reactant interaction forms activated adsorbed complex and adsorption is always exothermic.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**33.** **Assertion:** The elementary reaction is single step reaction and does not possess mechanism.

**Reason:** An elementary reaction has order of reaction and molecularity same.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both are assertion and reason are incorrect

**34.** Units of rate constant of first and zero order reactions in terms of molarity M unit are respectively

(1) $sec^{-1}$, M $sec^{-1}$ (2) $sec^{-1}$, M

(3) M $sec^{-1}$, $sec^{-1}$ (4) M, $sec^{-1}$

**35.** The differential rate law for the reaction $H_2 + I_2 \rightarrow 2HI$ is:

(1) $-\frac{d[H_2]}{dt} = -\frac{d[I_2]}{dt} = -\frac{d[HI]}{dt}$

(2) $\frac{d[H_2]}{dt} = \frac{d[I_2]}{dt} = \frac{1}{2}\frac{d[HI]}{dt}$

(3) $\frac{1}{2}\frac{d[H_2]}{dt} = \frac{1}{2}\frac{d[I_2]}{dt} = -\frac{d[HI]}{dt}$

(4) $-2\frac{d[H_2]}{dt} = -2\frac{d[I_2]}{dt} = +\frac{d[HI]}{dt}$

**36.** The rate law for a reaction between the substances A and B is given by rate = k $[A]^n$ $[B]^m$. On doubling the concentration of A and halving the concentration of B, the ratio of the new rate to the earlier rate of the reaction will be as

(1) $\frac{1}{2^{m+n}}$ (2) (m + n)

(3) (n – m) (4) $2^{(n-m)}$.

**37.** For the reaction system: $2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$, volume is suddenly reduced to half its value by increasing the pressure on it. If the reaction is of first order with respect to $O_2$ and second order with respect to NO, the rate of reaction will:

(1) Diminish to one-fourth of its initial value

(2) Diminish to one-eighth of its initial value

(3) Increase to eight times of its initial value

(4) Increase to four times of its initial value.

**38.** In the respect of the equation $k = Ae^{-Ea/RT}$ in chemical kinetics, which one of the following statements is correct:

(1) k is equilibrium constant

(2) A is adsorption factor

(3) $E_a$ is energy of activation

(4) R is Rydberg constant.

**39.** The rate equation for the reaction $2A + B \longrightarrow C$ is found to be: rate = k[A] [B]. The correct statement in relation to this reaction is that the:

(1) Unit of k must be $sec^{-1}$

(2) $t_{1/2}$ is a constant

(3) Rate of formation of C is twice the rate of disappearance of A

(4) Value of k is independent of initial concentrations of A and B.

**40.** The half - life of a radioisotope is four hours. If the initial mass of the isotope was 200 g, the mass remaining after 24 hours undecayed is:

(1) 1.042 g (2) 2.084 g

(3) 3.125 g (4) 4.167 g.

**41.** Consider an endothermic reaction $X \longrightarrow Y$ with the activation energies $E_b$ and $E_f$ for the backward and forward reaction, respectively. In general

(1) $E_b < E_f$ (2) $\Delta H = \Delta U$

(3) $\Delta H < \Delta U$ (4) $\Delta H > \Delta U$

**42.** A reaction involving two different reactants can never be:

(1) Unimolecular reaction

(2) First order reaction

(3) Second order reaction

(4) Bimolecular reaction

**43.** A reaction was found to be second order with respect to the concentration of carbon monoxide. If the concentration of carbon monoxide is doubled, with everything else kept the same, the rate of reaction will
(1) Remain unchanged
(2) Get tripled
(3) Increased by a factor of 4
(4) Get doubled

**44.** The half-life period of a first order chemical reaction is 6.93 minutes. Time required for the completion of 99% of the chemical reaction will be (log 2 = 0.301):
(1) 23.03 minutes
(2) 46.06 minutes
(3) 460.6 minutes
(4) 230.3 minutes

**45.** A reactant (A) forms two products:

$A \xrightarrow{k_1} B$, Activation Energy ($Ea_1$)

$A \xrightarrow{k_2} C$, Activation Energy ($Ea_2$)

If $Ea_2 = 2\ Ea_1$, then $k_1$ and $k_2$ are related as:
(1) $k_2 = k_1 e^{Ea_1/RT}$
(2) $k_2 = k_1 e^{Ea_2/RT}$
(3) $k_1 = Ak_2 e^{Ea_1/RT}$
(4) $k_1 = 2k_2 e^{Ea_2/RT}$

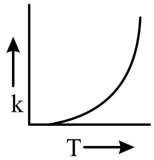
**46.** The rate of a reaction doubles when its temperature changes from 300 K to 310 K. Activation energy of such a reaction will be: (R = 8.314 $JK^{-1}\ mol^{-1}$ and log 2 = 0.301)
(1) 53.6 $kJ\ mol^{-1}$
(2) 48.6 $kJ\ mol^{-1}$
(3) 58.5 $kJ\ mol^{-1}$
(4) 60.5 $kJ\ mol^{-1}$

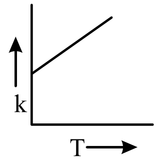
**47.** For the non-stoichiometric reaction $2A + B \rightarrow C + D$, the following kinetic data were obtained in three separate experiments, all at 298 K.

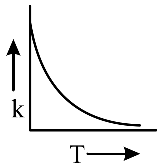
| Initial Concentration (A) | Initial Concentration (B) | Initial rate of formation of C (mol $L^{-}S^{-}$) |
|---|---|---|
| 0.1 M | 0.1 M | $1.2\times10^{-3}$ |
| 0.1 M | 0.2 M | $1.2\times10^{-3}$ |
| 0.2 M | 0.1 M | $2.4\times10^{-3}$ |

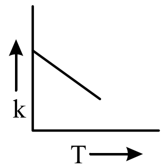
The rate law for the formation of C is:
(1) $\frac{dc}{dt} = k[A][B]$
(2) $\frac{dc}{dt} = k[A]^2[B]$
(3) $\frac{dc}{dt} = k[A][B]^2$
(4) $\frac{dc}{dt} = k[A]$

**48.** Plots showing the variation of the rate constant (k) with temperature (T) are given below. The plot that follows Arrhenius equation is:

(1)



(2)



(3)



(4)



**49.** The reaction $A(g) + 2B(g) \rightarrow C(g)$ is an elementary reaction. In an experiment involving this reaction, the initial partial pressures of A and B are $P_A = 0.40$ atm and $P_B = 1.0$ atm respectively. When pressure of C becomes 0.3 atm in the reaction the rate of the reaction relative to the initial rate is:
(1) $\frac{1}{12}$
(2) $\frac{1}{50}$
(3) $\frac{1}{25}$
(4) $\frac{1}{20}$

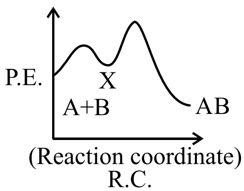
**50.** Which of the following statement is incorrect?
(1) Unit of rate of disappearance is $Ms^{-1}$
(2) Unit of rate of reaction is $Ms^{-1}$
(3) Unit of rate constant k is depends on order
(4) Unit of k for first order reaction is $Ms^{-1}$

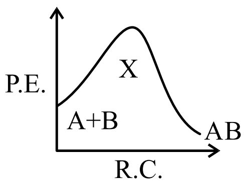
**51.** Which of the following statement is incorrect?
(1) A second order reaction must be a bimolecular elementary reaction
(2) A bimolecular elementary reaction must be a second order reaction
(3) Zero order reaction must be a complex reaction
(4) First order reaction may be complex or elementary reaction

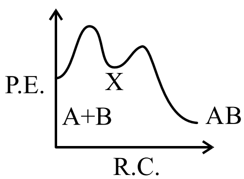
**52.** For an elementary reaction $2A + B \longrightarrow A_2B$ if the volume of vessel is quickly reduced to half of it's original volume then rate of reaction will:
(1) Unchange
(2) Increase four times
(3) Increase eight times
(4) Decrease eight times

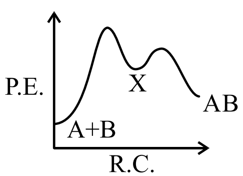
**53.** In the presence of acid, the initial concentration, of cane-sugar was reduced from 0.2 M to 0.1 M in 5 hr and to 0.05 M in 10 hr. The reaction must be of
(1) Zero order
(2) First order
(3) Second order
(4) Fractional order

**54.** For an exothermic chemical process occurring in two steps as follows
(i) $A + B \longrightarrow X$ (slow)
(ii) $X \longrightarrow AB$ (fast)
the process of reaction can be best described by:

(1) 


(2) 

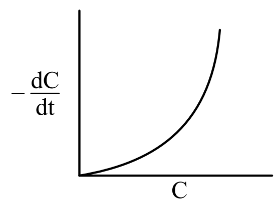

(3) 

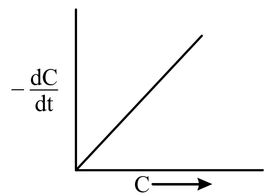

(4) 

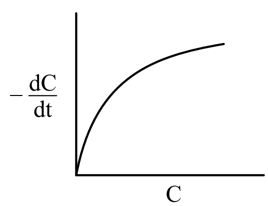

**55.** The temperature coefficient of a reaction is:
(1) The rate constant
(2) The rate constant at a fixed temperature
(3) The ratio of rate constant at two temperature
(4) The ratio of rate constant differing by 10ºC preferably $k_{308}/k_{298}$

**56.** The time of decay for a nuclear reaction is given by $t = 4t_{1/2}$. The relation between the mean life (T) and time of decay (t) is given by the value of t =
(1) 2 T ln 2 (2) 4 T ln 2
(3) $2T^4 \ln 2$ (4) $\frac{1}{T^2} \ln 2$

**57.** In three different reactions, involving a single reactant in each case, a plot of rate of the reaction on the y–axis, versus concentration of the reactant on the x-axis, yields three different curves shown below.

(i) 


(ii) 


(iii) 


What are the possible orders of the reactions (i), (ii), (iii)?
(1) 1, 2, 3 (2) 2, 1, 1/2
(3) 0, 1, 2 (4) 0, 1, 1/2

**58.** $t_{1/2}$ = constant, confirms that the order of the reaction is one. $a^2 t_{1/2}$ = constant, confirms that the reaction is of:
(1) Zero order
(2) First order
(3) Second order
(4) Third order

**59.** If the initial concentration of reactants in certain reaction is doubled, the half-life period of the reaction doubles, the order of a reaction is:
(1) Zero (2) First
(3) Second (4) Third

**60.** If rate constant is numerically the same for three reactions of first, second and third order respectively. Which of the following is correct:
(1) if [A] = 1 then $r_1 = r_2 = r_3$
(2) if [A] < 1 then $r_1 > r_2 > r_3$
(3) if [A] > 1 then $r_3 > r_2 > r_1$
(4) All

*Integer Type Questions (61 to 75)*

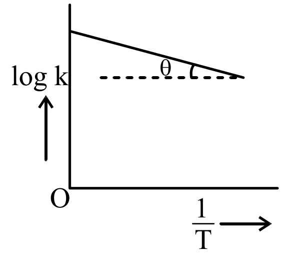
**61.** How many times faster would a reaction proceeds at 25°C than at 0°C if the activation energy is 65 kJ?

**62.** Two substances A ($t_{1/2}$ = 5 min) and B ($t_{1/2}$ = 15 min) are taken in such a way that initially [A] = 4[B]. If t(min) is the time after which both the concentration will be equal, (Assume that reaction is first order) the value of t is (in min.)

**63.** From different sets of data of $t_{1/2}$ at different initial concentration say 'a' for a given reaction, the product $[t_{1/2} \times a]$ is found to be constant. The order of reaction is:

**64.** The rate constant of a first order reaction is $4 \times 10^{-3}$ $sec^{-1}$. At a reactant concentration of 0.02 M. the rate of reaction would be is $x \times 10^{-6}$ mole/$sec^{-1}$. The value of x is

**65.** Graph between log k and $\frac{1}{T}$ (k is rate constant in $s^{-1}$ and T is the temperature in K) is a straight line. As shown in figure if OX = 5 and slope of the line= $-\frac{1}{2.303}$




then $E_a$ is y cal. The value of y is

**66.** The activation energy for the forward reaction $X \rightleftharpoons Y$ is 60 KJ $mol^{-1}$ and ΔH is –20 KJ $mol^{-1}$. The activation energy for the backward reaction $Y \rightleftharpoons X$ is:

**67.** For a given reaction, energy of activation for forward reaction ($E_{af}$) is 80 $kJ.mol^{-1}$. ΔH = –40 $kJ.mol^{-1}$ for the reaction. A catalyst lowers $E_{af}$ to 20 $kJ.mol^{-1}$. The ratio of energy of activation for reverse reaction before and after addition of catalyst is:

**68.** For the reaction A + 2B → C, rate is given by $R = k[A][B]^2$ then the order of the reaction is :

**69.** In a first order reaction, the concentration of the reactant, decreases from 0.8 M to 0.4 M in 15 minutes. The time taken for the concentration to change from 0.1 M to 0.025 M is: (in min.)

**70.** The following mechanism has been proposed for the reaction of NO with $Br_2$ to form NOBr.
$NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$ ; $NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$ (slow step)
If the second step is the rate determining step, the order of the reaction with respect to NO(g) is

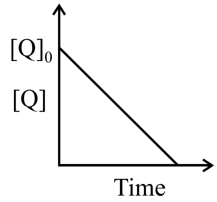
**71.** The energies of activation for forward and reverse reactions for $A_2 + B_2 \rightleftharpoons 2AB$ are 180 kJ mol$^{-1}$ and 200 kJ mol$^{-1}$ respectively. The presence of a catalyst lowers the activation energy of both (forward and reverse) reactions by 100 kJ mol$^{-1}$. If the enthalpy change of the reaction ($A_2 + B_2 \rightleftharpoons 2AB$) in the presence of catalyst will be (in kJ mol$^{-1}$) is –x. The value of x is

**72.** A radioactive element gets spilled over the floor of a room. Its half-life period is 30 days. If the initial activity is ten times the permissible value, after how many days will it be safe to enter the room:

**73.** The rate of a chemical reaction doubles for every 10ºC rise of temperature. If the temperature is raised by 50ºC, the rate of the reaction increases by about x times. The value of x is

**74.** In the reaction, $P + Q \longrightarrow R + S$

The time taken for 75% reaction of P is twice the time taken for 50% reaction of P. The concentration of Q varies with reaction time as shown in the figure. The overall order of the reaction is:




**75.** If the rate of the reaction is equal to the rate constant, the order of the reaction is:

CHAPTER 13

# THE p-BLOCK ELEMENTS (GROUP 13 TO 18)

*Single Option Correct Type Questions (01 to 60)*

**1.** There is considerable increase in covalent radius from N to P. However, from Sb to Bi only small increase (of 7 pm) in covalent radius is observed. This is due to :
(1) poor shielding by completely filled d- and f-orbitals in Bi.
(2) similar electronegativity of Sb and Bi.
(3) the Bi being last element of the group.
(4) similar densities of Sb and Bi.

**2.** With respect to protonic acids, which of the following statement is correct ?
(1) $PH_3$ is more basic than $NH_3$
(2) $PH_3$ is less basic than $NH_3$
(3) $PH_3$ is equally basic as $NH_3$
(4) $PH_3$ is amphoteric while $NH_3$ is basic.

**3.** Which of the following can convert acidified $Cr_2O_7^{2-}$ to green ?
(1) $SO_2$ / $H_2SO_3$ / $H_2SO_4$
(2) $SO_3$ / $H_2SO_3$ / $H_2S$
(3) $S_2O_3^{2-}/H_2S/Fe^{2+}$
(4) $S_2O_3^{2-}/SO_3/Fe^{3+}$

**4.** Which of the following is incorrect for the oxides of 16th group elements ?
(1) Reducing property of their dioxides decreases from $SO_2$ to $TeO_2$
(2) Basic character of their dioxide increases down the group i.e acidic character decreases down the group.
(3) (1) and (2) both
(4) None

**5.** The decrease in stability of compounds of higher oxidation state in p–block with increasing atomic number is due to:
(1) decrease in bond energy as on going down the group.
(2) energy required to unpair $ns^2$ – electrons is not compensated by the energy released in forming the two additional bonds.
(3) both are correct.
(4) none is correct.

**6.** For $H_3PO_3$ and $H_3PO_4$, the correct choice is:
(1) $H_3PO_3$ is stronger acid than $H_3PO_4$
(2) $H_3PO_3$ is dibasic and reducing.
(3) $H_3PO_4$ is tribasic and reducing
(4) (1) and (2) both

**7.** Which of the following is the most basic oxide?
(1) $SeO_2$ (2) $P_2O_3$
(3) $Sb_2O_3$ (4) $Bi_2O_3$

**8.** In group 15, the melting points of the elements:
(1) increase regularly on moving down the group.
(2) decrease regularly on moving down the group.
(3) first decrease upto As and then increase to Bi.
(4) first increase from N to As and then decrease to Bi.

**9.** The hydrides of group 15 elements act as :
(1) lewis acids (2) lewis bases
(3) both (4) none

**10.** Single N-N bond is weaker than the single P-P bond. This is because of :
(1) larger N-N bond length in comparison to P-P bond length .
(2) high interelectronic repulsion of the non-bonding electrons, owing to the small N-N bond length in comparison to that in P-P single bond .
(3) higher electronegativity of N in comparison to P.
(4) smaller atomic size of N as compared to that of P.

**11.** The basic strength of the hydrides of group 15 elements :
(1) decreases on moving down the group
(2) increases on moving down the group
(3) first decreases upto $AsH_3$ and then increases
(4) first increases upto $AsH_3$ and then decreases

**12.** What causes nitrogen to be chemically inert ?
(1) Multiple bond formation in the molecule
(2) Absence of bond polarity
(3) Short internuclear distance
(4) High bond energy

**13.** Which of the following oxides is the most acidic?
(1) $N_2O_5$ (2) $P_2O_5$
(3) $As_2O_5$ (4) $Sb_2O_5$

**14.** Which of the following oxides is amphoteric in nature ?
(1) $N_2O_3$ (2) $P_4O_6$
(3) $Sb_4O_6$ (4) $Bi_2O_3$

**15.** In case of nitrogen, $NCl_3$ is possible but not $NCl_5$ while in case of phosphorous, $PCl_3$ as well as $PCl_5$ are possible. It is due to
(1) Availability of vacant d-orbital in P but not in N
(2) Lower electronegativity of P than N
(3) Lower tendency of H bond formation in P than N
(4) Occurrence of P in solid while N in gaseous state at room temperature.

**16.** Which of the following acts as semi metal ?
(1) S (2) Te
(3) Po (4) O

**17.** Which element of chalcogens has maximum tendency to show catenation?
(1) Oxygen (2) Selenium
(3) Sulphur (4) Tellurium

**18.** Which of the following compounds is the strongest reducing agent ?
(1) $H_2O$ (2) $H_2S$
(3) $H_2Se$ (4) $H_2Te$

**19.** Which one of the following statements is false?
(1) Because of the compact nature of oxygen atom, it has less negative electron gain enthalpy than sulphur.
(2) Next to fluorine, oxygen has the highest electronegativity value amongst the elements.
(3) There is large difference in the melting and boiling points of oxygen and sulphur because oxygen exists as diatomic molecules ($O_2$) where as sulphur exists as polyatomic molecules ($S_8$) .
(4) None

**20.** The correct order of the thermal stability of the following hydrides is :

| $H_2O$ | $H_2Se$ | $H_2S$ | $H_2Te$ |
|---|---|---|---|
| (I) | (II) | (III) | (IV) |

(1) I > II > III > IV (2) I > III > II > IV
(3) III > I > IV > II (4) IV > III > II > I

**21.** Which of the following hydride is most acidic ?
(1) $H_2Te$ (2) $H_2Se$
(3) $H_2O$ (4) $H_2S$

**22.** $H_2S$ is far more volatile than water because
(1) sulphur atom is more electronegative than oxygen atom.
(2) oxygen being more electronegative than sulphur forms hydrogen bond.
(3) $H_2O$ has bond angle of nearly 105°.
(4) hydrogen atom is loosely bonded with sulphur.

**23.** It is possible to obtain oxygen from air by fractional distillation because
(1) Oxygen is in a different group of the periodic table from nitrogen
(2) Oxygen is more reactive than nitrogen
(3) Oxygen has higher b.p. than nitrogen
(4) Oxygen has a lower density than nitrogen

**24.** The boiling points of the following hydrides follow the order
(1) $SbH_3 > NH_3 > AsH_3 > PH_3$
(2) $NH_3 > PH_3 > AsH_3 > SbH_3$
(3) $NH_3 > SbH_3 > AsH_3 > PH_3$
(4) $SbH_3 > AsH_3 > NH_3 > PH_3$

**25.** **Assertion :** Nitrogen and Oxygen are the main components in the atmosphere but these do not react to form oxides of nitrogen.
**Reason :** The reaction between nitrogen and oxygen requires high temperature.
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**26.** The correct order of acidic strength is :
(1) $Cl_2O_7 > SO_3 > P_4O_{10}$
(2) $CO_2 > N_2O_5 > SO_3$
(3) $Na_2O > MgO > Al_2O_3$
(4) $K_2O > CaO > MgO$

**27.** Amongst $H_2O$, $H_2S$, $H_2Se$ and $H_2Te$ the one with highest boiling point is :
(1) $H_2O$ because of H-bonding.
(2) $H_2Te$ because of higher molecular weight.
(3) $H_2S$ because of H-bonding.
(4) $H_2Se$ because of lower molecular weight

**28.** Nitrogen and oxygen exist as diatomic but their congeners are $P_4$ and $S_8$ respectively because :
(1) phosphorus and sulphur are solids.
(2) phosphorus and sulphur catenate due to the existence of d-orbitals and form stainless structures.
(3) phosphorus and sulphur polymerise as soon as they are formed.
(4) catenation tendency of P and S is stronger because of the high P – P and S – S bond energies as compared to N – N and O – O bond energies.

**29.** Which of the following is correct statement ?
(1) $F_2$ has higher dissociation energy than $Cl_2$
(2) F has higher electron affinity than Cl
(3) HF is stronger acid than HCl
(4) Boiling point increases down the group in halogens

**30.** Which is the correct sequence in the following properties. For the correct order mark **(T)** and for the incorrect order mark **(F)** :
(a) Acidity order : $SiF_4 < SiCl_4 < SiBr_4 < SiI_4$
(b) Melting point : $NH_3 > SbH_3 > AsH_3 > PH_3$
(c) Boiling point : $NH_3 > SbH_3 > AsH_3 > PH_3$
(d) Dipole moment order : $NH_3 > SbH_3 > AsH_3 > PH_3$

(1) FTFF (2) TFTF
(3) FFTT (4) FFTF

**31.** Match List I with List II and select the correct answer using the codes given below the lists :

| List-I | List II |
|---|---|
| a. $BBr_3$ | i. Dimer |
| b. $Tl_2O$ | ii. Trigonal planar |
| c. $B(OH)_3$ | iii. Basic |
| d. $AlCl_3$ | iv. Monobasic acid |

**Code :**

| | a | b | c | d |
|---|---|---|---|---|
| (1) | i | ii | iii | iv |
| (2) | ii | iii | iv | i |
| (3) | iv | iii | i | ii |
| (4) | iii | iv | ii | iii |

**32.** Match List I with List II and select the correct answer using the codes given below the lists :

| List I | List II |
|---|---|
| a. $(SiH_3)_3N$ | i. 3 centre-2-electron bond |
| b. $BF_3$ | ii. sp3-hybridization |
| c. $SiO_2$ | iii. pπ-pπ bond |
| d. $B_2H_6$ | iv. pπ-dπ bond |

**Code :**

| | a | b | c | d |
|---|---|---|---|---|
| (1) | iv | iii | i | ii |
| (2) | ii | iii | iv | i |
| (3) | i | ii | iii | iv |
| (4) | iv | iii | ii | I |

**33.** The halogens are :
(1) transition elements
(2) inner-transition elements
(3) noble elements
(4) representative elements

**34.** All halogens are coloured. This is due to :
(1) Large negative value of electron gain enthalpy.
(2) Absorption of radiations in visible region.
(3) Large electronegativity and higher ionization enthalpy.
(4) Absorption of radiations in ultra-violet region.

**35.** The order of negative electron gain enthalpy of halogens is :
(1) F > Cl > Br > I
(2) Cl > Br > F > I
(3) Cl > F > Br > I
(4) I > Br > Cl > F

**36.** The halogen-halogen bond length is longest for:
(1) fluorine (2) chlorine
(3) bromine (4) iodine

**37.** Which statement is correct about halogens ?
(1) They are all diatomic and form univalent ions
(2) They are all capable of exhibiting several oxidation states
(3) They are all diatomic and form divalent ions
(4) They can mutually displace each other from the solution of their compounds with metals.

**38.** Oxidising action increases in the following order :
(1) Cl < Br < I < F (2) Cl < I < Br < F
(3) I < F < Cl < Br (4) I < Br < Cl < F

**39.** Which of the following hydrogen halides is most volatile ?
(1) HCl (2) HF
(3) HI (4) HBr

**40.** The strongest reducing agent is :
(1) $F^-$ (2) $Cl^-$
(3) $Br^-$ (4) $I^-$

**41.** The common oxidation states exhibited by the halogens are
(1) +2, +4, +6
(2) –1, +1, +3, +5, +7
(3) +1, +2, +3
(4) +1 to +7

**42.** Fluorine does not show positive oxidation states due to the absence of :
(1) d-orbitals (2) s-orbitals
(3) p-orbitals (4) f-orbitals

**43.** Fluorine is a stronger oxidising agent than chlorine in aqueous solution. This is attributed to many factors except :
(1) heat of dissociation
(2) electron affinity
(3) ionization potential
(4) heat of hydration

**44.** Which of the following has highest bond strength :
(1) HI (2) HCl
(3) HF (4) HBr

**45.** The formation of $O_2^+ [PtF_6]^-$ is the basis for the formation of xenon fluorides. This is because :

(1) $O_2$ and Xe have comparable sizes.

(2) both $O_2$ and Xe are gases.

(3) $O_2$ and Xe have comparable ionisation energies.

(4) $O_2$ and Xe have comparable electronegativities.

**46.** Among noble gases (from He to Xe) only xenon reacts with fluorine to form stable fluorides because xenon :

(1) has the largest size.

(2) has the lowest ionization enthalpy.

(3) has the highest heat of vaporization.

(4) is the most readily available noble gas.

**47.** Which of the noble gas has highest polarizability?

(1) He (2) Ar

(3) Kr (4) Xe

**48.** Which of the following is weakest oxidising agent?

(1) $F_2$ (2) $Cl_2$

(3) $Br_2$ (4) $I_2$

**49.** Which of the following orders is not correct with respect to the property indicated against each ?

(1) $F < Cl < Br < I \longrightarrow$ covalent radius

(2) $F^- > Cl^- > Br > I^- \longrightarrow$ enthalpy of hydration

(3) $F_2 > Cl_2 > Br_2 > I_2 \longrightarrow$ bond dissociation enthalpy

(4) $F_2 < Cl_2 < Br_2 < I_2 \longrightarrow$ X–X bond length (pm)

**50.** Which of the following statements is false :

(1) Acidic Strength of oxyacids : $HClO_4 > HClO_3 > HClO_2 > HClO$

(2) Acidic Strength of oxyacids : $HClO_4 > HBrO_4 > HIO_4$

(3) Number of pπ-pπ bonds : $HClO_4 > HClO_3 > HClO_2 > HClO$

(4) Percentage s-character of central atom : $HClO_4 > HClO_3 > HClO_2 > HClO$

**51.** The set with correct order of acidity is :

(1) $HClO < HClO_2 < HClO_3 < HClO_4$

(2) $HClO_4 < HClO_3 < HClO_2 < HClO$

(3) $HClO < HClO_4 < HClO_3 < HClO_2$

(4) $HClO_4 < HClO_2 < HClO_3 < HClO$

**52.** Which of the following element is a metalloid ?

(1) Bi (2) Sn

(3) Ge (4) C

**53.** Among following species which of them have maximum $Z_{eff}$

(1) Sn

(2) $Sn^{4+}$

(3) In

(4) $In^+$

**54.** Increasing order of electronegativity is :

(1) $Bi < P < S < Cl$

(2) $P < Bi < S < Cl$

(3) $C > F > N > O$

(4) $F < O < N < C$

**55.** Which of the following does not exists :

(1) $TlI_3 (Tl^{+3})$

(2) $PbF_4$

(3) Both (1) and (2)

(4) None of these

**56.** The increasing order of the first ionization enthalpies of the elements B, P, S and F (lowest first) is :

(1) $F < S < P < B$

(2) $P < S < B < F$

(3) $B < P < S < F$

(4) $B < S < P < F$

**57.** The stability of dihalides of Si, Ge, Sn and Pb increases steadily in the sequence.

(1) $SiX_2 < GeX_2 < SnX_2 < PbX_2$

(2) $PbX_2 < SnX_2 < GeX_2 < SiX_2$

(3) $GeX_2 < SiX_2 < SnX_2 < PbX_2$

(4) $SiX_2 < GeX_2 < PbX_2 < SnX_2$

**58.** The following statements concern elements in the periodic table. Which of the following is true?

(1) The Group 13 elements are all metals.

(2) All the elements in Group 17 are gases.

(3) In general, elements of Group 16 have lower first ionization enthalpy values compared to those of Group 15 in the corresponding periods.

(4) For Group 15 elements, the stability of +5 oxidation state increases down the group.

**59.** Assertion : F atom has a less negative electron gain enthalpy than Cl atom.

Reason : Additional electrons are repelled more effectively by 3p electrons in Cl atom than by 2p electrons in F atom.

(1) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.

(2) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.

(3) Assertion is true but Reason is false.

(4) Assertion is false but Reason is true.

**60.** Statement-1 : $Pb^{4+}$ compounds are stronger oxidizing agents than $Sn^{4+}$ compounds

Statement-2 : The higher oxidation states for the group 14 elements are more stable for the heavier members of the group due to 'inert pair effect'.

(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(3) Statement-1 is True, Statement-2 is False

(4) Statement-1 is False, Statement-2 is True

## Integer Type Questions (61 to 75)

**61.** 1 mol each of $H_3PO_2$, $H_3PO_3$ and $H_3PO_4$ will neutralise x mole of NaOH, y mol of $Ca(OH)_2$ and z mole of $Al(OH)_3$ (assuming all as strong electrolytes) respectively. And the value of x + y + z .

**62.** Amongst the following oxo-acids of phosphorus , how many of them are dibasic in nature ?

$H_3PO_2$, $H_3PO_3$, $H_3PO_4$, $H_4P_2O_5$, $H_4P_2O_7$

**63.** How many of the following reactions do not depict the oxidising behaviour of $H_2SO_4$ ?

(i) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl$

(ii) $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

(iii) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(iv) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$

(v) $Al + H_2SO_4 \rightarrow Al_2(SO_4)_3 + H_2$

**64.** How many of the following statements are correct for the group $15^{th}$ elements ?

(i) Metallic character increases down the group with decrease in ionisation enthalpy and increase in atomic size.

(ii) The stability of +5 oxidation state decreases and that of +3 state increases down the group on account of inert pair effect.

(iii) The tendency to exhibit –3 oxidation state decreases down the group due to increase in size and metallic character.

(iv) The Ionisation energy of group-15 elements is less than that of group 14 elements in the corresponding period.

**65.** How many of the following statements are correct for group $16^{th}$ elements?

(i) Oxygen is a gas while other elements exist as solids.

(ii) Sulphur exists as staggered 8-atom rings.

(iii) Density in solid state decreases from oxygen to tellurium.

(iv) First ionisation energy of sulphur is lower than that of selenium.

**66.** How many of the following statement are wrong?

(i) The stability of hydrides increase from $NH_3$ to $BiH_3$ in group 15 of the periodic table :

(ii) Nitrogen cannot form $d\pi$-$p\pi$ bond.

(iii) Single N – N bond is weaker than the single P – P bond.

(iv) $N_2O_4$ has two resonating structure

**67.** Which of the following is true about helium ?

(i) It has the lowest boiling point.

(ii) It has the highest first ionization energy.

(iii) It can diffuse through rubber and plastic material.

(iv) It can form clathrate compounds.

(v) If is non-inflammable and light-gas.

(vi) It is used in gas-cooled nuclear reactors.

**68.** Which of the following orders is in accordance with the property stated against it ?

(i) $F_2 > Cl_2 > Br_2 > I_2$ ; bond dissociation energy

(ii) $F_2 > Cl_2 > Br_2 > I_2$; oxidising power

(iii) HI > HBr > HCl > HF; acidic property in water

(iv) $F_2 > Cl_2 > Br_2 > I_2$; electronegativity

(v) B < Ga < Al < In < Tl, covalent radius

(vi) B > Tl > Ga > Al > In; 1st ionisation energy

**69.** Consider following properties of the noble gases.

(i) They readily form compounds which are colourless.

(ii) They generally do not form ionic compounds.

(iii) Xenon has variable oxidation states in its compounds.

(iv) the smaller He and Ne do not form clathrate compounds.

Find the number of correct properties.

**70.** How many of the following are correct orders of stability :

(i) $Tl^{3+} > Bi^{3+}$ (ii) $PbO_2 < PbO$

(iii) $BiI_5 < BiF_5$ (iv) $Sn^{2+} = Ge^{2+}$

(v) $Bi^{+3} > Bi^{+5}$ (vi) $In^{+1} > Tl^{+1}$

(vii) $In^{+3} > Tl^{+3}$

**71.** How many of the following oxides of N are neutral ?

(i) $N_2O_3$ (ii) $N_2O_5$

(iii) $N_2O_4$ (iv) $N_2O$

(v) NO

**72.** What is the atomic number of the inert gas which has abnormal behaviour on liquefaction:

(i) Xe (ii) He

(iii) Ar (iv) Kr

**73.** How many of the following statements are correct regarding allotropes of carbon :

(a) Graphite is not a good conductor of electricity in perpendicular direction of layers at ordinary temperatures.

(b) Coke is the impure form of carbon.

(c) Anthracite is the purest form of Carbon.

(d) Buckminster fullerene contains 12 five membered rings and 20 six-membered rings.

(e) Diamond is a good conductor of Heat.

(f) Graphite is diamagnetic in nature.

(g) Graphite is thermodynamically more stable than diamond

**74.** For Boron family (B, Al, Ga, In and Tl)

x: Number of elements which are solid at 40°C.

y: Period number of element which has greater ionization energy than element just above and below it in periodic table.

z: Period number of most abundant element of group 13.

Report your answer x + 2y + 3z

**75.** Consider a prototypical fullerene, $C_{60}$.

Let, a = Number of 5-membered rings

b = Number of 6-membered rings

c = Number of $\pi$-bonds in $C_{60}$

Find the value of (3a – 2b + c)

CHAPTER

14

# THE d- AND f- BLOCK ELEMENTS & QUALITATIVE ANALYSIS

*Single Option Correct Type Questions (01 to 60)*

**1.** Identify the incorrect statement among the following.

(1) Among V, Cr, Mn and Fe ; Mn is expected to have the highest third ionization enthalpy.

(2) Eu(II) acts as a strong reducing agent.

(3) The ionic sizes of lanthanoids decrease in general with increasing atomic number.

(4) $VOCl_2$ and $FeCl_2$ are expected to have the same magnetic moment ('spin only')

**2.** The basic character of the transition metal monoxide follows the order:

(At. no. : Ti = 22, V = 23, Cr = 24, Fe = 26)

(1) VO > CrO > TiO > FeO

(2) CrO > VO > FeO > TiO

(3) TiO > FeO > VO > CrO

(4) TiO > VO > CrO > FeO

**3.** Which of the following factor may be regarded as the main cause of Lanthanide contraction?

(1) Poor shielding of one of the 4f-electrons by another in the sub-shell.

(2) Effective shielding of one of the 4f-electrons by another in the sub-shell.

(3) Poorer shielding of 6d electron by 4f electrons.

(4) Greater shielding of 5d electron by 4f electron.

**4.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I | | List- II | |
|---|---|---|---|
| I | $CuCl_2$, $2H_2O$ | P | Colourless and diamagnetic |
| II | $Cu_2Cl_2$ | Q | Green and paramagnetic |
| III | CuO | R | Calamine |
| IV | $ZnCO_3$ | S | Black and basic |

(1) I-Q ; II-P ; III-S ; IV-R

(2) I-S ; II-Q ; III-R ; IV-P

(3) I-S ; II-Q ; III-R ; IV-P

(4) I-P ; II-Q ; III-R ; IV-S

**5.** Match List I with List II and select the correct answer using the code given below the lists:

| List- I (Reaction) | | List- II (Process) Photographic | |
|---|---|---|---|
| I | $NH_4Br + AgNO_3 \rightarrow AgBr + NH_4NO_3$ | P | Preparation of sensitive film |
| II | $C_6H_4(OH)_2 + 2AgBr \rightarrow 2Ag + C_6H_4O_2 + 2HBr$ | Q | Developing of the film |
| III | $2Na_2S_2O_3 + AgBr \rightarrow Na_3[Ag(S_2O_3)_2] + 2NaBr$ | R | Fixing of the film |
| IV | $AuCl_3 + 3Ag \rightarrow 3AgCl + Au$ | S | Toning Process |

(1) I-P ; II-Q ; III-R ; IV-S

(2) I-P ; II-R ; III-Q ; IV-S

(3) I-P ; II-S ; III-Q ; IV-R

(4) I-Q ; II-S ; III-P ; IV-R

**6.** Which of the statements is False?

(1) In 3d series, there is a regular increase in the first ionisation enthalpy of transition elements from left to right.

(2) In 3d series, the negative value of standard electrode potential (E/V) for $M^{2+}/M$ decreases in the order Ti > Mn > Cr > Fe.

(3) The decreases in metallic radius coupled with increase in atomic mass results in a general increase in the density of transition elements from Ti to Cu.

(4) The higher oxidation state are favoured by the heavier elements (i.e. heavier members) in the groups of d-block.

**7.** Which of the following statements is correct?

(1) The lesser number of oxidation states in 3d-series in the beginning of the series is due to the presence of too few electrons to loose or share

(2) The lesser number of oxidation states in 3d-series towards the end of the series is due to the presence of too many electrons and thus fewer empty orbitals to share electrons with the ligands

(3) (1) and (2) both

(4) None is correct

**8.** Which of the following statement is false?

(1) Of the $d^4$ species, manganese (III) is strongly reducing while $Cr^{2+}$ is strongly oxidising.

(2) Cobalt (II) is stable in aqueous solution but in the presence of complexing reagents it is easily oxidised.

(3) The $d^1$ configuration is very unstable in ions.

(4) None of these

**9.** The magnetic moment of $_{25}Mn$ in ionic state is 3.87 B.M, then Mn is in:

(1) +2 state

(2) +3 state

(3) +4 state

(4) +5 state

**10.** When a salt is heated with dilute $H_2SO_4$ and $KMnO_4$ solution, the pink colour of $KMnO_4$ is discharged, the salt is :

(1) a sulphite (2) a carbonate

(3) a nitrate (4) a bicarbonate

**11.** Which of the following statement is correct?

(1) Transition metals and their many compounds act as good catalyst.

(2) The enthalpies of atomistation of the transition metals are high.

(3) The transition metals generally form interstitial compounds with small atoms like C, B, H etc.

(4) All of these

**12.** The yellow colour of chromates changes to orange on acidification due to formation of:

(1) $Cr^{3+}$ (2) $Cr_2O_3$

(3) $Cr_2O_7^{2-}$ (4) $CrO_4^{-}$

**13.** $KMnO_4$ is the oxo salt of:

(1) $MnO_2$ (2) $Mn_2O_7$

(3) $MnO_3$ (4) $Mn_2O_3$

**14.** When $SO_2$ is passed through acidified $K_2Cr_2O_7$ solution:

(1) The solution turns blue.

(2) $SO_2$ is reduced.

(3) Green $Cr_2(SO_4)_3$ is formed.

(4) The solution is decolourised.

**15.** Among the lanthanoides the one obtained by synthetic method is:

(1) Lu (2) Pm

(3) Pr (4) Gd

**16.** Across the lanthanide series, the basicity of the lanthanoide hydroxides:

(1) Increases

(2) Decreases

(3) First increases and then decreases

(4) Does not change

**17.** Lanthanoid and actinides resemble most in:

(1) General Electronic configuration

(2) Colour

(3) Ionization energy

(4) Formation of complexes

**18.** Copper has higher second ionization energy than that of both adjacent elements. This is because of:

(1) Smaller size of copper (I) ion.

(2) $d^{10}$ configuration of copper (I) ion.

(3) Higher nuclear charge of copper (I) ion.

(4) Larger size of copper (I) ion.

**19.** $E^{\ominus}$ values for the couples $Cr^{3+}/Cr^{2+}$ and $Mn^{3+}/Mn^{2+}$ are – 0.41 and + 1.51 volts respectively. Considering these values select the correct option from the following statements.

(1) $Cr^{2+}$ acts as a reducing agent and $Mn^{3+}$ acts as an oxidising agent in their aqueous solutions.

(2) $Cr^{2+}$ (aq.) is more stable than $Cr^{3+}$ (aq.).

(3) $Mn^{3+}$ (aq.) is more stable than $Mn^{2+}$ (aq).

(4) None of these.

**20.** Which of the following pairs of ions has magnetic moment of 5.93 B.M.?

(1) $Mn^{2+}, Fe^{3+}$ (2) $Mn^{2+}, Cr^{3+}$

(3) $Fe^{2+}, Co^{3+}$ (4) None

**21.** Compound that is both paramagnetic and coloured is:

(1) $K_2Cr_2O_7$ (2) $(NH_4)_2[TiCl_6]$

(3) $VOSO_4$ (4) $K_3[Cu(CN)_4]$

**22.** Which one of the following characteristics of the transition metals is associated with their catalytic activity?

(1) Colour of hydrated ions.

(2) Variable oxidation states.

(3) High enthalpy of atomization.

(4) Paramagnetic behaviour.

**23.** When hydrogen peroxide is added to acidified potassium dichromate, a blue colour is produced due to formation of:

(1) $CrO_3$ (2) $Cr_2O_3$

(3) $CrO_5$ (4) $Cr_4^{2-}$

**24.** Which of the following statements is not correct?

(1) $La(OH)_3$ is less basic than $Lu(OH)_3$

(2) In lanthanide series ionic radius of $Ln^{3+}$ ions decreases

(3) La is actually an element of transition series rather than lanthanide series

(4) Atomic radii of Zr and Hf are same because of lanthanide contraction

**25.** **Assertion:** The free gaseous chromium atom has six unpaired electrons

**Reason:** Half filled orbital has greater stability than fully filled orbital

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is correct, but the reason is incorrect

(4) Both are assertion and reason are incorrect

**26.** **Assertion:** The colour of the solutions of $V^{2+}$ ions and $Cr^{3+}$ ions in water is similar.

**Reason:** $V^{2+}$ and $Cr^{3+}$ each has three unpaired electrons and both have $d^3$ configuration.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both are assertion and reason are incorrect

**27.** **Assertion:** Copper (I) compounds are unstable in aqueous solutions and undergo disproportionation.

**Reason:** $Cu^{2+}$ (aq) is stable than $Cu^{+}$ (aq) due to the much more negative enthalpy of hydration of $Cu^{2+}$ (aq.) than $Cu^{+}$, which more than compensates for the second ionization enthalpy of Cu.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**28.** **Assertion:** The green manganate is paramagnetic but the purple permanganate is diamagnetic in nature.

**Reason:** $MnO_4^{2-}$ contains one unpaired electron while in $MnO_4^{-}$, all electrons are paired.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**29.** Which of the following ions has the maximum magnetic moment?

(1) $Mn^{2+}$ (2) $Fe^{2+}$
(3) $Ti^{2+}$ (4) $Cr^{2+}$.

**30.** Most common oxidation state for Ce (Cerium) are:

(1) +3, +4 (2) +2, +3
(3) +2, +4 (4) +3, +5

**31.** What would happen when a solution of potassium chromate is treated with an excess of dilute $HNO_3$?

(1) $Cr_2O_7^{2-}$ and $H_2O$ are formed
(2) $CrO_4^{2-}$ is reduced to +3 state of Cr
(3) $CrO_4^{2-}$ is oxidised to +7 state of Cr
(4) $Cr^{3+}$ and $Cr_2O_7^{2-}$ are formed

**32.** The atomic numbers of V,Cr,Mn and Fe are respectively 23,24,25 and 26. Which one of these may be expected to have the highest second ionization enthalpy?

(1) Cr (2) Mn
(3) Fe (4) V

**33.** Which of the following group of transition metals is called coinage metals?

(1) Cu, Ag, Au (2) Ru, Rh, Pb
(3) Fe, Co, Ni (4) Os. Ir, Pt

**34.** A test tube containing a nitrate and another containing a bromide and $MnO_2$ are treated with concentrated $H_2SO_4$. The reddish brown fumes evolved are passed through water. The water will be coloured by :

(1) the nitrate
(2) the bromide
(3) both
(4) neither (1) nor (2)

**35.** The radius of $La^{3+}$ (Atomic number of La = 57) is 1.06Å. Which one of the following given values will be closest to the radius of $Lu^{3+}$ (Atomic number of Lu = 71)?

(1) 1.60Å (2) 1.40Å
(3) 1.06Å (4) 0.85Å

**36.** Cerium (Z = 58) is an important member of the lanthanoide. Which of the following statement about cerium is incorrect?

(1) The common oxidation state of cerium are +3 and +4.
(2) The +3 oxidation state of cerium is more stable than +4 oxidation state.
(3) The +4 oxidation state of cerium is not known in solution.
(4) Cerium (IV) acts as an oxidizing agent.

**37.** The lanthanide contraction is responsible for the fact that

(1) Zr and Y have about the same radius
(2) Zr and Nb have similar oxidation state
(3) Zr and Hf have about the same radius
(4) Zr and Zn have same oxidation state.

**38.** The ''spin-only'' magnetic moment [in units of Bohr magneton, ($\mu_B$) of $Ni^{2+}$ in aqueous solution would be (atomic number of Ni = 28)

(1) 2.84 (2) 4.90

(3) 0 (4) 1.73

**39.** Identify the incorrect statement among the following.

(1) The chemistry of various lanthanoids is very similar.

(2) 4f and 5f orbitals are equally shielded.

(3) d-block elements show irregular and erratic chemical properties among themselves.

(4) La and Lu have partially filled d orbitals and no other partially filled orbitals.

**40.** The actinoids exhibit more number of oxidation states in general than the lanthanoids. This is because

(1) The actinoids are more reactive than the lanthanoids.

(2) The 5f orbitals extend farther from the nucleus than the 4f orbitals.

(3) The 5f orbitals are more buried than the 4f orbitals

(4) There is a similarity between 4f and 5f orbitals in their angular part of the wave function

**41.** Larger number of oxidation states are exhibited by the actinoids than those by the lanthanoids, the main reason being.

(1) lesser energy difference between 5f and 6d than between 4f and 5d orbitals

(2) more energy difference between 5f and 6d than between 4f and 5d orbitals

(3) more reactive nature of the actinoids than the lanthanoids

(4) 4f orbitals more diffused than the 5f orbitals

**42.** In context of the lanthanoids, which of the following statement is not correct?

(1) There is a gradual decrease in the radii of the members with increasing atomic number in the series.

(2) All the member exhibit +3 oxidation state.

(3) Because of similar properties, the separation of lanthanoids is not easy.

(4) Availability of 4f electrons results in the formation of compounds in +4 state for all the members of the series.

**43.** The outer electron configuration of Lu (Atomic No: 71) is:

(1) $4f^3\,5d^5\,6s^2$ (2) $4f^8\,5d^0\,6s^2$

(3) $4f^4\,5d^4\,6s^2$ (4) $4f^{14}\,5d^1\,6s^2$

**44.** The colour of $KMnO_4$ is due to:

(1) M $\rightarrow$ L charge transfer transition

(2) d – d transition

(3) L $\rightarrow$ M charge transfer transition

(4) $\sigma - \sigma^*$ transition

**45.** When $MnO_2$ is fused with KOH, a coloured compound is formed. The product and its colour is:

(1) $K_2MnO_4$, green (2) $Mn_2O_3$, brown

(3) $Mn_2O_4$, black (4) $KMnO_4$, purple

**46.** The product of oxidation of $I^-$ with $MnO_4^-$ in alkaline medium is:

(1) $IO_3^-$ (2) $I_2$

(3) $IO^-$ (4) $IO_4^-$

**47.** Among the following, the coloured compound is:

(1) CuCl

(2) $K_3\,[Cu(CN)_4]$

(3) $CuF_2$

(4) $[Cu(CH_3CN)_4]BF_4$

**48.** Which oxide of manganese is most acidic in nature?

(1) MnO (2) $Mn_2O_7$

(3) $Mn_2O_3$ (4) $MnO_2$.

**49.** The pair of the compounds in which both the metals are in the highest possible oxidation state is,
(1) $[Fe(CN)_6]^{3-}$ , $[Co(CN)_6]^{3-}$
(2) $CrO_2Cl_2$ , $MnO_4^-$ .
(3) $TiO_2$, $MnO_2$
(4) $[Co(CN)_6]^{3-}$, $Mn_2O_7$ .

**50.** **$S_1$:** The densities of 4d series are high and 5d series values are even higher.
**$S_2$:** The magnetic moment of $Cr^{2+}$ ion in aqueous solution is 3.87 BM.
**$S_3$:** Interstitial compounds have high melting points, higher than those of pure metals.
**$S_4$:** $KMnO_4$ does not act as an oxidising agent in alkaline medium
(1) T T F T (2) T F T F
(3) F T F T (4) T F F T

**51.** $Fe(CN)_3 + KCN \longrightarrow X \xrightarrow{FeCl_3} Y$
Y is:
(1) Brown coloured complex, Inner orbital complex
(2) White coloured complex, Inner orbital complex
(3) Blue coloured complex, outer orbital complex
(4) Blue coloured complex, Inner orbital complex

**52.** $KMnO_4$ in excess on treatment with concentrated $H_2SO_4$ forms a compound (X) which decomposes explosively on heating forming (Y). The (X) and (Y) are respectively:
(1) $Mn_2O_7$, $MnO_2$ (2) $Mn_2O_7$, $Mn_2O_3$
(3) $MnSO_4$, $Mn_2O_3$ (4) $Mn_2O_3$, $MnO_2$

**53.** Which of the following statement is wrong?
(1) An acidified solution of $K_2Cr_2O_7$ liberates iodine from iodides.
(2) In acidic solution, dichromate ions are converted to chromate ions.
(3) Ammonium dichromate on heating undergo exothermic decomposition to give $Cr_2O_3$ .
(4) Potassium dichromate is used as a titrant for $Fe^{2+}$.

**54.** Amongst the following metals, which has highest melting point?
(1) Ti (2) Cr
(3) Fe (4) Cu

**55.** When KI is added to acidified solution of sodium nitrite :
(1) NO gas is liberated and $I_2$ is set free
(2) $N_2$ gas is liberated and HI is produced
(3) $N_2O$ gas is liberated and $I_2$ is set free
(4) $N_2$ gas is liberated and HOI is produced

**56.** Which amongst the following can give the greater number of oxidation states?
(1) V (2) Mn
(3) Cr (4) Fe

**57.** Which of the following transition metal ions has the lowest density?
(1) Copper (2) Nickel
(3) Scandium (4) Zinc

**58.** How many of the following oxides are amphoteric in nature?
(1) $V_2O_5$, $Cr_2O_3$ (2) $V_2O_3$, $Cr_2O_3$
(3) $Mn_2O_7$, $CrO_3$ (4) CrO, FeO

**59.** Among the following transition elements, pick out the element/elements with highest second ionization energy.
(i) V (At. no. = 23)
(ii) Cr (At. no. = 24)
(iii) Mn (At. no. = 25)
(iv) Cu (At. no. = 29)
(v) Zn (At. no. 30)
(1) (iii) (2) (ii)
(3) (i) (4) (iv)

**60.** Match list – I with List – II and select the correct answer using the codes given below the lists

| List- I (Metal ion) | | List- II [Magnetic moment (BM)] | |
|---|---|---|---|
| I | $Cr^{3+}$ | P | $\sqrt{35}$ |
| II | $Fe^{2+}$ | Q | $\sqrt{30}$ |
| III | $Ni^{2+}$ | R | $\sqrt{24}$ |
| IV | $Mn^{2+}$ | S | $\sqrt{15}$ |
| | | T | $\sqrt{8}$ |

(1) I-P ; II-R ; III-T ; IV-S
(2) I-Q ; II-R ; III-T ; IV-P
(3) I-S ; II-R ; III-T ; IV-P
(4) I-S ; II-T ; III-R ; IV-P

## *Integer Type Questions (61 to 75)*

**61.** Knowing that the Chemistry of lanthanoids (Ln) is dominated by its +3 oxidation state, how many of the following statement are correct
(i) The ionic sizes of Ln (III) decrease in general with increasing atomic number.
(ii) Ln (III) compounds are generally colourless.
(iii) Ln (III) hydroxides are mainly basic in character
(iv) Because of the large size of the Ln (III) ions the bonding in its compounds is predominently ionic in character.

**62.** How many of the following arrangements represent the correct order of the property stated against it?
(i) $V^{2+} < Cr^{2+} < Mn^{2+} < Fe^{2+}$ : paramagnetic behaviour
(ii) $Ni^{2+} < Co^{2+} < Fe^{2+} < Mn^{2+}$ : ionic size
(iii) $Co^{3+} < Fe^{3+} < Cr^{3+} < Sc^{3+}$ : stability in aqueous solution
(iv) Sc < Ti < Cr < Mn : number of oxidation states

**63.** How many of the following are correct statements
i. Cobalt (III) is more stable in octahedral complexes.
ii. Zinc forms coloured ions or complexes
iii. Most of the d-block elements and their compounds are ferromagnetic
iv. Osmium shows (VIII) oxidation state
v. Cobalt (II) is more stable in octahedral complexes.

**64.** Atomic number of the metal which is king of metals

**65.** The atomic number of the transition metal where all metal atoms have $3d^2\ 4s^2$ electronic configuration is:

**66.** The smallest atomic number of the transition metal ions, amongst the following in which all metal ions do not have d-electrons?
$_{24}Cr^{6+}$ ; $_{22}Ti^{4+}$ ; $_{25}Mn^{7+}$

**67.** The number of moles of $KMnO_4$ that will be needed to react with 10 mole of sulphite ion in acidic medium is:

**68.** The number of d-electrons retained in $Fe^{2+}$ (At. no. Fe = 26) ions are:

**69.** A metal ion from the first transition series has a magnetic moment (calculated) of 3.87 B.M. How many unpaired electrons are expected to be present in the ion?

**70.** Titanium shows magnetic moment of 1.73 BM in its compound. If +x is the oxidation number of Ti in the compound, then x is

**71.** The number of moles of $KMnO_4$ that will be needed to react completely with 15 mole of ferrous oxalate in acidic solution is:

**72.** When $FeSO_4$ is strongly heated, the number of acidic gases produced is:

**73.** Percentage of gold in 12 carat gold is

**74.** How many transition metal are coinage metal

**75.** Atomic number of transition element having no electron in s-orbital of outermost shell.

CHAPTER 15

# COORDINATION COMPOUNDS

*Single Option Correct Type Questions (01 to 60)*

**1.** Which of the following are bidentate monoanion ligands?
(a) Dimethylglyoximato
(b) Oxalato ion
(c) Ethane-1,2-diamine
Select the correct answer using the codes given below:
(1) a only (2) a and c only
(3) c only (4) b and c only

**2.** Which of the following is not correctly matched?
(1) $NO_2^-$ – Bidentate ligand
(2) Ethylenediamine – Bidentate ligand
(3) $SCN^-$ – Monodentate ligand
(4) (CO) – Monodentate ligand

**3.** An ambidentate ligand is one which:
(1) Is linked to the metal atom at two points.
(2) Has two donor atoms but only one of them has the capacity to form a coordinate bond.
(3) Has two donor atoms but either of the two can form a coordinate bond.
(4) Forms chelate rings.

**4.** Consider the following:

| Complex | | Coordination Number | |
|---|---|---|---|
| I | $[CuCl_2]^-$ | P | 6 |
| II | $Ni(CO)_4$ | Q | 5 |
| III | $[PtCl_6]^{4-}$ | R | 4 |
| IV | $[Ni(NH_3)_6]^{2+}$ | S | 2 |

(1) I-P ; II-Q ; III-R ; IV-S
(2) I-R ; II-S ; III-Q ; IV-S
(3) I-S ; II-R ; III-P ; IV-P
(4) I-P ; II-R ; III-Q ; IV-S

**5.** Oxidation state of nitrogen is incorrectly given for:

| Compound | Oxidation state |
|---|---|
| (1) $[Co(NH_3)_5Cl]\ Cl_2$ | 0 |
| (2) $NH_2OH$ | –1 |
| (3) $(N_2H_5)_2\ SO_4$ | –2 |
| (4) $Mg_3N_2$ | –3 |

**6.** The IUPAC name of $[Co(NH_3)_3\ BrCl(NO_2)]$ will be:
(1) Triamminebromidochloridonitrito-N-cobaltate(III)
(2) Triamminebromidochloridonitrito-N-cobalt(III)
(3) Triamminebromidochloridonitrito-O-cobaltate(III)
(4) Triamminenitrito-O bromidochloridocobaltate(III)

**7.** The IUPAC name of the complex ion $[Cr(NO_2)(NH_3)(CN)_4]^{2-}$ is:
(1) Amminetetracyanidonitrito-O-chromate (III)
(2) Amminetetracyanidonitrito-N-chromate(III)
(3) Amminetetracyanidonitrito-N-chromium(III)
(4) Amminetetracyanidonitrito-N-chromate(II)

**8.** IUPAC name of $K_3[Al(C_2O_4)_3]$ is called:
(1) Potassium aluminooxalato
(2) Potassium aluminium (III) trioxalate
(3) Potassium trioxalatoaluminate (III)
(4) Potassium trioxalatoaluminate (IV)

**9.** The correct IUPAC name of complex, $[Rh(en)_2(ONO)(SCN)]NO_3$ is:
(1) Diethane-1, 2-diamine nitrito-O-thiocyanato-S-rhodium (III) nitrate
(2) bis(ethane-1, 2-diamine) nitrito-O-thiocyanato-S-rhodium(III) nitrate
(3) bis(ethane-1, 2-diamine) nitrito-O-thiocyanato-S-rhodate(III) nitrate
(4) bis(ethane-1, 2-diamine) nitrito-N-thiocyanato-N-rhodium(II) nitrate.

**10.** In which of the following pairs of complexes, the central metals/ions do not have same effective atomic number?
(1) $[Cr(CO)_6]$ and $[Fe(CO)_5]$
(2) $[Cu(CN)_4]^{3-}$ and $[Ni(CO)_4]$
(3) $[Co(NH_3)_6]^{2+}$ and $[Ni(NH_3)_6]^{2+}$
(4) $[V(CO)_6]^{-}$ and $[Co(NO_2)_6]^{3-}$

**11.** The type of hybridization involved in the metal ion of $[Ni(H_2O)_6]^{2+}$ complex is
(1) $d^3sp^2$ (2) $sp^3d^2$
(3) $sp^3$ (4) $dsp^2$

**12.** $[Pt(NH_3)_4]Cl_2$ is:
(1) Square planar (2) Tetrahedral
(3) Pyramidal (4) Pentagonal

**13.** A complex compound which is formed by nitrate and bromide ligands, gives 2 mol precipitate of AgBr, when reacts with $AgNO_3$, the formula of complex is:
(1) $[Co(NH_3)_5(NO_3)]Br_2$
(2) $[Co(NH_3)_5Br]Br(NO_3)$
(3) $[Co(NH_3)_4Br_2]NO_3$
(4) None of these

**14.** The geometry and magnetic moment of the complexes $[NiCl_4]^{2-}$ and $[PdCl_4]^{2-}$ respectively are:
(1) Tetrahederal, square planar ; 2.83, 0
(2) Tetrahedral, tetrahedral ; 2.83, 2.83
(3) Square planar, tetrahedral ; 0, 2.83
(4) Square planar, square planar : 0, 0

**15.** The most stable complex among the following is:
(1) $[NiCl_4]^{2-}$ (2) $[Ni(H_2O)_2Cl_2]$
(3) $[Ni(NH_3)_4]^{2+}$ (4) $[Ni(CN)_4]^{2-}$

**16.** All the following complex ions are found to be paramagnetic:
P : $[FeF_6]^{3-}$ Q : $[CoF_6]^{3-}$
R : $[V(H_2O)_6]^{3+}$ S : $[Ti(H_2O)_6]^{3+}$
The correct order of their paramagnetic moment (spin only) is:
(1) P > Q > R > S (2) P < Q < R < S
(3) P = Q = R = S (4) P > R > Q > S

**17.** In which of the following complex ion, the metal ion will have $t_{2g}^6, e_g^0$ configuration according to CFT:
(1) $[FeF_6]^{3-}$ (2) $[Fe(CN)_6]^{3-}$
(3) $[Fe(CN)_6]^{4-}$ (4) All of these

**18.** Amongst $Ni(CO)_4$, $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$
(1) $Ni(CO)_4$ and $[NiCl_4]^{2-}$ are diamagnetic and $[Ni(CN)_4]^{2-}$ is paramagnetic
(2) $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $Ni(CO)_4$ is paramagnetic
(3) $Ni(CO)_4$ and $[Ni(CN)_4]^{2-}$ are diamagnetic and $[NiCl_4]^{2-}$ is paramagnetic
(4) $Ni(CO)_4$ is diamagnetic and $[NiCl_4]^{2-}$ and $[Ni(CN)_4]^{2-}$ are paramagnetic

**19.** The most stable complex among the following is:
(1) $K_3[Al(C_2O_4)_3]$
(2) $[Pt(en)_2]Cl_2$
(3) $[Ag(NH_3)_2]Cl$
(4) $K_2[Ni(EDTA)]$

**20.** Which of the following complex ions does not show optical activity:
(1) $[PtBrClI(NO_2)(H_2O)NH_3]$
(2) cis$[Co(en)_2Cl_2]^{+}$
(3) cis$[Co(en)(NH_3)_2Cl_2]^{+}$
(4) $[Co(NH_3)_4Cl_2]^{+}$

**21.** Which of the following complex shows ionization isomerism?
(1) $[Cr(NH_3)_6]Cl_3$
(2) $[Cr(en)_2]Cl_2$
(3) $[Cr(en)_3]Cl_3$
(4) $[Co(NH_3)_5Br]SO_4$

**22.** Which kind of isomerism is shown by the complex $[Co(NH_3)_5(ONO)]SO_4$?
a. Ionization isomerism
b. Linkage isomerism
c. Geometrical isomerism
d. Optical isomerism
(1) a, b, c and d are correct
(2) a, c and d are correct only
(3) a and b are correct only
(4) b, c and d are correct only

**23.** Which one of the following will not show geometrical isomerism
(1) $[Cr(NH_3)_4Cl_2]Cl$
(2) $[Co(en)_2Cl_2]Cl$
(3) $[Co(NH_3)_5NO_2]Cl_2$
(4) $[Pt(NH_3)_2Cl_2]$

**24.** The IUPAC name of $[Co(NH_3)_6][Cr(C_2O_4)_3]$ is:
(1) Hexaamminecobalt (III) tris (Oxalato) chromate (III)
(2) Hexaamminecobalt (III) tris (Oxalato) chromium (III)
(3) Hexaamminecobalt (II) tris (Oxalato) chromium (III)
(4) Hexaamminecobalt (III) trisoxalatechromium (III)

**25.** Consider the following statements:
According to Werner's theory.
(I) Ligands are connected to the metal ions by ionic bonds.
(II) Secondary valencies have directional properties
(III) Secondary valencies are non-ionizable
Of these statements:
(1) I, II and III are correct
(2) II and III are correct
(3) I and II are correct
(4) I and II are correct

**26.** The two isomers X and Y with the formula $Cr(H_2O)_5ClBr_2$ were taken for experiment on depression in freezing point. It was found that one mole of X gave depression corresponding to 2 moles of particles and one mole of Y gave depression due to 3 moles of particles. The structural formulae of X and Y respectively are:
(1) $[Cr(H_2O)_5Cl]Br_2$, $[Cr(H_2O)_4Br_2]Cl.\ H_2O$
(2) $[Cr(H_2O)_4Br_2]Cl.H_2O$, $[Cr(H_2O)_5Cl]Br_2$
(3) $[Cr(H_2O)_5Br]BrCl$, $[Cr(H_2O)_4ClBr]Br.H_2O$
(4) $[Cr(H_2O)_5Cl]Br_2$, $[Cr(H_2O)_3ClBr_2].2H_2O$

**27.** Which of the following compounds show optical isomerism?
I. cis-$[Co(NH_3)_4Cl_2]^+$
II. trans-$[Co(en)_2Cl_2]^+$
III. cis-$[Co(en)_2Cl_2]^+$
IV. $[Co(en)_3]^{3+}$
Select the correct answer using the codes given below:
(1) I and II
(2) II and III
(3) III and IV
(4) I, III and IV

**28.** Which of the following coordination compounds would exhibit optical isomerism?
(1) Pentaamminenitrocobalt (III) iodide
(2) Diamminedichloroplatinum (II)
(3) Trans-dicyanobis (ethylenediamine) chromium (III) chloride
(4) Tris-(ethylenediamine) cobalt (III) bromide

**29.** Among $[Ni(CO)_4]$, $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ species, the hybridisation states of the Ni atom are, respectively
(At number of Ni = 28)
(1) $sp^3$, $dsp^2$, $dsp^2$
(2) $sp^3$, $dsp^2$, $sp^3$
(3) $sp^3$, $sp^3$, $dsp^2$
(4) $dsp^2$, $sp^3$, $sp^3$

**30.** $[Cr(H_2O)_6]Cl_3$ (at. no. of Cr = 24) has a magnetic moment of 3.83 B.M. The correct distribution of 3d electrons in the Chromium of the complex is:

(1) $3d^1_{xy}, 3d^1_{yz}, 3d^1_{xz}$

(2) $3d^1_{xy}, 3d^1_{yz}, 3d^1_{z^2}$

(3) $3d^1_{(x^2-y^2)}, 3d^1_{z^2}, 3d^1_{xz}$

(4) $3d^1_{xy}, 3d^1_{(x^2-y^2)}, 3d^1_{yz}$

**31.** Which of the following complex ions is expected to absorb visible light?
(At. no Zn = 30, Sc = 21, Ti = 22, Cr = 24)

(1) $[Sc(H_2O)_3(NH_3)_3]^{3+}$

(2) $[Ti(en)_2(NH_3)_2]^{4+}$

(3) $[Cr(NH_3)_6]^{3+}$

(4) $[Zn(NH_3)_6]^{2+}$

**32.** Among the following complexes the one which shows Zero crystal field stabilizations energy (CFSE)

(1) $[Ti(H_2O)_6]^{3+}$ (2) $[Fe(H_2O)_6]^{3+}$

(3) $[Co(H_2O)_6]^{2+}$ (4) $[Co(H_2O)_6]^{3+}$

**33.** Cobalt (III) chloride forms several octahedral complexes with ammonia. Which of the following will not give test for chloride ions with silver nitrate at 25°C?

(1) $CoCl_3 \cdot 4NH_3$ (2) $CoCl_3 \cdot 5NH_3$

(3) $CoCl_3 \cdot 6NH_3$ (4) $CoCl_3 \cdot 3NH_3$

**34.** The IUPAC name of $K_2[Cr(CN)_2O_2(O)_2(NH_3)]$ is:

(1) Potassium amminedicyanodioxoperoxochromate(VI)

(2) Potassium amminecyanoperoxodioxochromium(IV)

(3) Potassium amminecyanoperoxodioxochromium(V)

(4) Potassium amminecyanoperoxodioxochromatic(IV)

**35.** The increasing order of the crystal field splitting power of some common ligands is:

(1) $H_2O < OH^- < Cl^- < F^- < CN^-$

(2) $H_2O < Cl^- < OH^- < F^- < CN^-$

(3) $CN^- < H_2O < OH^- < F^- < Cl^-$

(4) $Cl^- < F^- < OH^- < H_2O < CN^-$

**36.** **Assertion:** In complex, $[Co(NH_3)_5(CO_3)]Cl$, the oxidation state of cobalt is +3.

**Reason:** Carbonate ligand is a monodentate bivalent anion.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both are assertion and reason are incorrect

**37.** **Assertion:** The species $[CuCl_4]^{2-}$ exists but $[CuI_4]^{2-}$ does not.

**Reason:** $[NiCl_2(PPh_3)_2]$ have tetrahedral geometry.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion

(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion

(3) The assertion is incorrect, but the reason is correct

(4) Both are assertion and reason are incorrect

**38.** The most stable ion is:

(1) $[Fe(OH)_5]^{3-}$

(2) $[FeCl_6]^{3-}$

(3) $[Fe(CN)_6]^{3-}$

(4) $[\ [Fe(H_2O)_6]^{3+}$

**39.** One mole of $Co(NH_3)_5Cl_3$ gives 3 moles of ions on dissolution in water. One mole of this reacts with two moles of $AgNO_3$ to give two moles of AgCl. The complex is :
(1) $[Co(NH_3)_4Cl_2]Cl.NH_3$
(2) $[Co(NH_3)_4Cl]Cl_2.NH_3$
(3) $[Co(NH_3)_5Cl]Cl_2$
(4) $[Co(NH_3)_3Cl_3].2NH_3$

**40.** The co-ordination number of a central metal atom in a complex is determined by:
(1) The number of only anionic ligands bonded to metal ion
(2) The number of ligands around a metal ion bonded by pi bonds
(3) The number of ligands around a metal ion bonded by sigma and pi bonds
(4) The number of ligands around a metal ion bonded by sigma bonds

**41.** Co-ordination compounds have great importance in biological systems. In this context, which statement is incorrect?
(1) Carboxypeptidase–A is an enzyme and contains zinc.
(2) Haemoglobin is the red pigment of blood and contains iron.
(3) Cyanocobalmin is $B_{12}$ and contains cobalt.
(4) Chlorophylls are green pigments in plants and contain calcium.

**42.** Which one has largest number of isomers?
(1) $[Co(en)_2Cl_2]^+$ (2) $[Co(NH_3)_5Cl]^{2+}$
(3) $[Ir(PR_3)_2H(CO)]^{2+}$ (4) $[Ru(NH_3)_4Cl_2]^+$

**43.** The correct order of magnetic moments (only spin value in BM) is:
(1) $Fe(CN)_6^{4-} > [CoCl_4]^{2-} > [MnCl_4]^{2-}$
(2) $[MnCl_4]^{2-} > [Fe(CN)_6]^{4-} > [CoCl_4]^{2-}$
(3) $[Fe(CN)_6]^{4-} > [MnCl_4]^{2-} > [CoCl_4]^{2-}$
(4) $[MnCl_4]^{2-} > [CoCl_4]^{2-} > [Fe(CN)_6]^{4-}$

**44.** The value of 'spin only' magnetic moment for one of the following configurations is 2.84 BM. The correct one is:
(1) $d^4$ (in strong field ligand)
(2) $d^4$ (in weak field ligand)
(3) $d^3$ (in weak as well as strong field ligand)
(4) $d^5$ (in strong field ligand)

**45.** Nickel (Z = 28) combines with a uninegative monodentate ligand $X^-$ to form a paramagnetic complex $[NiX_4]^{2-}$ The number of unpaired electron(s) in the nickel and geometry of this complex ion are, respectively :
(1) One, tetrahedral
(2) Two, tetrahedral
(3) One, square planar
(4) Two, square planar

**46.** In which of the following octahedral complexes of Co (at no. 27), will the magnitude of $\Delta_0$ be the highest?
(1) $[Co(C_2O_4)_3]^{3-}$
(2) $[Co(H_2O)_6]^{3+}$
(3) $[Co(NH_3)_6]^{3+}$
(4) $[Co(CN)_6]^{3-}$

**47.** A solution containing 2.675 g of $CoCl_3.6NH_3$ (molar mass = 267.5 g $mol^{-1}$) is passed through a cation exchanger. The chloride ions obtained in solution were treated with excess of $AgNO_3$ to give 4.305 g of AgCl
(molar mass = 143.5 g $mol^{-1}$). The formula of the complex is (At. mass of Ag = 108 u)
(1) $[Co(NH_3)_6]Cl_3$
(2) $[CoCl_2(NH_3)_4]Cl$
(3) $[CoCl_3(NH_3)_3]$
(4) $[CoCl(NH_3)_5]Cl_2$

**48.** Which of the following facts about the complex $[Cr(NH_3)_6]Cl_3$ is **wrong**?
(1) The complex involves $d^2sp^3$ hybridisation and is octahedral in shape.
(2) The complex is paramagnetic.
(3) The complex is an outer orbital complex.
(4) The complex gives white precipitate with silver nitrate solution.

**49.** Which of the following complex species is not expected to exhibit optical isomerism?
(1) $[Co(en)_3]^{3+}$
(2) $[Co(en)_2 Cl_2]^{+}$
(3) $[Co(NH_3)_3 Cl_3]$
(4) $[Co(en)(NH_3)_2 Cl_2]^{+}$

**50.** The octahedral complex of a metal ion $M^{3+}$ with four monodentate ligands $L_1$, $L_2$, $L_3$ and $L_4$ absorb wavelengths in the region of red, green, yellow and blue, respectively. The increasing order of ligand strength of the four ligands is:
(1) $L_4 < L_3 < L_2 < L_1$
(2) $L_1 < L_3 < L_2 < L_4$
(3) $L_3 < L_2 < L_4 < L_1$
(4) $L_1 < L_2 < L_4 < L_3$

**51.** On treatment of 100 mL of 0.1 M solution of $CoCl_3.6H_2O$ with excess $AgNO_3$; $1.2 \times 10^{22}$ ions are precipitated. The complex is:
(1) $[Co(H_2O)_3Cl_3].3H_2O$
(2) $[Co(H_2O)_6]Cl_3$
(3) $[Co(H_2O)_5Cl]Cl_2.H_2O$
(4) $[Co(H_2O)_4Cl_2]Cl.2H_2O$

**52.** The correct statement about of the magnetic properties of $[Fe(CN)_6]^{3-}$ and $[FeF_6]^{3-}$ is: (Z = 26)
(1) Both are paramagnetic
(2) Both are diamagnetic
(3) $[Fe(CN)_6]^{3-}$ is diamagnetic, $[FeF_6]^{3-}$ is paramagnetic.
(4) $[Fe(CN)_6]^{3-}$ is paramagnetic, $[FeF_6]^{3-}$ is diamagnetic.

**53.** Which of the following name formula combinations is not correct?

| | Formula | Name |
|---|---|---|
| (1) | $K_2[Pt(CN)_4]$ | Potassium tetracyanoplatinate (II) |
| (2) | $[Mn(CN)_5]^{2-}$ | Pentacyanomanganese (II) ion |
| (3) | $K[Cr(NH_3)_2Cl_4]$ | Potassium diamminetetrachlorochromate (III) |
| (4) | $[Co(NH_3)_4(H_2O)l]SO_4$ | Tetraammineaquaiodocobalt (III) sulphate |

**54.** Which of the following complex ions has electrons that are symmetrically filled in both $t_{2g}$ and $e_g$ orbitals?
(1) $[FeF_6]^{3-}$
(2) $[Mn(CN)_6]^{4-}$
(3) $[CoF_6]^{3-}$
(4) $[Co(NH_3)_6]^{2+}$

**55.** Identify the correct trend given below: (Atomic No.: Ti = 22, Cr = 24 and Mo = 42)
(1) $\Delta_o$ of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and $\Delta_o$ of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$
(2) $\Delta_o$ of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and $\Delta_o$ of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$
(3) $\Delta_o$ of $[Cr(H_2O)_6]^{2+} > [Mo(H_2O)_6]^{2+}$ and $\Delta_o$ of $[Ti(H_2O)_6]^{3+} < [Ti(H_2O)_6]^{2+}$
(4) $\Delta_o$ of $[Cr(H_2O)_6]^{2+} < [Mo(H_2O)_6]^{2+}$ and $\Delta_o$ of $[Ti(H_2O)_6]^{3+} > [Ti(H_2O)_6]^{2+}$

**56.** $[Co_2(CO)_8]$ displays:
(1) One Co–Co bond, four terminal CO and four bridging CO
(2) One Co–Co bond, six terminal CO and two bridging CO
(3) No Co–Co bond, four terminal CO and four bridging CO
(4) No Co–Co bond, six terminal CO and two bridging CO

**57.** The bond length in CO is 1.128 Å. What will be the bond length of CO in $Fe(CO)_5$?
(1) 1.158 Å (2) 1.128 Å
(3) 2.198 Å (4) 1.118 Å

**58.** Among the following metal carbonyls, the C–O bond order is lowest in:
(1) $[Mn(CO)_6]^{+}$ (2) $[V(CO)_6]^{-}$
(3) $[Cr(CO)_6]$ (4) $[Fe(CO)_5]$

**59.** Match each coordination compound in List-I with an appropriate pair of characteristics from List-II and select the correct answer using the code given below the lists.
{en = $H_2NCH_2CH_2NH_2$ ; atomic numbers : Ti = 22; Cr = 24; Co = 27; Pt = 78}

| | List- I | | List- II |
|---|---|---|---|
| I | $[Cr(NH_3)_4Cl_2]Cl$ | P | Paramagnetic and exhibits ionisation isomerism |
| II | $[Ti(H_2O)_5Cl](NO_3)_2$ | Q | Diamagentic and exhibits *cis-trans* isomerism |
| III | $[Pt(en)(NH_3)Cl]NO_3$ | R | Paramagentic and exhibits *cis-trans* isomerism |
| IV | $[Co(NH_3)_4(NO_3)_2]NO_3$ | S | Diamagentic and exhibits ionisation isomerism |

(1) I-S ; II-Q ; III-R ; IV-P
(2) I-R ; II-P ; III-S ; IV-Q
(3) I-Q ; II-P ; III-R ; IV-S
(4) I-P ; II-R ; III-S ; IV-Q

**60.** Consider the following statements:

**$S_1$:** $[Cr(NH_3)_6]^{3+}$ is an inner orbital complex with crystal field stabilization energy equal to – 1.2 $\Delta_o$

**$S_2$:** The complex formed by joining the $CN^-$ ligands to $Fe^{3+}$ ion has theoretical value of 'spin only' magnetic moment equal to 1.73 B.M.

**$S_3$:** $Na_2S + Na_2[Fe(CN)_5NO] \rightarrow Na_4[Fe(CN)_5NOS]$, In reactant and product the oxidation states of iron are not same

And arrange in the order of true/false.

(1) F T F  (2) T T F
(3) T T T  (4) F F F

*Integer Type Questions (61 to 75)*

**61.** The oxidation state of Fe in brown ring complex $[Fe(H_2O)_5NO]SO_4$ is :

**62.** The number of geometrical isomers of $[Pt(NH_3)_2Cl_2]$ is:

**63.** The number of isomers possible for square planar complex $K_2[PdClBr_2(SCN)]$ is

**64.** The number of unpaired electrons in the complex ion $[CoF_6]^{3-}$ is: (At number Co = 27)

**65.** An excess of $AgNO_3$ is added to 100 mL of a 0.01M solution of dichlorotetraaquachromium (III) chloride. The number of mili-moles of AgCl precipitated would be:

**66.** How many EDTA (ethylenediaminetetraacetic acid) molecules are required to make an octahedral complex with a $Ca^{2+}$ ion?

**67.** The magnetic moment (spin only) of $[NiCl_4]^{2-}$ in Bohr magneton (BM) is: (Nearest integer)

**68.** The number of geometric isomers that can exist for square planar $[Pt(Cl)(py)(NH_3)(NH_2OH)]^+$ is (py = pyridine):

**69.** The spin magnetic moment of cobalt in the compound, $Hg[Co(SCN)_4]$ in Bohr magneton (BM) is:
(Nearest integer)

**70.** How many of the following complexes are diamagnetic $K_3[Fe(CN)_6]$, $[Co(NH_3)_6]Cl_3$, $Na_3[Co(oxalate)_3]$,
$[Ni(H_2O)_6]Cl_2$, $K_2[Pt(CN)_4]$ and
$[Zn(H_2O)_6](NO_3)_2$

**71.** In the complex $Fe(CO)_x$, the value of x is:

**72.** The number of d-electrons in $[Cr(H_2O)_6]^{3+}$ [atomic number of Cr = 24] is:

**73.** If excess of $AgNO_3$ solution is added to 100 mL of a 2.4 M solution of dichlorobis (ethylenediamine) cobalt (III) chloride. How many mili- moles of AgCl be precipitated?

**74.** Oxidation number of Fe in violet coloured complex $Na_4[Fe(CN)_5(NOS)]$ is:

**75.** Coordination number of Ni in $[Ni(C_2O_4)_3]^{4-}$ is:

# CHAPTER 16

# HALOALKANES AND HALOARENES

## Single Option Correct Type Questions (01 to 60)

**1.** A dextro-rotatory optically active alkyl halide undergoes hydrolysis by $S_N2$ mechanism. The resulting alcohol is:
(1) Dextrorotatory
(2) Laevorotatory
(3) Optically inactive due to racemization
(4) May be dextro or laevorotatory

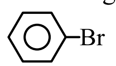
**2.** Neopentyl bromide undergoes dehydro halogenation to give alkene even though it has no β-hydrogen. This is due to:
(1) E2 mechanism
(2) by direct dehydrohalogenation
(3) rearrangement of carbocation by E1 mechanism
(4) E1cB mechanism

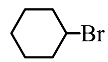
**3.** Which of the following does not give a precipitate with alcoholic $AgNO_3$?
(1) Benzyl chloride (2) Chlorobenzene
(3) Allyl chloride (4) t-butyl chloride

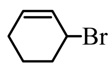
**4.** When alkyl halide is heated with dry $Ag_2O$. It produces:
(1) Ester (2) Ether
(3) Ketone (4) Alcohol

**5.** Phosgene is a poisonous gas obtained in chloroform bottles, substance used to make it non-poisonous is:
(1) Formic acid
(2) Ethanol
(3) Dichloro methane
(4) $CH_3COOH$

**6.** Order of hydrolysis of the following in increasing order is:


(A)

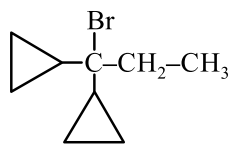

(B)


(C)

Ph—$CH_2$—Br
(D)

(1) A < B < C < D
(2) D < C < B < A
(3) C < B < A < D
(4) B < C < A < D

**7.** Which of the following will be most reactive for E1 reaction?

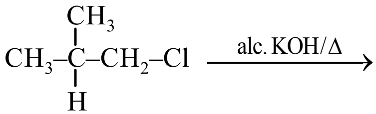
(1) 

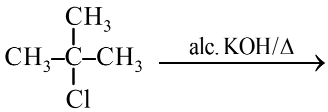
(2)
Br
|
$C_6H_5$–CH–Br

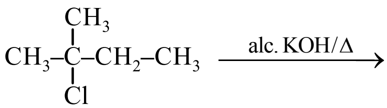
(3)
Br
|
$CH_2$=CH–CH–$CH_3$

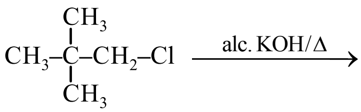
(4)
Br
|
$CH_2$=CH–C–$CH_3$
|
$CH_3$

**8.** In which of the following reaction, regioselectivity can be observed?

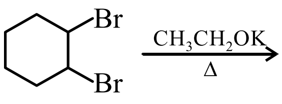
(1) 

(2) 

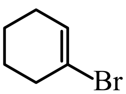
(3) 

(4) 

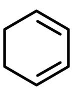
**9.** The most probable product in the following reaction is:

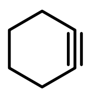


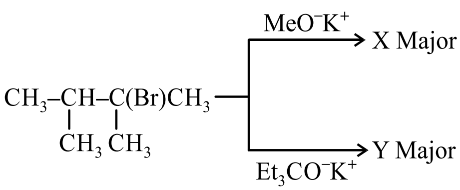
Trans

(1) 

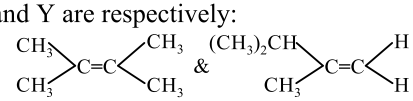
(2) 

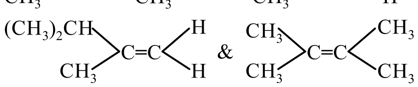
(3) 

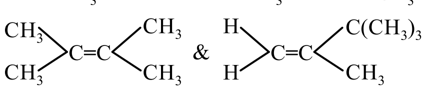
(4) 

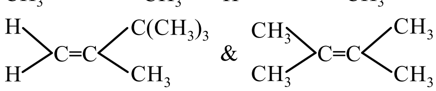
**10.** 

X and Y are respectively:

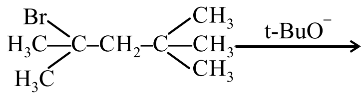
(1) 

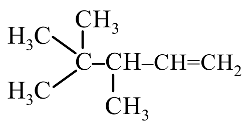
(2) 

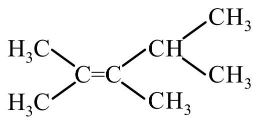
(3) 

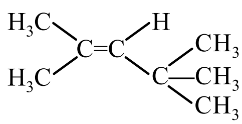
(4) 

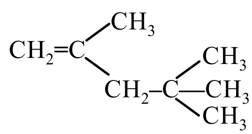
**11.** Which is the product of the following elimination reaction?



(1) 

(2) 

(3) 

(4) 

**12.** $C_3H_6Cl_2 \xrightarrow[\text{2. } H_3O^{\oplus} \text{ 3. } \Delta]{\text{1. KCN}} CH_3-\underset{\underset{CH_3}{|}}{C}HCOOH$ :

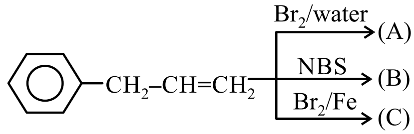
Hence reactant is:

(1) $Cl-CH_2-CH_2-CH_2-Cl$

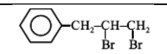
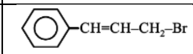
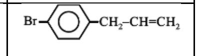
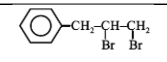
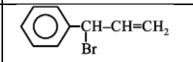
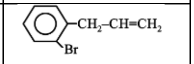
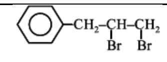
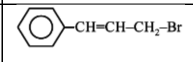
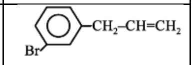
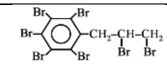
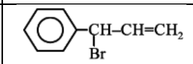
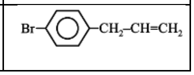
(2) $CH_3-\underset{\underset{Cl}{|}}{CH}-\underset{\underset{Cl}{|}}{CH_2}$

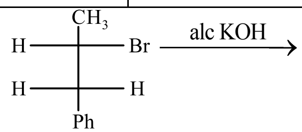
(3) $CH_3-CH_2-CH(Cl)_2$

(4) $CH_3-\underset{\underset{CH_3}{|}}{C}(Cl)_2$

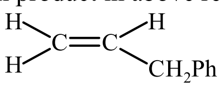
**13.** 

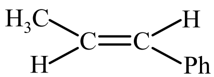
(A), (B) and (C) respectively are:

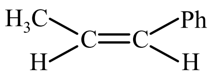
| | A | B | C |
|---|---|---|---|
| 1 |  |  |  |
| 2 |  |  |  |
| 3 |  |  |  |
| 4 |  |  |  |

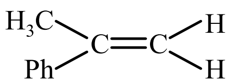
**14.**  Product:

Main product in above reaction is:

(1) 

(2) 

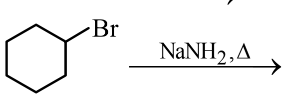
(3) 

(4) 

**15.** Which one of the following is not E2 reaction?

(1) $CH_3-CH(Cl)-CH_2-CH_3 \xrightarrow{\text{alc KOH},\Delta}$

(2) $CH_3-CH(CH_3)-CH(Br)-CH_3 \xrightarrow{(CH_3)_3C\overset{\ominus}{O}K^{\oplus},\Delta}$

(3) 

(4) $CH_3-C(CH_3)_2-CH_2-Br \xrightarrow[\Delta]{NH_3(\ell)}$

**16.** Most reactive alkyl halide towards E2 mechanism is:

(1) $(CH_3)_3C-CH_2Br$

(2) $(CH_3)_2CH-CH(Br)CH_3$

(3) $(CH_3)_3C-CH_2CH_2Br$

(4) $(CH_3)_3C-CH(C(CH_3)_3)-CH_2Br$

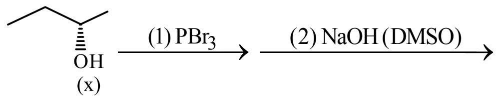
**17.** $S_N2$ reaction at an asymmetric carbon of a compound always gives:

(1) An enantiomer of the substrate

(2) A product with opposite optical rotation

(3) A mixture of diastereomers

(4) A single stereoisomer

**18.** 

(y)

(x) and (y) are:

(1) Structural isomers

(2) Enantiomers

(3) Different compounds

(4) Identical compounds

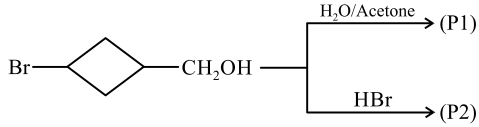
**19.** Racemic mixture is obtain in which substrate when it is treated with $CH_3OH$

(1) $CH_3-C(H)(H)-CH_2-Cl$

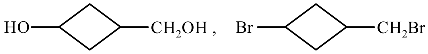
(2) $CH_3-C(CH_3)(H)-CH_2-Cl$

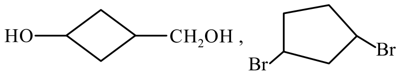
(3) $CH_3-C(CH_2CH_3)(D)-CH_2-Cl$

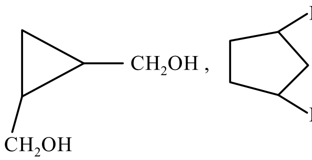
(4) $CH_3-C(CH_2CH_3)(H)-CH_2-Cl$

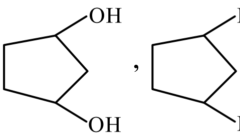
**20.** 

P1 and P2 are respectively:

(1) 

(2) 

(3) 

(4) 

**21.** Reaction between neopentyl bromide and ethanol gives 2-ethoxy-2-methylbutane as the principal product. Which one of the following is not true about this reaction?

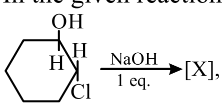
(1) This involves a 1, 2-hydride shift

(2) This involves a 1,2-methyl shift

(3) This occurs through a $S_N1$ mechanism

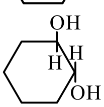
(4) This is accompanied with formation of alkenes as minor product

**22.** In the given reaction

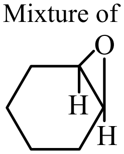


[X] will be:

(1) 

(2) 

(3) Mixture of (1) and (2)

(4) 

**23.** Select false statement from the following?

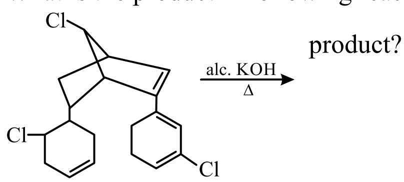
(1) The step $F-CF_2-\overset{\ominus}{C}Cl_2 \longrightarrow :\overset{\ominus}{F} + CF_2=CCl_2$ is a part of E1 cB elimination.

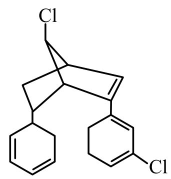
(2) E-1 reaction can be regio selective.

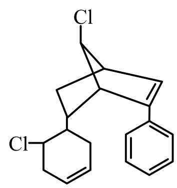
(3) Both $S_N2$ & E2 reactions can be stereo specific.

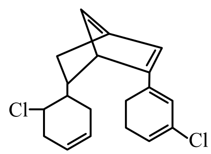
(4) In E1 and E2 reactions inversion of configuration takes place.

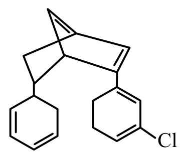
**24.** What is the product in following reaction?



(1) 

(2) 

(3) 

(4) 

**25.** Which of the following is polar protic solvent?

(1) $CH_3COCH_3$

(2) $C_2H_5-OH$

(3) $CH_3SOCH_3$

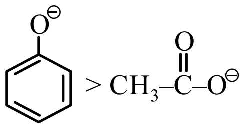
(4) $CH_3-\underset{\underset{O}{\|}}{C}-N(Me)_2$

**26.** Which one of the following has maximum nucleophilicity:

(1) $\overset{\ominus}{C}H_3$ (2) $\overset{\ominus}{N}H_2$

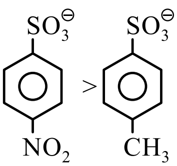
(3) $CH_3\overset{\ominus}{O}$ (4) $CH_3-\underset{CH_3}{\overset{CH_3}{C}}-\overset{\ominus}{O}$

**27.** Which of the following is **incorrect** order for leaving group ability in $S_N$ reaction?

(1) 

(2) $Cl^{\ominus} > F^{\ominus}$

(3) $CF_3SO_3^{\ominus} > CH_3SO_3^{\ominus}$

(4) 

**28.** Which one of the following has maximum nucleophilicity:

(1) $CH_3S^{\ominus}$ (2) $C_6H_5-\overset{\ominus}{O}$

(3) $Et_3N$ (4) $F^{\ominus}$

**29.** For the following the increasing order of nucleophilicity would be:

(i) $I^-$ (ii) $Cl^-$

(iii) $Br^-$

(1) $I^- < Cl^- < Br^-$

(2) $Br^- < Cl^- < I^-$

(3) $I^- < Br^- < Cl^-$

(4) $Cl^- < Br^- < I^-$

**30.** The correct order of leaving group ability is/are:

(1) $Ph-COO^{\ominus} > CH_3SO_3^{\ominus}$

(2) $CF_3SO_3^{\ominus} > CCl_3SO_3^{\ominus}$

(3) $\overset{\ominus}{C}N > I^{\ominus}$

(4) $\overset{\ominus}{N}H_2 > \overset{\ominus}{O}H$

**31.** Which of the following statement is not true?

(1) Nucleophiles possess unshared pairs of electron which are utillized in forming bonds with electrophilic substrate.

(2) The cyanide ion is an ambident nucleophile and causes nucleophilic substitution of alkyl halide by either of its carbon atom or nitrogen atom.

(3) The nitrite ion is an ambident nucleophile and causes nucleophilic substitution of alkyl halide by either of its oxygen atom or nitrogen atom.

(4) Strength of nucleophile generally decreases on going down a group in the periodic table.

**32.** Out of the followings best leaving group is:

(1) $F^-$ (2) $Cl^-$

(3) $Br^-$ (4) $I^-$

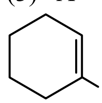
**33.** $CH_3Br + Nu^- \rightarrow CH_3 - Nu + Br^-$

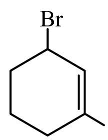
The decreasing order of the rate of the above reaction with nucleophiles ($Nu^-$) A to D is:

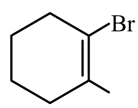
[$Nu^-$ = (A) $PhO^-$, (B) $AcO^-$, (C) $HO^-$, (D) $CH_3O^-$]

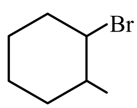
(1) D > C > A > B (2) D > C > B > A

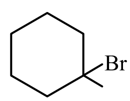
(3) A > B > C > D (4) B > D > C > A

**34.**  + HBr $\xrightarrow{R_2O_2}$ Product: Product is:

(1) 


(2) 


(3) 


(4) 


**35.** Chlorobenzene is o, p-directing in electrophilic substitution reaction. The directing influence is explained by

(1) +M of Ph (2) +I of Cl

(3) +M of Cl (4) +I of Ph

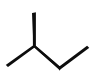
**36.** Benzene reacts with n-propyl chloride in the presence of anhydrous $AlCl_3$ to give predominantly:
(1) n-propylbenzene
(2) Cumene
(3) 3-propyl-1-chlorobenzene
(4) no reaction

**37.** Lindane can be obtained by reaction of benzene with
(1) $CH_3Cl$/anhy $AlCl_3$
(2) $Cl_2$/sunlight
(3) $C_2H_5I$/anhy. $AlCl_3$
(4) $CH_3COCl/AlCl_3$

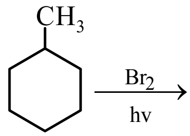
**38.** In which of the following pairs, the bromination of first member is easier than the second member ?
(1) Isobutane, n-butane
(2) n-Butane, isobutane
(3) Methane, ethane
(4) None of these

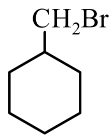
**39.** Halogenation of alkanes is an example of
(1) Free radical addition reaction
(2) Free radical substitution reaction
(3) Nucleophilic substitution reaction
(4) Nucleophilic addition reaction.

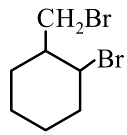
**40.** Methane reacts with excess of chlorine in diffused sunlight to give the final product as
(1) Chloroform
(2) Carbon tetrachloride
(3) Methylene chloride
(4) Methyl chloride.

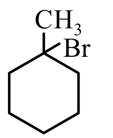
**41.** A gaseous hydrocarbon 'X' on reaction with bromine in light forms a mixture of two monobromo alkanes and HBr. The hydrocarbon 'X' is:
(1) $CH_3–CH_3$
(2) 
(3) 
(4) 

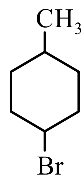
**42.** The major product obtained in the reaction:




(1) 


(2) 


(3) 


(4) 


**43.** Iodination of an alkane is carried out in presence of:
(1) Alcohol
(2) $P + I_2$
(3) $HNO_3$ or $HIO_3$
(4) A reducing agent

**44.** Tert-alkyl halide is obtained as major product in:
(1) $(CH_3)_3CH \xrightarrow[hv]{Br_2}$
(2) $(CH_3)_2CH–CH=CH_2 \xrightarrow[Peroxide]{HBr}$
(3) $(CH_3)_2\ CH–CH=CH_2 \xrightarrow{HBr}$
(4) Both (1) and (3)

**45.** Intermediate in the following reaction is
$CH_3–CH=CH_2 \xrightarrow[Peroxide]{HCl}$
(1) $CH_3-\overset{\oplus}{C}H-CH_3$
(2) $CH_3–\underset{Cl}{\underset{|}{C}H}–\dot{C}H_2$
(3) $CH_3-\dot{C}H-CH_2-Cl$
(4) $CH_3-\overset{\oplus}{C}H-CH_2-Cl$

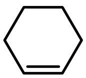
**46.** $CH_2 = CHCH_2CH = CH_2 \xrightarrow{NBS} X$ (Major), (X) is:

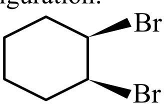
(1) $CH_2 = CH - \underset{\underset{Br}{|}}{C}HCH = CH_2$

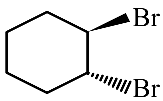
(2) $CH_2 = CH - CH = CH - CH_2 - Br$

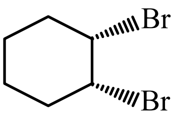
(3) $CH_2 = CHCH_2CH = CHBr$

(4) $CH_2 = CHCH_2\underset{\underset{Br}{|}}{C} = CH_2$

**47.**  + $Br_2 \longrightarrow$ P, P will have configuration:

(1) 

(2) 

(3) 

(4) All of these

**48.** $CH_3 - C \equiv C - CH_3 \xrightarrow[(2)\ Br_2]{(1)\ H_2/Pd/CaCO_3 \text{ or } BaSO_4} X$

(1) (d)-2, 3-Dibromobutane

(2) ($\ell$)-2, 3-Dibromobutane

(3) (d, $\ell$)-2, 3-Dibromobutane

(4) meso-2, 3-Dibromobutane

**49.** 1-Butyne can be converted into 1-bromo-1-butene by reacting it with which of the following reagent?

(1) HBr

(2) HBr and $(C_6H_5COO)_2$

(3) $Br_2$ and $H_2O$

(4) $Br_2$ and $CCl_4$

**50.** When nitrobenzene is treated with $Br_2$ in presence of $FeBr_3$ the major product formed is m-bromonitrobenzene. Statement which is related to obtain the m-isomer is:

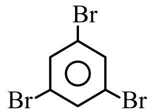
(1) The electron density on meta carbon is more than that on ortho and para positions

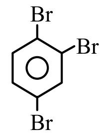
(2) Loss of aromaticity when $Br^+$ attacks at the ortho and para positions and not at meta position

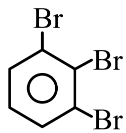
(3) Easier loss of $H^+$ to regain aromaticity from the meta position than from ortho and para positions

(4) None of the above

**51.** A particular form of tribromobenzene forms three possible mononitrotribromo-benzene. The structure of the compound is:

(1) 

(2) 

(3) 

(4) Both 2 and 3

**52.** Which statement is correct about photochemical bromination of Butane

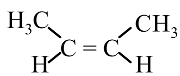
$CH_3 - CH_2 - CH_2 - CH_3 \xrightarrow{Br_2, h\nu}$

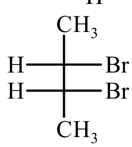
(1) 1-Bromobutane and 2-Bromobutanes are formed in equal amounts.

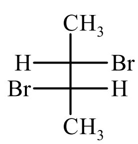
(2) 2-Bromobutane is formed with faster rate than 2-chlorobutane in the other experiment of chlorination.

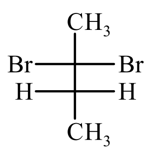
(3) The major product is an equimolar mixture of two compounds

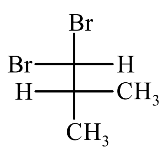
(4) Homolysis of C – H bond has lower activation energy than homolysis of Br – Br bond.

**53.**  + $Br_2 \xrightarrow{CCl_4}$ ? Product is:

(1) 

(2) 

(3) 

(4) 

**54.** Match the reaction intermediates formed during the reactions given in Column-I with Column-II

| | **Column-I** | | **Column-II** |
|---|---|---|---|
| P | $CH_3-C\equiv C-H \xrightarrow{Na}$ | A | Carbocation (Non classical) |
| Q | $CH_3-CH=CH_2 \xrightarrow{HBr}$ | B | Carbocation (Classical) |
| R | $CH_3-CH=CH_2 \xrightarrow[Peroxide]{HBr}$ | C | Carbanion |
| S | $CH_3-CH=CH_2 \xrightarrow{Br_2/CCl_4}$ | D | Alkyl free radical |

| | **P** | **Q** | **R** | **S** |
|---|---|---|---|---|
| (1) | A | C | B | D |
| (2) | C | D | A | B |
| (3) | C | B | D | A |
| (4) | A | D | C | B |

**55.** Reaction of one molecule of HBr with one molecule of 1, 3-butadiene at 40°C gives predominantly

(1) 3-bromobutene under kinetically controlled conditions
(2) 1-bromo-2-butene under thermodynamically controlled conditions
(3) 3-bromobutene under thermodynamically controlled conditions.
(4) 1-bromo-2-butene under kinetically controlled conditions.

**56.** 2-Methylbutane on reacting with bromine in the presence of sunlight gives mainly?

(1) 1-Bromo-3-methylbutane
(2) 1-Bromo-2-methylbutane
(3) 2-Bromo-3-methylbutane
(4) 2-Bromo-2-methylbutane

**57.** Of the five isomeric hexanes, the isomer which can give two monochlorinated structural isomers is

(1) n - hexane
(2) 2,3 – dimethylbutane
(3) 2,2 - dimethylbutane
(4) 2 - methylpentane

**58.** The reaction of toluene with $Cl_2$ in presence of $FeCl_3$ gives predominantly:

(1) o- and p-chlorotoluene
(2) m-chlorotoluene
(3) benzoylchloride
(4) benzyl chloride

**59.** Which of the following reactions will yield 2,2-dibromopropane?

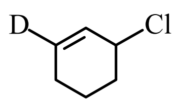
(1) $CH_3-C\equiv CH + 2HBr \longrightarrow$
(2) $CH_3CH=CHBr + HBr \longrightarrow$
(3) $CH\equiv CH + 2HBr \longrightarrow$
(4) $CH_3-CH=CH_2 + HBr \longrightarrow$

**60.** **Assertion:** Addition of bromine to trans-2-butene yields meso-2. 3-dibromobutane.

**Reason:** Bromine addition to an alkene is an electrophilic addition

(1) Assertion is True, Reason is True; Reason is a correct explanation for Assertion.
(2) Assertion is True, Reason is True; Reason is NOT a correct explanation for Assertion.
(3) Assertion is True, Reason is False.
(4) Assertion is False, Reason is True.

## *Integer Type Questions (61 to 75)*

**61.** 

$\xrightarrow{H_2O/Acetone}$ Possible number of products and fractions on fractional distillation are x and y respectively. Find the value of x + y.

**62.** How many of the following is an electrophile?

(i) $H_2O$
(ii) $OH^-$
(iii) $NO_2^+$
(iv) $SO_3$
(v) $PCl_5$

**63.** Chlorination of butane takes place as,

$$CH_3–CH_2–CH_2–CH_3 + Cl_2 \xrightarrow[\text{Light}]{h\nu}$$

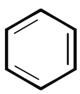
$$\underset{\text{1-Chlorobutane}}{\overset{Cl}{\overset{|}{C}}H_2–CH_2–CH_2–CH_3} + \underset{\text{2-Chlorobutane}}{CH_3–\overset{Cl}{\overset{|}{C}}H–CH_2–CH_3}$$

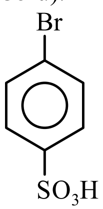
Consider the following relative reactivity of C – H bonds for chlorination.

| Degree of C – H | 1° C – H | 2° C – H | 3° C – H |
|---|---|---|---|
| Relative reactivity for chlorination (RR) | 1 | 3 | 5 |

Percentage yield of 2-chlorobutane will be: (Nearest integer)

**64.** The molar mass of compound X in the reaction is:

 $+ ICl \xrightarrow{\text{anhydrous } AlCl_3}$ X (Consider Atomic weight of Iodine: 127 u and chlorine: 35 u).

**65.**  $\xrightarrow[\text{(ii) } H_2O, \Delta, H^+]{\text{(i) } Cl_2 / Fe}$ Product. Total no. of substituents present on benzene ring in final product is:

**66.** The number of monochloro derivatives of isohexane is (Only structural isomers)

**67.** When 1-butyne is treated with excess of HBr, the expected product is p, q- dibromobutane, where p and q are position of bromine. Find the value of (p + q).

**68.** The number of possible enantiomer pairs that can be produced during monochlorination of 2-methylbutane is

**69.** 3-Methyl-pent-2-ene on reaction with HBr in presence of peroxide forms an addition product. The number of possible stereoisomers for the product is:

**70.** In the following reaction sequence

$Cl–Cl \longrightarrow \dot{C}l + \dot{C}l$ (Step–1)

$CH_4 + \dot{C}l \longrightarrow \dot{C}H_3 + HCl$ (Step–2)

$\dot{C}H_3 + Cl_2 \longrightarrow CH_3Cl + \dot{C}l$ (Step–3)

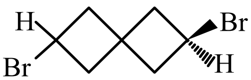
$\dot{C}H_3 + \dot{C}H_3 \longrightarrow CH_3 – CH_3$ (Step–4)

The chain terminating step is:

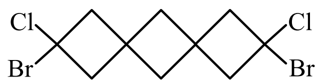
**71.** Which of the following are chiral molecules

(i) Ph–CH=C=C=CH–Cl

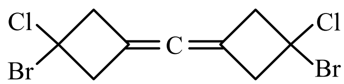
(ii) $CH_3–CH=C=C=C=CH–CH_3$

(iii) 

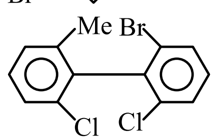


(iv) 



(v) 



(vi) 



**72.** How many n-octene can show geometrical isomerism?

**73.** How many geometrical isomers are possible for Hepta-2, 5-dienoic acid:

**74.** For given compound

$$CH_3 – \underset{\underset{OH}{|}}{C}H – CH = CH – CH_3$$

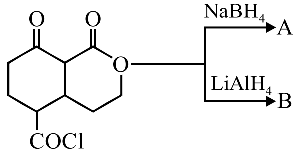
Number of optically active stereoisomers are?

**75.** The total number of possible isomers with molecular formula $C_6H_{12}$ that contain a cyclobutane ring.

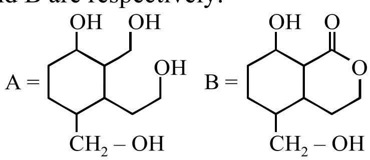
# CHAPTER 17

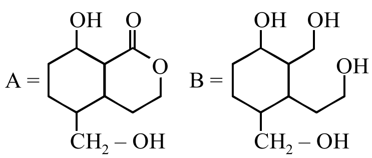
# ALCOHOLS, PHENOLS AND ETHERS

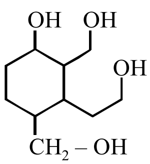
## *Single Option Correct Type Questions (01 to 60)*

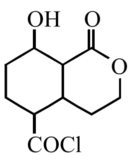
**1.** 

A and B are respectively:

(1) 

(2) 

(3) Both A and B 

(4) Both A and B 

**2.** Choose the correct statement:

(1) $LiAlH_4$ cannot reduce isolated carbon – carbon double or triple bond

(2) Borane and $LiAlH_4$ have generally same reducing power and same mechanism

(3) $LiAlH_4$ can reduce isolated carbon – carbon double bond

(4) $LiAlH_4$ is a weak hydride donor than $NaBH_4$

**3.** Reaction involving syn addition is:

(1) $CH_2 = CH_2 \xrightarrow{H^+/H_2O}$

(2) $CH_3CH = CH_2 \xrightarrow{HX}$

(3) $CH_3CH = CH_2 \xrightarrow[NaBH_4]{Hg(OAc)_2/H_2O}$

(4) $CH_2 = CH_2 \xrightarrow[H_2O_2/OH^-]{B_2H_6/THF}$

**4.** An alkene obtained by the dehydration of an alcohol (A) on ozonolysis gives two molecules of acetaldehyde for each molecule of the alkene. The alcohol (A) is

(1) $CH_3CH_2CH_2OH$

(2) $CH_3CH_2OH$

(3) $CH_3 - CH = CHCH_2OH$

(4) $CH_3CH_2CHOHCH_3$

**5.** An organic compound having the molecular formula $C_3H_6O$ does not give a precipitate with 2, 4 dinitrophenyl hydrazine and does not react with sodium metal. The compound is expected to be

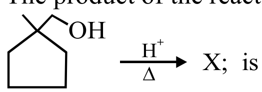
(1) $CH_3 - CH_2 - CHO$

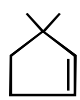
(2) $CH_3 - CO - CH_3$

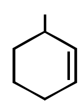
(3) $CH_3 = CH - CH_2 - OH$

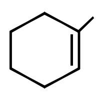
(4) $CH_2 = CH - OCH_3$

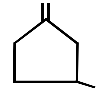
**6.** The product of the reaction



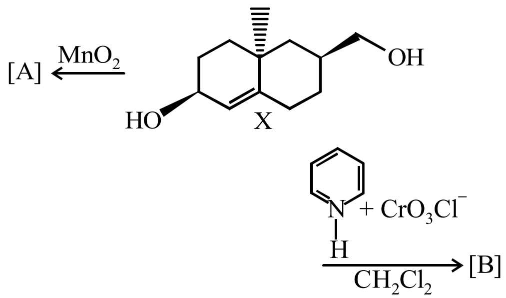
(1) 

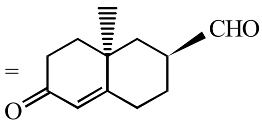
(2) 

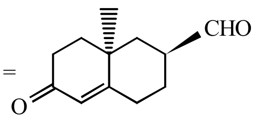
(3) 

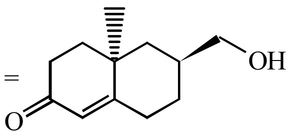
(4) 

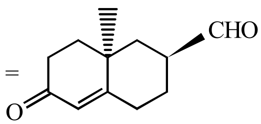
**7.** Pyridinium chlorochromate and $MnO_2$ are used as selective oxidizing agents in organic synthesis. What would be the oxidation products of compound X, when it reacts separately with PCC and $MnO_2$?

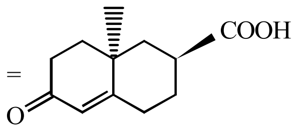


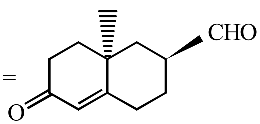

(1) [A] = 

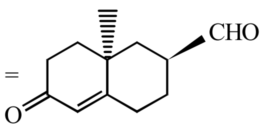
and [B] = 

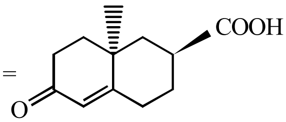
(2) [A] = 

and [B] = 

(3) [A] = 

and [B] = 

(4) [A] = 

and [B] = 

**8.** A compound of molecular formula $C_6H_6O$ turns ferric chloride solution violet and produces no effervescence with $NaHCO_3$. The compound is

(1) Phenol
(2) Anisole
(3) Benzoic acid
(4) All of these

**9.** Which of the following reaction does not form ether as major product?

(1) $CH_3-C(CH_3)_2-O-Na + CH_3CH_2Br \longrightarrow$

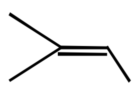
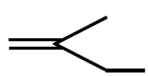
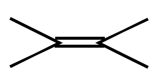
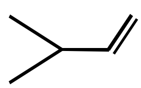
(2) $CH_3-C(CH_3)_2-Br + CH_3CH_2ONa \longrightarrow$

(3) $CH_3-CH_2-Br + CH_3ONa \longrightarrow$ (i.e. $CH_3-C(H)(H)-Br$)

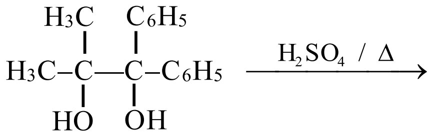
(4) $CH_3-CH(CH_3)-ONa + CH_3-CH_2-CH_2Br \longrightarrow$

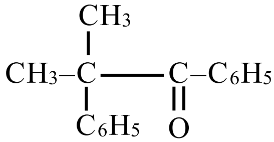
**10.** $CH_3-C(CH_3)(OH)-CH_2-CH_3 \xrightarrow[\Delta]{\text{Conc. } H_2SO_4}$ Major Product

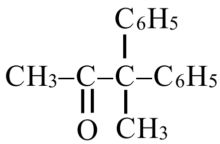
Major Product is:

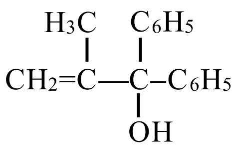
(1) 
(2) 
(3) 
(4) 

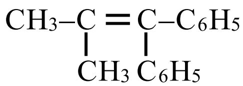
**11.** Identify the major product formed in the following reaction



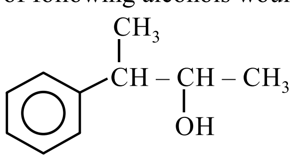
(1) 

(2) 

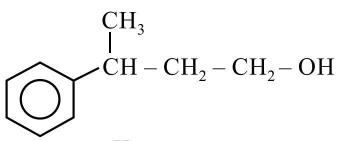
(3) 

(4) 

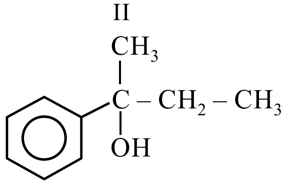
**12.** The relative rate of acid catalyzed dehydration of following alcohols would be:



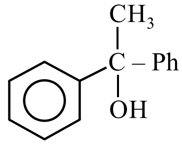
I



II



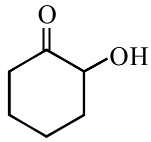
III

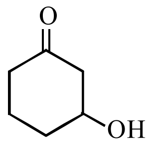


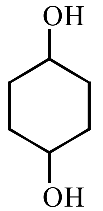
IV

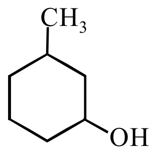
(1) III > I > IV > II (2) III >IV > I > II
(3) I > III > IV > II (4) IV > III > I > II

**13.** Maximum dehydration takes place that of:

(1) 

(2) 

(3) 

(4) 

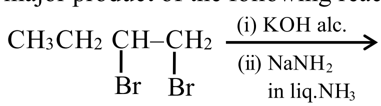
**14.** During dehydration of alcohols to alkenes by heating with concentrated $H_2SO_4$, the initiation step is

(1) Protonation of alcohol molecule
(2) Formation of carbocation
(3) Elimination of water
(4) Formation of an ester

**15.** Which of the following compounds will most readily be dehydrated to give alkene under acidic condition?

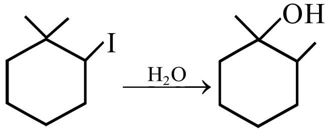
(1) 4-Hydroxypentan-2-one
(2) 3-Hydroxypentan-2-one
(3) 1-Pentanol
(4) 2-Hydroxycyclopentanone

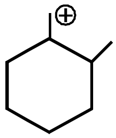
**16.** The major product of the following reaction is:

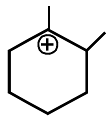


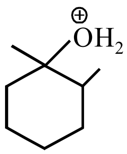
(1) $CH_3CH=C=CH_2$
(2) $CH_3CH=CHCH_2NH_2$
(3) $CH_3CH_2C\equiv CH$
(4) $CH_2=CH—CH=CH_2$

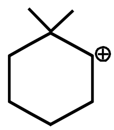
**17.** Which of the following is not expected to be intermediate of the following reaction?



(1) 

(2) 

(3) 

(4) 

**18.** $Ph\text{–}CH_2\text{–}\underset{\large OH}{\underset{|}{C}}H\text{–}CH_3 \xrightarrow{\text{Conc. HCl + Anhydrous } ZnCl_2} X$ (Major Product)

X is:

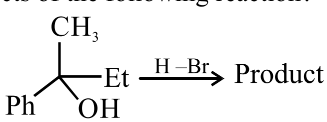
(1) $Ph\text{–}CH_2\text{–}\underset{\large Cl}{\underset{|}{C}}H\text{–}CH_3$

(2) $Ph\text{–}\underset{\large Cl}{\underset{|}{C}}H\text{–}CH_2\text{–}CH_3$

(3) $Ph\text{–}CH_2\text{–}CH_2\text{–}\underset{\large Cl}{\underset{|}{C}}H_2$

(4) $Ph\text{–}\overset{\large Cl}{\overset{|}{\underset{\large CH_3}{\underset{|}{C}}}}\text{–}CH_3$

**19.** Which describes the best stereochemical aspects of the following reaction?



(1) Inversion of configuration occurs at the carbon undergoing substitution.

(2) Retention of configuration occurs at the carbon undergoing substitution.

(3) Racemization occurs at the carbon undergoing substitution.

(4) The carbon undergoing substitution is not stereogenic

**20.** $\underset{\text{1–butanol}}{CH_3(CH_2)_2CH_2OH} \xrightarrow{HBr} \underset{\text{(major)}}{X,}$

Identify X and the type of mechanism of the reaction?

(1) $CH_3 – CH_2 – CH_2 – CH_2 – Br$ & $S_N1$

(2) $CH_3 – CH_2 – CH_2 – CH_2 – Br$ & $S_N2$

(3) $CH_3\text{–}\underset{\large Br}{\underset{|}{C}}H\text{–}CH_2\text{–}CH_3$ & $S_N1$

(4) $CH_3\text{–}\underset{\large Br}{\underset{|}{C}}H\text{–}CH_2\text{–}CH_3$ & $S_N2$

**21.**

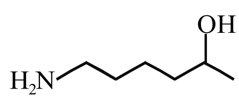
(1) S-2-Chlorobutane

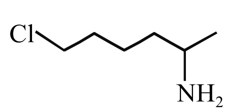
(2) R-2-Chlorobutane

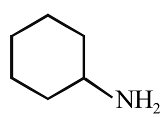
(3) Mixture of R and S, 2-Chlorobutane

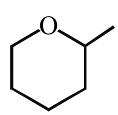
(4) 1-Chlorobutane

**22.** 6-Chlorohexan-2-ol $\xrightarrow[\Delta]{NaNH_2}$ major product is:

(1) 

(2) 

(3) 

(4) 

**23.** Consider the following reaction.

$$CH_3-CH_2-\underset{}{\overset{OH}{\overset{|}{C}H}}-CH_3 \xrightarrow[\text{ether}]{SOCl_2} CH_3-CH_2-\overset{Cl}{\overset{|}{C}H}-CH_3$$

In the above reaction which phenomenon will take place:

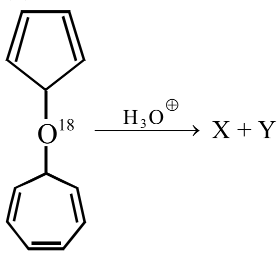
(1) Inversion (2) Retention
(3) Racemisation (4) Isomerisation

**24.** In the given reaction,

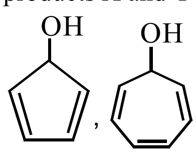
$$CH_3\text{–}CH_2\text{–}CH_2\text{–}O\text{–}CH_2\text{–}CH_3 \xrightarrow{HCl/\Delta} [X] + [Y]$$

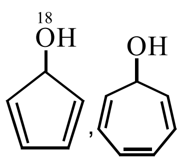
[X] and [Y] respectively will be:

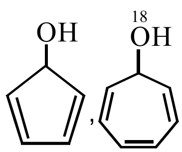
(1) $CH_3\text{–}CH_2\text{–}CH_2OH$ & $CH_3\text{–}CH_2\text{–}Cl$
(2) $CH_3\text{–}CH_2\text{–}CH_2\text{–}Cl$ & $CH_3\text{–}CH_2\text{–}OH$
(3) $CH_3\text{–}CH_2\text{–}CH_2\text{–}Cl$ & $CH_2=CH_2$
(4) $CH_3\text{–}CH=CH_2$ & $CH_2=CH_2$

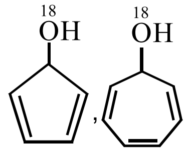
**25.** 

The products X and Y are:

(1) 

(2) 

(3) 

(4) 

**26.** $$Ph-\overset{H}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-O-CH_3 \xrightarrow{HBr} \underset{\text{Alcohol}}{(P)} + \underset{\text{Alkyl Halide}}{(Q)}$$

(P) & (Q) respectively is:

(1) $Ph-\overset{H}{\overset{|}{\underset{CH_3}{\underset{|}{C}}}}-OH,\ CH_3-Br$

(2) $Ph\text{–}CH_2\text{–}OH,\ CH_3\text{–}CH_2\text{–}Br$

(3) $CH_3-OH,\ Ph-\underset{Br}{\underset{|}{C}H}-CH_3$

(4) $CH_3\text{–}OH,\ Ph\text{–}CH_3\text{–}CH_2\text{–}Br$

**27.** $$\underbrace{CH_3-CH-CH_2}_{\text{O bridging CH and CH}_2} + (CH_3)_2CHMgBr \xrightarrow[\text{(ii) } H_2O]{\text{(i) } Et_2O}$$

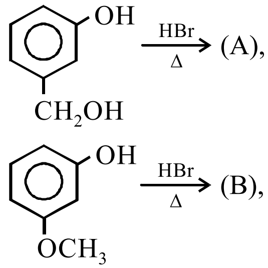
What will be the product:

(1) $CH_3\text{–}(CH_2)_4\text{–}CH_2\text{–}OH$

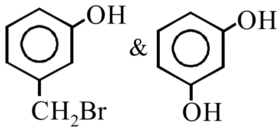
(2) $CH_3-CH=CH-\underset{CH_3}{\underset{|}{C}H}-CH_3$

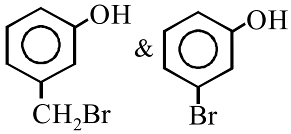
(3) $CH_3-\underset{OH}{\underset{|}{C}H}-CH_2-CH\begin{matrix}CH_3\\CH_3\end{matrix}$

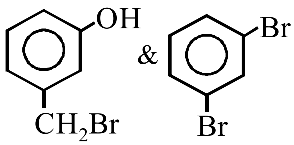
(4) $CH_3-\underset{CH(CH_3)_2}{\underset{|}{C}H}-CH_2-CH_2OH$

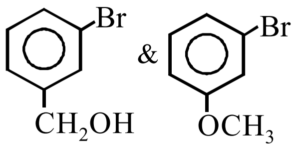
**28.** 

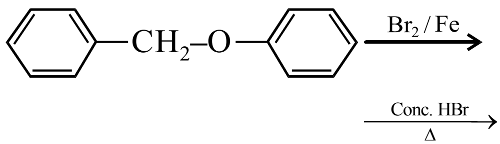
The product (A) and (B) are respectively:

(1) 

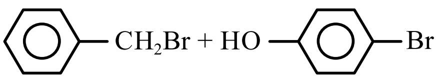
(2) 

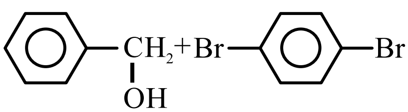
(3) 

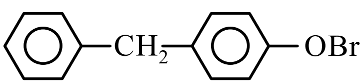
(4) 

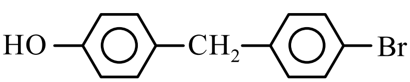
**29.** 

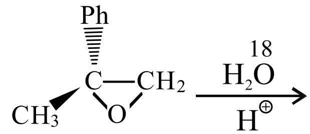
Product is:

(1) 

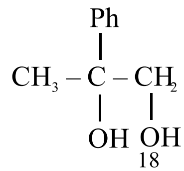
(2) 

(3) 

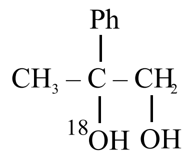
(4) 

**30.** 

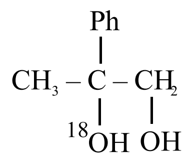
The major product is:

(1) 

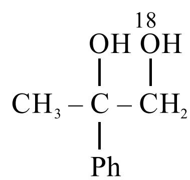
with retention, optically active

(2) 

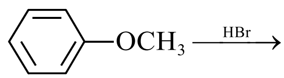
with racemisation

(3) 

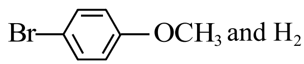
with inversion, optically active

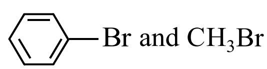
(4) 

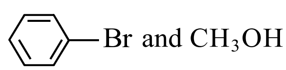
with racemisation

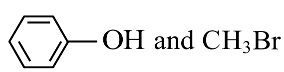
**31.** In the reaction 

the products are:

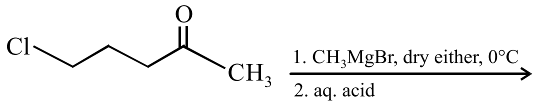
(1) 

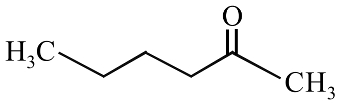
(2) 

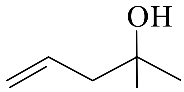
(3) 

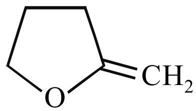
(4) 

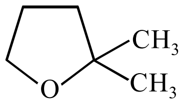
**32.** The major product in the following reaction is:



(1) 

(2) 

(3) 

(4) 

**33.** From amongst the following alcohols the one that would react fastest with conc. HCl and anhydrous $ZnCl_2$, is

(1) 2-Butanol

(2) 2-Methylpropan-2-ol

(3) 2-Methylpropanol

(4) 1-Butanol

**34.** An unknown alcohol is treated with the "Lucas reagent" to determine whether the alcohol is primary, secondary or tertiary. Which alcohol reacts fastest and by what mechanism:

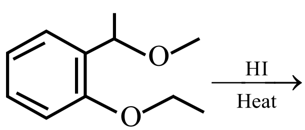
(1) Secondary alcohol by $S_N1$

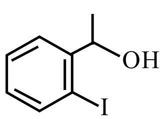
(2) Tertiary alcohol by $S_N1$

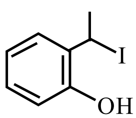
(3) Secondary alcohol by $S_N2$

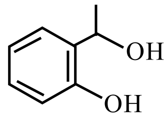
(4) Tertiary alcohol by $S_N2$

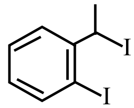
**35.** The major product formed in the following reaction is:



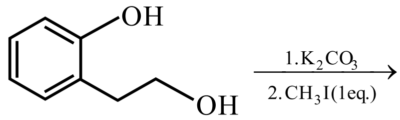
(1) 

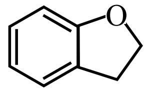
(2) 

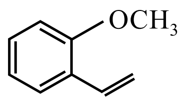
(3) 

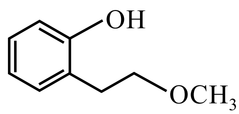
(4) 

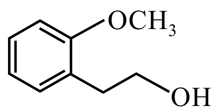
**36.** The major product of the following reaction is:



(1) 

(2) 

(3) 

(4) 

**37.** In the following reaction sequence:

$$\underset{\text{I}}{(C_3H_6Cl_2)} \xrightarrow{\text{KOH(aq)}} \text{II} \xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } CH_3MgBr} \text{III} \xrightarrow{\text{Anhy. } ZnCl_2 + \text{Con.HCl}}$$

gives turbidity immediately

The compound I is:

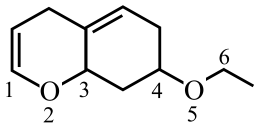
(1) $CH_2(Cl)-CH(Cl)-CH_3$

(2) $CH_3-CCl_2-CH_3$

(3) $Cl-CH(Cl)-CH_2-CH_3$

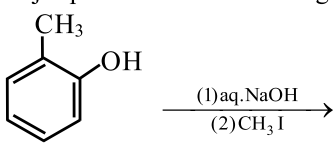
(4) $CH_2(Cl)-CH_2-CH_2(Cl)$

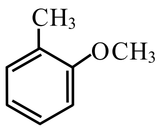
**38.** On treatment of the following compound with a strong acid, the most susceptible site for bond cleavage is:

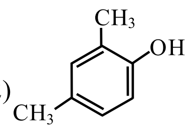


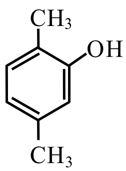

(1) $C_1 - O_2$ (2) $O_2 - C_3$
(3) $C_4 - O_5$ (4) $O_5 - C_6$

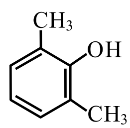
**39.** The major product of the following reaction:



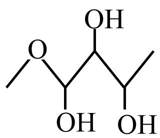

(1) 

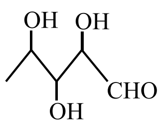

(2) 

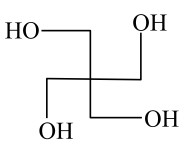

(3) 

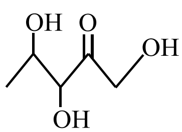

(4) 


**40.** A compound X ($C_5H_{12}O_4$) upon treatment with $CH_3MgX$ gives 4 mole of methane. Identify the structure of (X).

(1) 


(2) 


(3) 


(4) 


**41.** $CH_3 - CH_2 - \underset{\underset{O}{||}}{C} - CH_3 \xrightarrow[\text{(ii) } H_2O]{\text{(i) } CH_3MgBr}$

Product is:

(1) $CH_3 - CH_2 - \underset{\underset{OH}{|}}{\overset{\overset{CH_3}{|}}{C}} - CH_3$

(2) $CH_3 - CH_2 - \overset{\overset{CH_3}{|}}{CH} - \underset{\underset{OH}{|}}{CH_2}$

(3) $CH_3 - CH_2 - \underset{\underset{OH}{|}}{CH} - CH_2$

(4) $CH_3 - CH_2 - \underset{\underset{CH_3}{|}}{CH} - CH_3$

**42.** $P \xrightarrow{PhMgbr} \xrightarrow{H_2O} CH_3 - \overset{\overset{OH}{|}}{CH} - Ph$ $(d+\ell)$

(1) $CH_3COOH$ (2) $H–COOCH_3$
(3) $CH_3–COCl$ (4) $CH_3–CH = O$

**43.** Match List I (Reaction) with List II (Product) and select the correct answer using the code given below the lists:

| | List-I | | List-II |
|---|---|---|---|
| A | $CH_3COCH_3 + CH_3MgBr \xrightarrow{H_2O}$ | P | $CH_3–CH_2–CH_2–OH$ |
| B | $CH_3–\underset{\underset{O}{\|\|}}{C}–CH_3 + NaBH_4 \xrightarrow{EtOH}$ | Q | $CH_3–\underset{\underset{OH}{\|}}{CH}–CH_3$ |
| C | $CH_3–\underset{\underset{O}{\|\|}}{C}–CH_2–CH_3 + CH_3MgBr \xrightarrow{H_2O}$ | R | $CH_3–\underset{\underset{OH}{\|}}{\overset{\overset{CH_3}{\|}}{C}}–CH_2–CH_3$ |
| D | $CH_3–CH_2–\underset{\underset{O}{\|\|}}{C}–OCH_3 + LiAlH_4 \xrightarrow{H_2O}$ | S | $CH_3–\underset{\underset{OH}{\|}}{\overset{\overset{CH_3}{\|}}{C}}–CH_3$ |

**Codes:**

| | A | B | C | D |
|---|---|---|---|---|
| (1) | Q | S | R | P |
| (2) | S | Q | R | P |
| (3) | S | Q | P | R |
| (4) | Q | S | P | R |

**44.** Consider reduction of 2-butanone.

$$B \xleftarrow[D_2O]{NaBD_4} \text{2-butanone} \begin{cases} \xrightarrow[H_2O]{NaBD_4} A \\ \xrightarrow[D_2O]{NaBH_4} C \end{cases}$$

A, B and C are respectively:

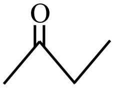
(1) $CH_3CH(OH)CH_2CH_3$ in all cases

(2) $CH_3C(OH)(D)CH_2CH_3$, $CH_3C(OD)(D)CH_2CH_3$, $CH_3C(OD)(H)CH_2CH_3$

(3) $CH_3C(OH)(D)CH_2CH_3$ in all cases

(4) $CH_3C(OH)(D)CH_2CH_3$, $CH_3C(OH)(H)CH_2CH_3$, $CH_3C(OD)(H)CH_2CH_3$

**45.** 2-Phenylbutan-2-ol can be prepared by

(1) PhMgBr +  $\xrightarrow{Ether} \xrightarrow{H^{\oplus}}$

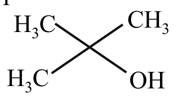
(2) $CH_3MgBr + Ph{-}\overset{O}{\overset{\|}{C}}{-}C_2H_5 \xrightarrow{Ether} \xrightarrow{H^{\oplus}}$

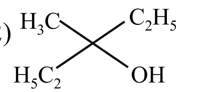
(3) $C_2H_5MgBr + Ph{-}\overset{O}{\overset{\|}{C}}{-}CH_3 \xrightarrow{Ether} \xrightarrow{H^{\oplus}}$

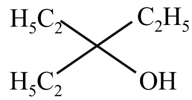
(4) $CH_3CH_2CH_2MgBr + PhCHO \xrightarrow{Ether} \xrightarrow{H^{\oplus}}$

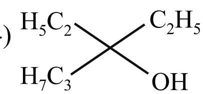
**46.** Ethylester $\xrightarrow[\text{excess}]{CH_3MgBr}$ P

The product P will be:

(1) 


(2) 


(3) 


(4) 


**47.** Acetyl bromide reacts with excess of $CH_3MgI$ followed by treatment with a saturated solution of $NH_4Cl$ gives

(1) Acetone

(2) Acetamide

(3) 2-Methyl-2-propanol

(4) Acetyl iodide

**48.** $CH_3CH_2{-}C(OH)(Ph){-}CH_3$ cannot be prepared by:

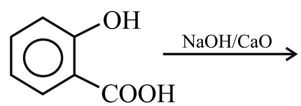
(1) $HCHO + PhCH(CH_3)CH_2MgX$

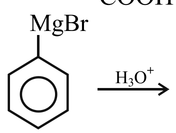
(2) $PhCOCH_2CH_3 + CH_3MgX$

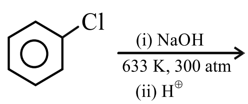
(3) $PhCOCH_3 + CH_3CH_2MgX$

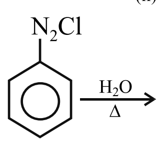
(4) $CH_3CH_2COCH_3 + PhMgX$

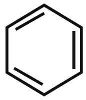
**49.** In which of the following reactions phenol is not obtained:

(1) 


(2) 

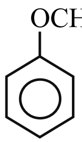

(3) 

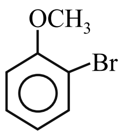
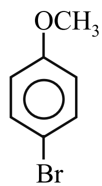
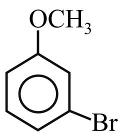
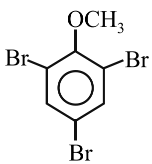

(4) 

**50.**  $+ CH_3–CH=CH_2 \xrightarrow[\Delta]{H_3PO_4} A$

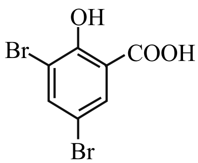
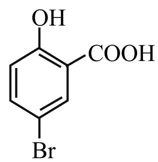
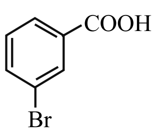
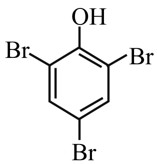
$\xrightarrow[(2)\ H_3O^+]{(1)\ O_2,\Delta} B + C$

The products B & C are respectively:
(1) Phenol & acetic acid
(2) Phenol & acetaldehyde
(3) Benzoic acid & acetone
(4) Phenol & acetone

**51.**  $\xrightarrow[CH_3COOH]{Br_2}$ Product. The major product obtained is:

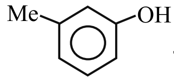
(1) 
(2) 
(3) 
(4) 

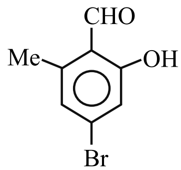
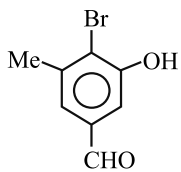
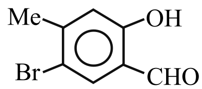
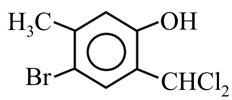
**52.** When 2-hydroxybenzoic acid (salicylic acid) is treated with bromine water, the product formed is

(1) 
(2) 
(3) 
(4) 

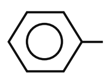
**53.** An organic compound having the molecular formula $C_7H_8O$ is insoluble in $NaHCO_3$ solution but dissolves in aqueous NaOH. When treated with bromine water the compound rapidly forms a precipitate having the molecular formula $C_7H_5OBr_3$. The organic compound is
(1) o-cresol
(2) m-cresol
(3) p-cresol
(4) anisole

**54.** The product (Y) of the following sequence of reactions would be:

 $\xrightarrow[(ii)\ H_3O^+]{(i)\ CHCl_3/NaOH/\Delta} (X) \xrightarrow{Br_2/Fe} (Y)$

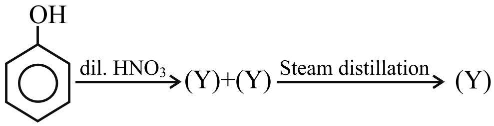
(1) 
(2) 
(3) 
(4) 

**55.** In the reaction sequence

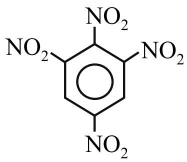
 $–SO_3Na \xrightarrow[350^o]{NaOH} A \xrightarrow{CH_3I} B \xrightarrow{HI} C + D$

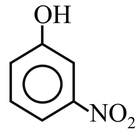
A, B, C & D are
(1) Sodium phenate, anisole, $C_6H_5I$, $CH_3OH$
(2) Sodium phenate, phenitole, $C_2H_5I$, $C_6H_5OH$
(3) Sodium phenate, anisole, $C_6H_5OH$, $CH_3I$
(4) Sodium phenate, phenitole, $C_6H_5I$, $C_2H_5OH$

**56.** Observe the following reaction, and select the correct option:

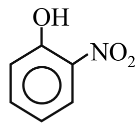



low boiling fraction:

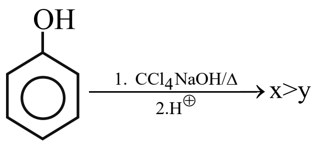
(1) 


(2) 


(3) 

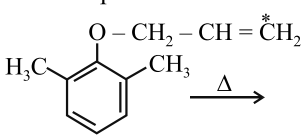

(4) 

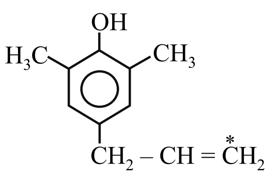

**57.** Compare the properties of two isomeric products x and y formed in the following reaction

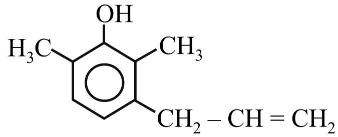


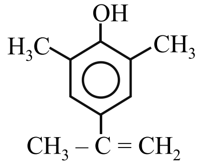

| | Acid Strength | $H_2O$ solubility | Volatility | Melting Point |
|---|---|---|---|---|
| (1) | y > x | y > x | x > y | y > x |
| (2) | x > y | x > y | y > x | x > y |
| (3) | y > x | x > y | y > x | y > x |
| (4) | x > y | y > x | x > y | y > x |

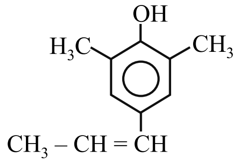
**58.** Give the product of the following reactions:



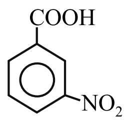

(1) 

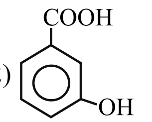

(2) 

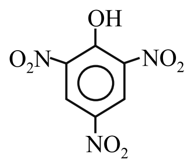

(3) 

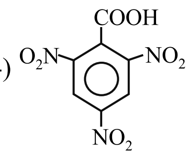

(4) 


**59.** Picric acid is:

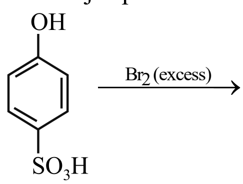
(1) 

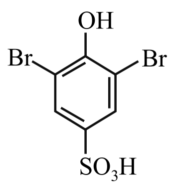

(2) 

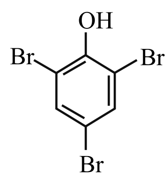

(3) 

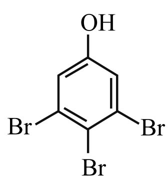

(4) 

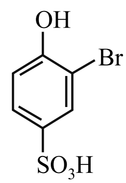

**60.** The major product of the following reaction is:




(1) 


(2) 

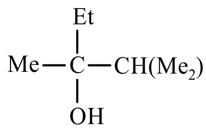

(3) 


(4) 

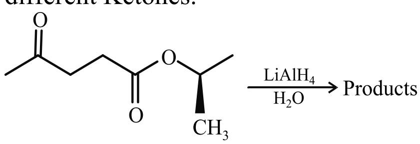
## *Integer Type Questions (61 to 75)*

**61.** A sample of 3 mg of an unknown alcohol (ROH) is added to methyl magnesium iodide then 1.12 ml gas is evolved. What will be the molecular weight of alcohol is

**62.** How many types of Grignard reagent (RMgCl) can be used to prepare the following alcohol, by using different Ketones.

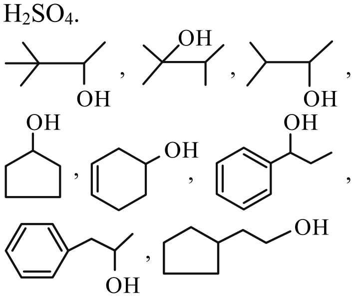


**63.**



Total number of products in the above reaction:

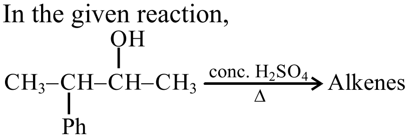
**64.** Identify number of alcohols, those will show rearrangements during dehydration with conc. $H_2SO_4$.



**65.** Calculate total number of α-H present in alkene formed when 2, 3-dimethyl butanol react with concentrated $H_2SO_4/\Delta$

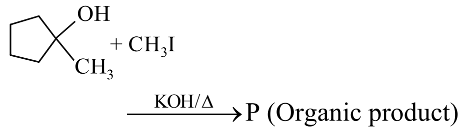
**66.** 'X' is a smallest optically active alkanol. On dehydration it can form Y number of alkenes (including stereoisomers). On reaction with Lucas reagent it forms Z number of alkyl halides (including stereoisomers). Report your answer as |Z|Y|.

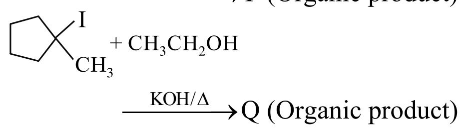
**67.** In the given reaction,



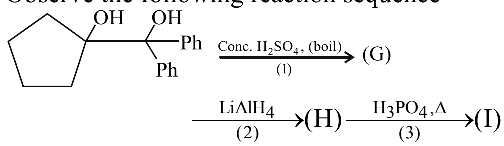
Total number of alkenes (Including stereo isomers) formed will be

**68.** The difference of molecular weights of the major products P and Q form in the following reactions is:

(i) 

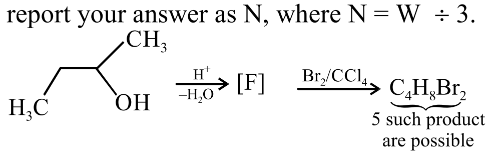
(ii) 

**69.** Observe the following reaction sequence



Calculate molecular mass [W] of product I and report your answer as N, where N = W ÷ 3.

**70.**

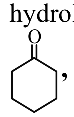


How many alkenes F are possible?

**71.** An alcohol (A), 0.22 g of the monohydric alcohol liberates 56 ml of $CH_4$ at STP on reaction with $CH_3MgBr$. Write the molecular weight of alcohol which satisfy these conditions.

**72.** How many carbonyl compounds will give secondary alcohol with molecular formula $C_5H_{12}O$ after reduction with $LiAlH_4$?

**73.** How many among the following compounds will give a 3° alcohol on reacting with excess of Grignard reagent followed by acid hydrolysis?

, HCHO, $C_2H_5CHO$, $CH_3COCH_3$, $RCOOC_2H_5$

**74.** Find the molecular weight of a sweet smelling compound which react with LAH to give only ethanol. (in g/mol)

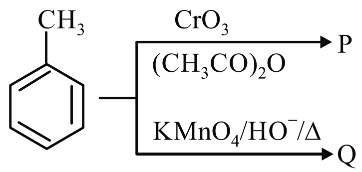
**75.** Total number of alkenes obtained by dehydration of 3,4-diethylhexan-2-ol in acidic medium?

CHAPTER

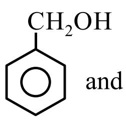
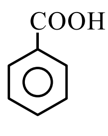
18

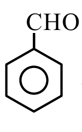
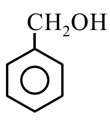
# ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

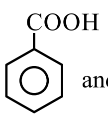
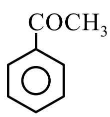
### *Single Option Correct Type Questions (01 to 60)*

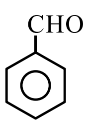
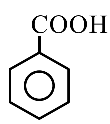
**1.** 

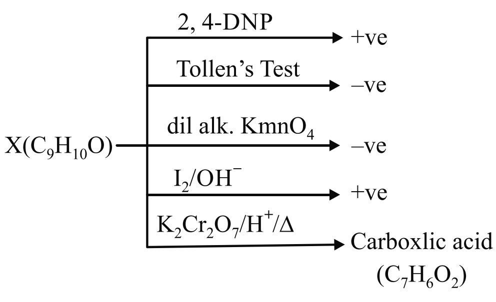

The products P & Q are respectively

(1)  and 

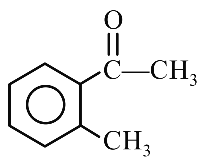
(2)  and 

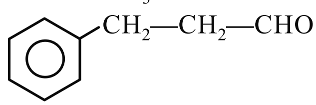
(3)  and 

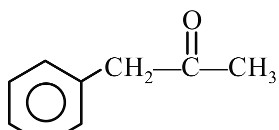
(4)  and 

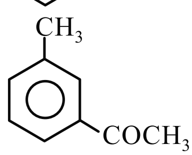
**2.** 


The compound X can be:

(1) 

(2) 

(3) 

(4) 

**3.** $CH_3COOH$ (I) $\quad$ $H{-}COOCH_3$ (II)

$CH_3{-}CONH_2$ (III)

$CH_3{-}CH_2{-}CH_2{-}OH$ (IV)

The correct increasing order of boiling points is:

(1) II < IV < I < III
(2) I < II < III < IV
(3) IV < II < I < III
(4) III < I < IV < II

**4.** Aldehydes and ketones are distinguished by using:

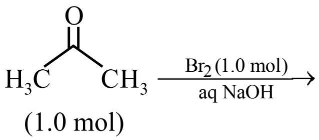
(1) Lucas reagent
(2) Hinsberg reagent
(3) Tollen's reagent
(4) All of these

**5.** $CH\equiv CH \xrightarrow[H_2SO_4]{HgSO_4} A \xrightarrow[H_2O]{CH_3MgBr} B \xrightarrow{Red\,P/Br_2} C$. Here C is:

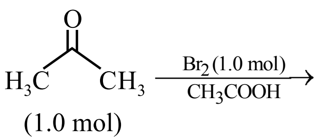
(1) $CH_3CH(Br)CH_3$
(2) $CH_3–CH_2–CH_2–Br$
(3) $CH_2=CH–Br$
(4) $Br–CH=CH–CH_3$

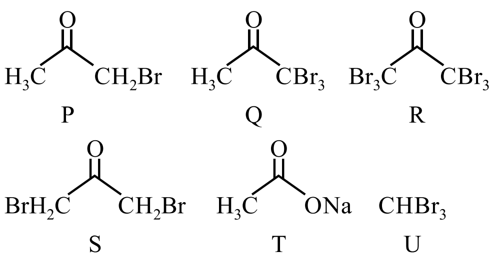
**6.** After completion of the reactions (**I** and **II**), the organic compound(s) in the reaction mixtures is:

Reaction I:



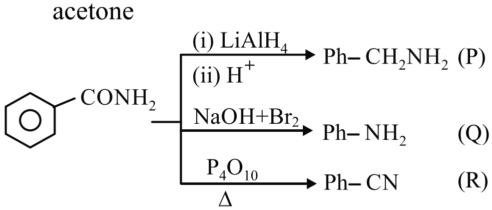

Reaction II:




(1) Reaction I : P and Reaction II : P
(2) Reaction I : U, acetone and Reaction II : Q, acetone
(3) Reaction I : T, U, acetone and Reaction II : P
(4) Reaction I : R, acetone and Reaction II : S, acetone

**7.**




Which of the following options is incorrect:

(1) P is 2-phenylethanamine.
(2) Q is aniline, process is Hofmann's bromamide.
(3) R is benzene carbonitrile, process is dehydration.
(4) formation of P, involves reduction.

**8.** Observe the following reaction

$CH_3-\underset{\underset{O}{\|}}{C}-CH_2-\underset{\underset{O}{\|}}{C}-CH_3 \xrightarrow{HCN\ (excess)} \xrightarrow{H_3O^{\oplus}/\Delta}$ Products.

The **correct** statement is

(1) The product is a mixture of two compounds.
(2) The product is optically active.
(3) The product is a mixture of two chiral and one achiral stereoisomers.
(4) The product is a mixture of four stereoisomers.

**9.** 1-Propanol and 2-Propanol can be best distinguished by:

(1) oxidation with alkaline $KMnO_4$ followed by reaction with Fehling solution.
(2) oxidation with acidic dichromate followed by reaction with Fehling solution.
(3) oxidation by heating with copper followed by reaction with Fehling solution.
(4) oxidation with concentrated $H_2SO_4$ followed by reaction with Fehling solution.

**10.** In which of the following reaction ketone is formed:

(1) $CH_3-CH_2-OH \xrightarrow{KMnO_4/\overset{\oplus}{H}}$

(2) $CH_3-CH_2-OH \xrightarrow{Cu/\Delta}$

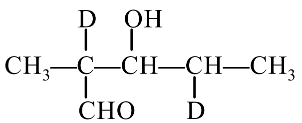
(3) $CH_3-\underset{\underset{CH_3}{|}}{CH}-OH \xrightarrow{Cu/\Delta}$

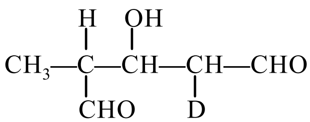
(4) $CH_3-\underset{\underset{CH_3}{|}}{\overset{\overset{CH_3}{|}}{C}}-OH \xrightarrow{Cu/\Delta}$

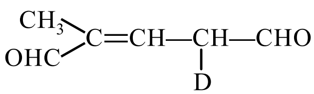
**11.** Aldol condensation is the characteristic reaction of

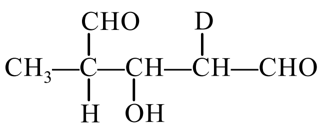
(1) all aldehydes and ketones.
(2) only those aldehydes and ketones which contain α-hydrogen atoms.
(3) only those aldehydes and ketones which do not contain α-hydrogen atoms.
(4) only aromatic aldehydes and ketones.

**12.** $CH_3-\underset{\underset{D}{|}}{CH}-CHO \xrightarrow{\text{dil NaOH}}$ Product, The product of this reaction would be:

(1) 

(2) 

(3) 

(4) 

**13.** Acetaldehyde reacts with nitromethane in the presence of dil. NaOH to give

(1) 1-Nitro-2-propanol
(2) 2-Nitro-1-propanol
(3) 2-Nitro-2-propanol
(4) None of these

**14.** The Cannizzaro's reaction is not given by:

(1) $C_6H_5CHO$ (2) HCHO
(3) $CH_3CHO$ (4) $(CH_3)_3C-CHO$

**15.** The only aldehyde which undergoes haloform reaction is

(1) Formaldehyde
(2) Acetaldehyde
(3) Benzaldehyde
(4) Propionaldehyde

**16.** An optically active compound reacts with hydroxylamine to form an oxime and also gives a positive haloform test. What is the structure of the compound?

(1) $CH_3CH_2CH(CH_3)COCH_3$
(2) $(CH_3)_2CHCH_2COCH_3$
(3) $CH_3CH_2CH_2COCH_2CH_3$
(4) $(CH_3)_2CHCOCH_2CH_3$

**17.** A compound with molecular formula, $C_4H_8O$ gives a positive haloform test and a 2,4-DNP derivative. The compound is

(1) $CH_3CH_2CH_2CHO$
(2) $CH_3COCH_2CH_3$
(3) $(CH_3)_2CHCHO$
(4) All the above

**18.** Tollen's reagent is not reduced by

(1) Formic acid (2) Acetaldehyde
(3) Benzaldehyde (4) Acetic acid

**19.** Oxidation of compound X gives a product which reacts with phenylhydrazine but does not give a silver mirror test. Possible structure for X is:

(1) $CH_3CHO$
(2) $CH_3CH_2OH$
(3) $(CH_3)_2CHOH$
(4) $CH_3CH_2CH_2OH$

**20.** The acid D obtained through the following sequence of reactions is:

$$C_2H_5Br \xrightarrow{\text{Alc. KOH}} A \xrightarrow[CCl_4]{Br_2} B \xrightarrow[\text{excess}]{KCN} C \xrightarrow{H_3O^+} D$$

(1) Succinic acid (2) Malonic acid
(3) Maleic acid (4) Oxalic acid

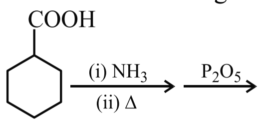
**21.** In which of the following reaction the final product is neither an acid nor an acid salt.

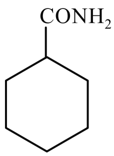
(1) $PhCHO \xrightarrow{\text{Tollen's reagent}}$
(2) $CH_3CH_2OH \xrightarrow{KMnO_4/\bar{O}H}$
(3) $PhCHO \xrightarrow{\text{Fehling solution}}$
(4) $PhCH_2OH \xrightarrow{K_2Cr_2O_7/H^+}$

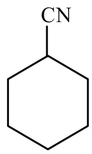
**22.** Which of the following will not undergo Hell-Volhard Zelinsky (HVZ) reaction?

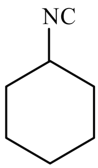
(1) HCOOH
(2) $CH_3COOH$
(3) $CH_3CH_2COOH$
(4) $CH_3CHBrCOOH$

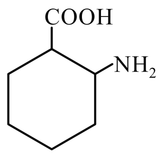
**23.** The product of the following reaction is:



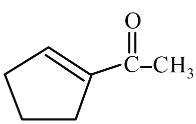

(1) 


(2) 

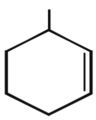

(3) 

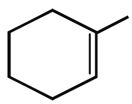

(4) 

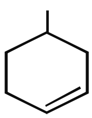

**24.** (A) $\xrightarrow[\text{(2) Zn, }H_2O]{\text{(1) }O_3}$ (B) $\xrightarrow[\Delta]{\text{NaOH}}$

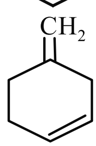



The reactant (A) will be:

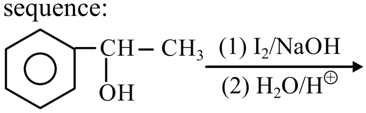
(1) 

(2) 

(3) 

(4) 


**25.** Identify product (B) in the following reaction sequence:



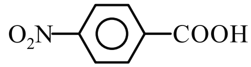

$CHI_3 + (A) \xrightarrow{SOCl_2} (B)$

(1) $C_6H_5-\underset{\underset{O}{\|}}{C}-CH_3$
(2) $C_6H_5-\underset{\underset{O}{\|}}{C}-CD_3$
(3) $C_6H_5-\underset{\underset{O}{\|}}{C}-Cl$
(4) $C_6H_5-CH_2-\underset{\underset{O}{\|}}{C}-Cl$

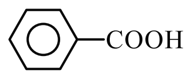
**26.** An optically active compound (X) has molecular formula $C_4H_8O_3$. It evolves $CO_2$ with $NaHCO_3$. (X) reacts with $LiAlH_4$ to give an achiral compound. Structure of (X) is.

(1) $CH_3-CH_2-\underset{\underset{OH}{|}}{CH}-COOH$
(2) $CH_3-\underset{\underset{Me}{|}}{CH}-COOH$
(3) $CH_3-\underset{\underset{CH_2-OH}{|}}{CH}-COOH$
(4) $CH_3-CH-\underset{\underset{OH}{|}}{CH_2}-COOH$

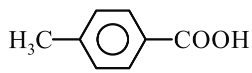
**27.** Give the order of ease of the esterification of the following acid



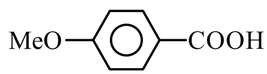
(I)



(II)



(III)



(IV)

(1) I > II > III > IV
(2) IV > III > II > I
(3) II > I > IV > III
(4) IV > II > III > I

**28.** Mixture of $C_6H_5CHO$ and HCHO is treated with NaOH then Cannizzaro's reaction involves:

(1) Oxidation of HCHO
(2) Reduction of HCHO
(3) Oxidation of $C_6H_5CHO$
(4) Reduction and oxidation of $C_6H_5CHO$

**29.** **Assertion:** Acetophenone and benzophenone can be distinguished by iodoform test.

**Reason:** Acetophenone and benzophenone both are carbonyl compounds.

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**30.** **Assertion:** Benzaldehyde undergoes disproportionation reaction in basic medium.

**Reason:** Aldehydes which do not have α-hydrogen undergo Cannizzaro reaction (i.e. disproportionation reaction).

(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

**31.** **Assertion:** Carboxylic acids have a carbonyl group but they do not give the test of carbonyl group.

**Reason:** Due to resonance, the double bond character of carbonyl group is greatly reduced.

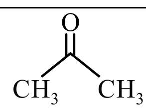
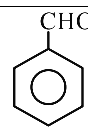
(1) Both assertion and reason are correct, and the reason is the correct explanation for the assertion
(2) Both assertion and reason are correct, but the reason is not the correct explanation for the assertion
(3) The assertion is incorrect, but the reason is correct
(4) Both are assertion and reason are incorrect

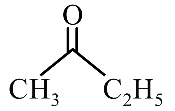
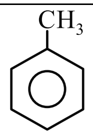
**32.** Match List I with List II and select the correct answer using the code given below the lists.

| List I | | List II | |
|---|---|---|---|
| I | Ph–CHO $\xrightarrow[CS_2,\ \Delta]{CrO_2Cl_2}$ | P | Perkin's Reaction |
| II | Ph–CHO $\xrightarrow[AcONa,\ \Delta]{Ac_2O}$ | Q | Etard Reaction |
| III | Ph–CHO $\xrightarrow{Al(OEt)_3}$ | R | Aldol Reaction |
| IV | Ph–$COCH_3$ $\xrightarrow{NaOH}$ | S | Tischenko reaction |

(1) I – Q ; II – P ; III – S ; IV – R
(2) I – R ; II – Q ; III – S ; IV – P
(3) I – P ; II – S ; III – Q ; IV – R
(4) I – S ; II – R ; III – Q ; IV – P

**33.** Match List I with List II and select the correct answer using the code given below the lists.

| List I | | List II | |
|---|---|---|---|
| I | $2CH_3COOH \xrightarrow[\Delta]{Ca(OH)_2}$ | P |  |
| II | $PhCN + CH_3MgBr \xrightarrow[H_2O]{Ether}$ | Q |  |

| | | | |
|---|---|---|---|
| III | $CH_3-\underset{CH_3}{\underset{\vert}{C}}=\underset{CH_3}{\underset{\vert}{C}}-CH_3-COOH \xrightarrow[\text{(ii) } Zn/CH_3COOH/\Delta]{\text{(i) } O_3}$ | R |  |
| IV |  $\xrightarrow{CrO_2Cl_2/CS_2}$ | S | $Ph-\overset{CH_3}{\overset{\vert}{C}}=O$ + $NH_3$ + Mg(OH)Br |

(1) I – Q ; II – P ; III – S ; IV – R
(2) I – P ; II – S ; III – P ; IV – Q
(3) I – P ; II – S ; III – Q ; IV – R
(4) I – S ; II – R ; III – Q ; IV – P

**34.** Which one of the following undergoes reaction with 50% sodium hydroxide solution to give the corresponding alcohol and acid ?
(1) Phenol (2) Benzoic acid
(3) Butanal (4) Benzaldehyde

**35.** Reaction of cyclohexanone with dimethylamine in the presence of catalytic amount of an acid forms a compound if water during the reaction is continuously removed. The compound formed is generally known as
(1) Amine (2) Imine
(3) Enamine (4) Schiff's base

**36.** In the following sequence of reactions,

$$CH_3CH_2OH \xrightarrow{\text{Red P+I}_2} A \xrightarrow[\text{Ether}]{\text{Mg}} B \xrightarrow{\text{HCHO}} C \xrightarrow{H_2O} D.$$

The compound 'D' is
(1) n-propyl alcohol
(2) propanal
(3) butanal
(4) n-butyl alcohol

**37.** In Cannizzaro reaction given below

$$2PhCHO \xrightarrow{^-OH} PhCH_2OH + PhCO_2^- ;$$ the slowest step is:
(1) the transfer of hydride to the carbonyl group
(2) the abstraction of proton from the carboxylic group
(3) the deprotonation of $PhCH_2OH$
(4) the attack of $^-OH$ at the carboxyl group

**38.** Trichloroacetaldehyde was subjected to Cannizzaro's reaction by using NaOH. The mixture of the products contains sodium trichloroacetate ion and another compound. The other compound is :
(1) 2, 2, 2–Trichloroethanol
(2) Trichloromethanol
(3) 2, 2, 2–Trichloropropanol
(4) Chloroform

**39.** Ozonolysis of an organic compound 'A' produces acetone and propionaldehyde in equimolar mixture. Identify 'A' from the following compounds:
(1) 1-Pentene
(2) 2-Pentene
(3) 2-Methyl-2-pentene
(4) 2-Methyl-1-pentene

**40.** Iodoform can be prepared from all except :
(1) Ethyl methyl ketone
(2) Isopropyl alcohol
(3) 3-Methyl-2-butanone
(4) Isobutyl alcohol

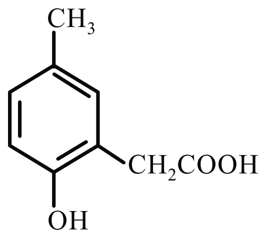
**41.** On vigorous oxidation by permangnate solution $(CH_3)_2C = CHCH_2CHO$ gives
(1) $(CH_3)_2CO$ and $OHCCH_2CHO$
(2) $(CH_3)_2\underset{OH}{\underset{\vert}{C}} - \underset{OH}{\underset{\vert}{C}}HCH_2CHO$
(3) $(CH_3)_2CO$ and $OHCCH_2COOH$
(4) $(CH_3)_2CO$ and $CH_2(COOH)_2$

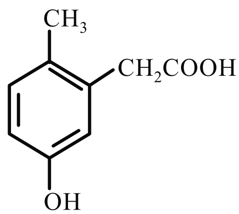
**42.** End product of the following reaction is:

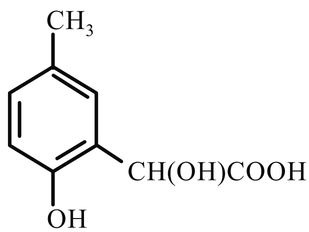
$$CH_3CH_2COOH \xrightarrow[\text{red P}]{Cl_2} \xrightarrow{\text{alcoholic KOH}}$$

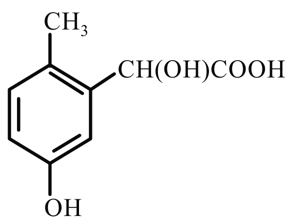
(1) $CH_3\underset{OH}{\underset{\vert}{C}}HCOOH$
(2) $\underset{OH}{\underset{\vert}{C}}H_2CH_2COOH$
(3) $CH_2 = CHCOOH$
(4) $\underset{Cl}{\underset{\vert}{C}}H_2\underset{OH}{\underset{\vert}{C}}HCOOH$

**43**. p-cresol reacts with chloroform in alkaline medium to give the compound A which adds hydrogen cyanide to form, the compound B. The latter on acidic hydrolysis gives chiral carboxylic acid. The structure of the carboxylic acid is:

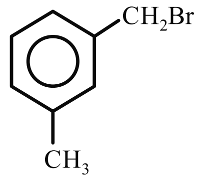
(1) 

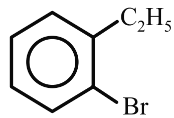
(2) 

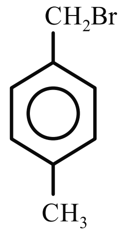
(3) 

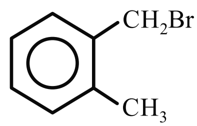
(4) 

**44**. Compound (A), $C_8H_9Br$, gives a pale-yellow precipitate when warmed with alcoholic $AgNO_3$. Oxidation of (A) gives an acid (B), $C_8H_6O_4$. (B) easily forms anhydride on heating. Identify the compound (A).

(1) 

(2) 

(3) 

(4) 

**45**. In the reaction sequence

$$2CH_3CHO \xrightarrow{OH^-} A \xrightarrow{\Delta} B;$$

the product B is:

(1) $CH_3-CH_2-CH_2-CH_2-OH$
(2) $CH_3-CH=CH-CHO$
(3) $CH_3-CH_2-CH_2-CH_3$
(4) $CH_3-\overset{\overset{O}{||}}{C}-CH_3$

**46**. The correct statement about the synthesis of erythritol ($C(CH_2OH)_4$) used in the preparation of PETN is:

(1) The synthesis requires two aldol condensations and two Cannizzaro reactions.
(2) Alpha hydrogens of ethanol and methanol are involved in this reaction.
(3) The synthesis requires four aldol condensations between methanol and ethanol.
(4) The synthesis requires three aldol condensations and one Cannizzaro reaction.

**47.** In the following reaction sequence:

$$\underset{(C_3H_6Cl_2)}{\text{I}} \xrightarrow{\text{KOH aq}} \text{II} \xrightarrow[\text{ii } H_2O/H^+]{\text{i } CH_3MgBr} \text{III} \xrightarrow{\text{Anhy.}ZnCl_2\text{+Conc. HCl}}$$

gives turbidity immediately. The compound I is:

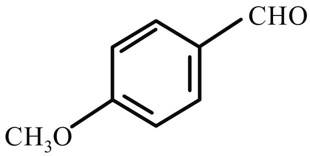
(1) $CH_2(Cl)-CH(Cl)-CH_3$

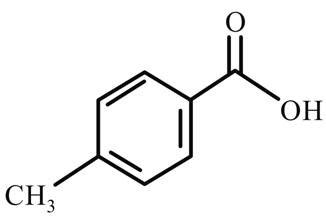
(2) $CH_3-C(Cl)_2-CH_3$

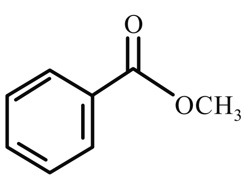
(3) $Cl-CH(Cl)-CH_2-CH_3$

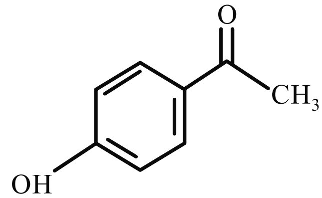
(4) $CH_2(Cl)-CH_2-CH_2(Cl)$

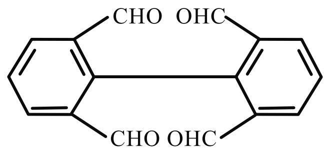
**48.** A compound of molecular formula $C_8H_8O_2$ reacts with acetophenone to form a single cross-aldol product in the presence of base. The same compound on reaction with conc. NaOH forms a derivative of benzyl alcohol as one of the products. The structure of the compound is:

(1) 

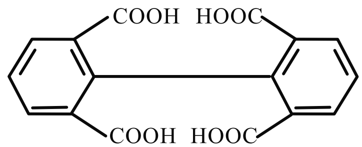

(2) 

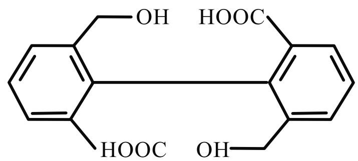

(3) 

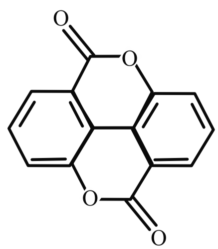

(4) 

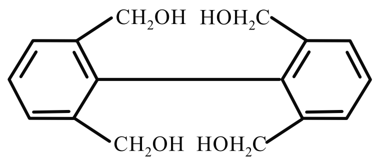

**49.** 


$\xrightarrow[\text{ii } H^+/H_2O]{\text{i NaOH}/100^\circ C}$ Major Product is:

(1) 


(2) 


(3) 


(4) 


**50.** In conversion of 2-butanone to propanoic acid which reagent is used.

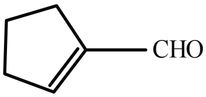
(1) $NaOH, NaI / H^{\oplus}$

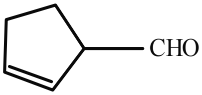
(2) Fehling solution

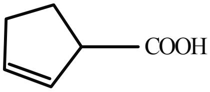
(3) $NaOH, I_2 / H^{\oplus}$

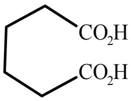
(4) Tollen's reagent

**51.** Cyclohexene on ozonolysis followed by reaction with zinc dust and water gives compound E. Compound E on further treatment with aqueous KOH followed by heating yields compound F. Compound F is:

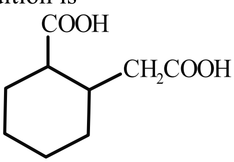
(1) 

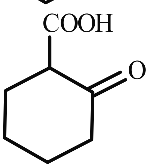
(2) 

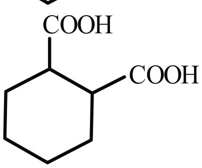
(3) 

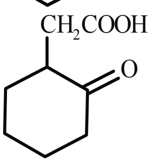
(4) 

**52.** The compound that undergoes decarboxlylation most readily under mild condition is

(1) 

(2) 

(3) 

(4) 

**53.** Which of the following compound takes maximum time for hydrolysis reaction.

(1) $CH_3-\underset{\underset{O}{\|}}{C}-Cl$

(2) $CH_3-\underset{\underset{O}{\|}}{C}-O-\underset{\underset{O}{\|}}{C}-CH_3$

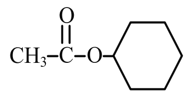
(3) $CH_3-\underset{\underset{O}{\|}}{C}-OEt$

(4) $CH_3-\underset{\underset{O}{\|}}{C}-NH_2$

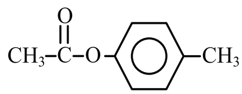
**54.** List the following esters in order of decreasing reactivity in the second step of a nucleophilic acyl substitution reaction.

$CH_3-\overset{\overset{O}{\|}}{C}-O-C_6H_5$

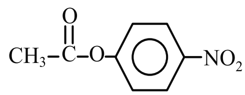
I



II

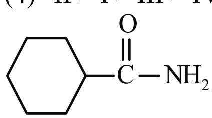


III



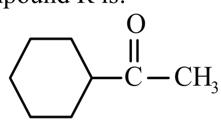
IV

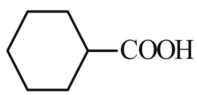
(1) IV > I > III > II
(2) IV > III > I > II
(3) III > IV > I > II
(4) II > I > III > IV

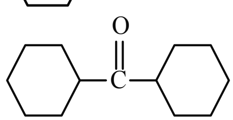
**55.** 

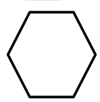
$\xrightarrow[\Delta]{P_4O_{10}} P \xrightarrow[H_3O^+]{MeMgBr} Q \xrightarrow[ii\ \ H^+]{i\ \ Ca\ OH\ _2 + I_2} R,$

compound R is:

(1) 

(2) 

(3) 

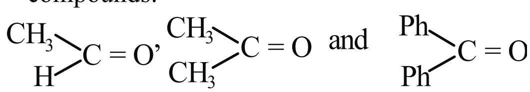
(4) 

**56.** Methyl acetate and ethyl acetate can be distinguished by :
(1) hot alkaline $KMnO_4$
(2) Neutral $FeCl_3$
(3) Iodoform test
(4) All of these

**57.** If heavy water is taken as solvent instead of normal water while performing Cannizaro reaction, the products of the reaction are
(1) $RCOO^- + RCH_2OH$
(2) $RCOO^- + RCH_2OD$
(3) $RCOOD + RCD_2OD$
(4) $RCOO^- + RCD_2OD$

**58.** Clemmensen reduction of a ketone is carried out in the presence of which of the following?
(1) Glycol with KOH
(2) Zn-Hg with HCl
(3) $LiAlH_4$
(4) $H_2$ and Pt as catalyst

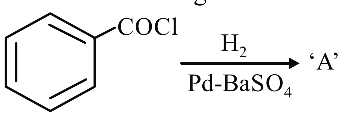
**59.** The order of reactivity of phenyl magnesium bromide (PhMgBr) with the following compounds:



I II III

(1) III > II > I (2) II > I > III
(3) I > III > II (4) I > II > III

**60.** Consider the following reaction:



The product 'A' is:
(1) $C_6H_5CHO$ (2) $C_6H_5OH$
(3) $C_6H_5COCH_3$ (4) $C_6H_5Cl$

*Integer Type Questions (61 to 75)*

**61.** How many of the following reactions represent the correct major product.

(I) $CHCl_3 + CH_3COCH_3 \xrightarrow{KOH}$ $CH_3-C(CH_3)(OH)-CCl_3$ (Chloretone - hypnotic)

(II) $PhNH_2 + CHCl_3 + KOH \longrightarrow PhNC$ (bad smell)

(III) $PhOH + CHCl_3 + NaOH \longrightarrow Ph-O-CH_3$

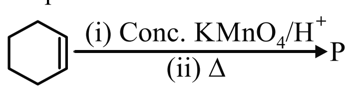
(IV) $CCl_3CHO + 2PhCl \xrightarrow{conc.\ H_2SO_4} CCl_3CH\ C_6H_4Cl\ _2$
DDT

**62.** The molecular mass of the major product H in the given reaction sequence is
$$CH_3CH_2COCH_3 \xrightarrow{^-CN} G \xrightarrow[\text{Heat}]{95\%\ H_2SO_4} H$$

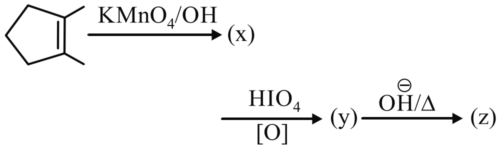
**63.** $$C_3H_8O \xrightarrow[K_2Cr_2O_7/H_2SO_4]{O} C_3H_6O \xrightarrow{I_2/NaOH} CHI_3 + Y$$
In this reaction the molar mass of compound [Y] is:

**64.** How many of the following does not give benzoic acid salt on oxidation with hot alkaline $KMnO_4$.
(I) $Ph–CH_3$
(II) $Ph–CH=CH–CH_3$
(III) $Ph–C\equiv C–CH_3$
(IV) $Ph–C(CH_3)_3$

**65.** If 3-hexanone is reacted with $NaBH_4$ followed by hydrolysis with $D_2O$, the molecular mass of the product will be:

**66.** 

The number of oxygen atom in the major product 'P' is:

**67.** 

The molecular mass of the product (Z) in the above reaction is:

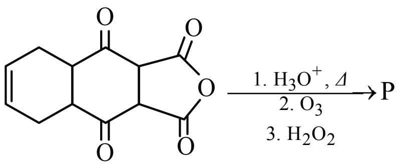
**68.** How many of the following gives haloform reaction:

$CH_3OH$, $CH_3CH_2OH$, $HCOOH$, $CH_3COOH$, $CH_3COOCH_3$, $CH_3COOC_2H_5$, $HCHO$, $CH_3COCH_3$

**69.** The molecular mass of the final product (C) in the following reaction is:

$$\text{H}_2\text{C}\text{X}_2 + KCN \longrightarrow A \xrightarrow{H_3O^+} B \xrightarrow{\Delta} C$$

**70.** The total number of carboxylic acid groups in the product P is



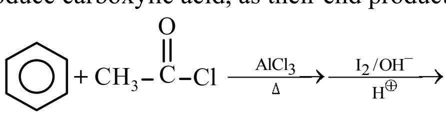
**71.** Cyclohexene is treated with cold $KMnO_4$ followed by lead tetra acetate to give (A) when (A) is heated with $Ba(OH)_2$. The molecular mass of the final product obtained will be:

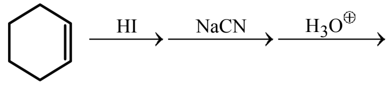
**72.** In a set of reactions acetic acid yielded a product D:

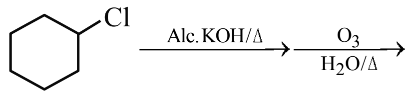
$$CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow[\text{Anhy.}AlCl_3]{\text{Benzene}} B \xrightarrow{HCN} C \xrightarrow{H_3O^+} D$$

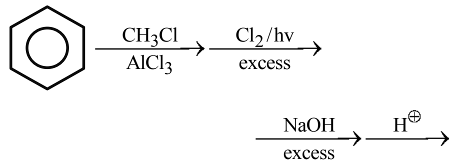
Total number of chiral centre in the final major product (D) is:

**73.** How many of the following reactions will produce carboxylic acid, as their end product.

(I) 

(II) 

(III) 

(IV) 

**74.** How many of the following reactions will give 3-pentanone.

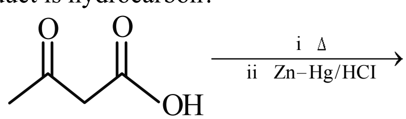
(I) $(CH_3-CH_2COO)_2Ca \xrightarrow{\Delta}$

(II) $CH_3-CH_2-C\equiv N \xrightarrow[2\ H_3O^+]{1\ CH_3-CH_2-MgBr}$

(III) $CH_3-\overset{O}{\overset{||}{C}}-CH_2-CH_2-\overset{O}{\overset{||}{C}}-OC_2H_5 \xrightarrow[2\ NaOH+CaO]{1\ H_2O/H^+}$

(IV) $CH_3-CH_2-\overset{O}{\overset{||}{C}}-\underset{CH_3}{\underset{|}{CH}}-\overset{O}{\overset{||}{C}}-OH \xrightarrow{\Delta}$

**75.** In how many of following reactions the end product is hydrocarbon?

(I) 

(II) $CH_3COOAg \xrightarrow{Br_2/CCl_4}$

(III) $Ph-COOH \xrightarrow[CaO,\ \Delta]{NaOH}$

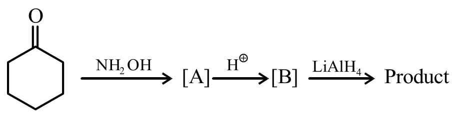
(IV) $CH_3-\underset{CH_3}{\underset{|}{\overset{CH_3}{\overset{|}{C}}}}-Cl \xrightarrow{C_2H_5OH}$

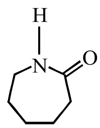
CHAPTER 19

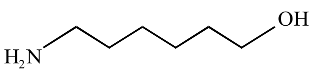
# AMINES

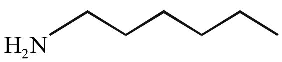
## Single Option Correct Type Questions (01 to 60)

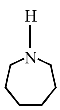
**1.** Final product of the following sequence of reactions would be:




(1) 

(2) 

(3) 

(4) 

**2.** $CH_3CH_2Cl \xrightarrow{NaCN} X \xrightarrow{Ni/H_2} Y \xrightarrow[\text{Anhydride}]{\text{Acetic}} Z.$

Z in the above reaction sequence is:

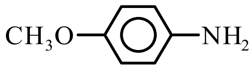
(1) $CH_3CH_2CH_2NHCOCH_3$

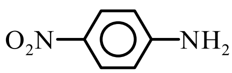
(2) $CH_3CH_2CH_2NH_2$

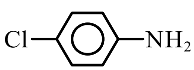
(3) $CH_3CH_2CH_2CONHCH_2$

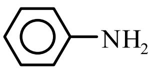
(4) $CH_3CH_2CH_2CONHCOCH_3$

**3.** Which of the following is most basic?

(1) 

(2) 

(3) 

(4) 

**4.** The order of nucleophilicity among

Ph—$NH_2$, Et-$NH_2$, Ph—NH—$NH_2$, $NH_2$—C(=O)—NH—$NH_2$

I, II, III, IV

(1) I > II > IV > III

(2) II > III > I > IV

(3) II > III > IV > I

(4) III > IV > I > II

**5.** A mixture containing primary, secondary and tertiary amine is treated with diethyl oxalate. Choose the correct statement

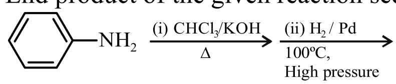
(1) The distillate of the mixture after treatment mainly contains 1° amine

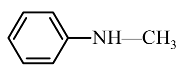
(2) 3° amine do not react with diethyl oxalate

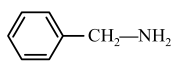
(3) This is Hinsberg method of separating 1°, 2° & 3° amines

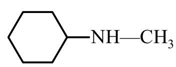
(4) 3° amine is removed by filtration

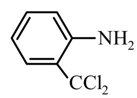
**6.** End product of the given reaction sequence is:



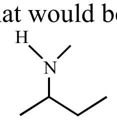

(1) 

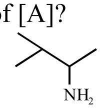
(2) 

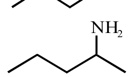
(3) 

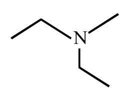
(4) 

**7.** An optically active compound [A] $C_5H_{13}N$ reacts with alkaline $CHCl_3$ to give an optically active. compound [B]. [A] also reacts with nitrous acid to give an optically inactive alcohol [C] ($C_5H_{11}OH$) as the major product. What would be the structure of [A]?

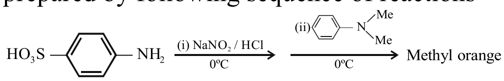
(1) 

(2) 

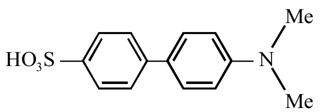
(3) 

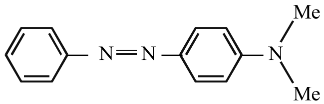
(4) 

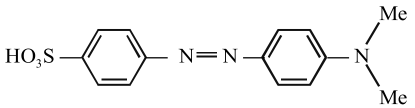
**8.** Methyl orange (an acid-base indicator) can be prepared by following sequence of reactions

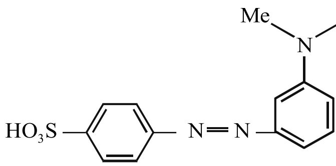


What would be the structure of methyl orange?

(1) 

(2) 

(3) 

(4) 

**9.** A nitrogenous compound (X) is treated with $HNO_2$, and the mixture is then made alkaline with dilute NaOH to give a blue colouration. Among the following, which one can be the compound (X)?

(1) $CH_3CH_2NH_2$ (2) $CH_3CH_2NO_2$
(3) $CH_3CH_2ONO$ (4) $(CH_3)_2CHNO_2$

**10.** An amine reacts with $C_6H_5SO_2Cl$ and the product is soluble in alkali, amine is:

(1) 1° amine (2) 2° amine
(3) 3° amine (4) All of these

**11.** What is the end product in the following sequence of reactions?

$$C_2H_5NH_2 \xrightarrow{HNO_2} A \xrightarrow{PCl_5} B \xrightarrow{NH_3} C$$

(1) Ethylcyanide (2) Ethylamine
(3) Methylamine (4) Acetamide

**12.** **STATEMENT-1:** Aryl amines cannot be prepared by Gabriel's phthalimide synthesis. and
**STATEMENT-2:** Aromatic halides do not give $S_N2$ reactions.

(1) Both statement 1 & 2 are correct.
(2) Both statement 1 & 2 are incorrect.
(3) Statement 1 is correct but statement 2 is incorrect.
(4) Statement 2 is correct but statement 1 is incorrect.

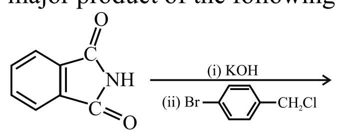
**13.** **STATEMENT-1:** Pyridine is more basic than pyrrole. and
**STATEMENT-2:** In pyridine nitrogen is $sp^2$ hybridized whereas in pyrrole N is $sp^3$ hybridized

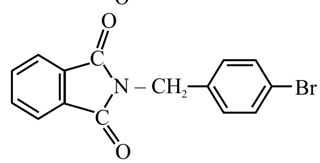
(1) Both statement 1 & 2 are correct.
(2) Both statement 1 & 2 are incorrect.
(3) Statement 1 is correct but statement 2 is incorrect.
(4) Statement 2 is correct but statement 1 is incorrect.

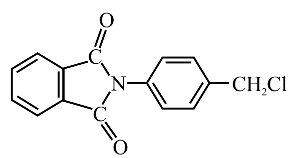
**14.** **STATEMENT-1:** Aniline on reaction with $NaNO_2/HCl$ at 0°C followed by coupling with β-naphthol gives a dark blue coloured precipitate. and
**STATEMENT-2:** The colour of the compound formed in the reaction of aniline with $NaNO_2/HCl$ at 0°C followed by coupling with β-naphthol is due to the extended conjugation.

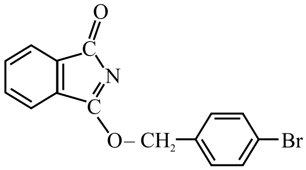
(1) Both statement 1 & 2 are correct.
(2) Both statement 1 & 2 are incorrect.
(3) Statement 1 is correct but statement 2 is incorrect.
(4) Statement 2 is correct but statement 1 is incorrect.

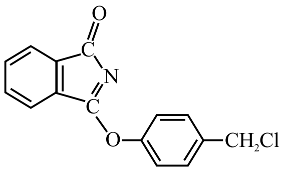
**15.** The major product of the following reaction is:



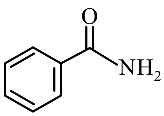
(1) 

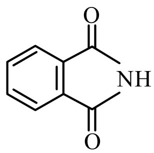
(2) 

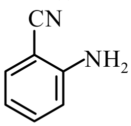
(3) 

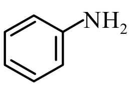
(4) 

**16.** The increasing order of reactivity of the following compounds towards reaction with alkyl halides directly is:


(I)

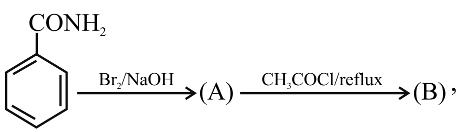

(II)


(III)

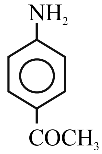

(IV)

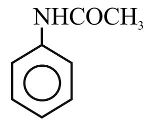
(1) (II) < (I) < (III) < (IV)
(2) (II) < (I) < (IV) < (III)
(3) (I) < (II) < (III) < (IV)
(4) (III) < (III) < (IV) < (II)

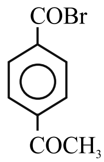
**17.** Which of the following sequence is best suited to convert benzene to 3-chloro aniline?
(1) Nitration, reduction, chlorination
(2) Chlorination, nitration, reduction
(3) Nitration, chlorination, reduction
(4) Nitration, reduction, acetylation, chlorination, hydrolysis

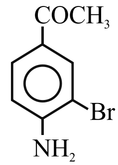
**18.** 

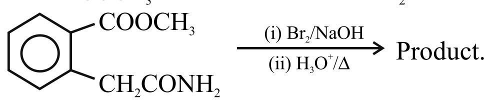
Identify the major product (B)

(1) 

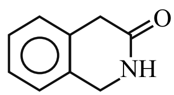
(2) 

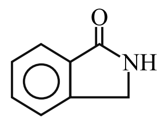
(3) 

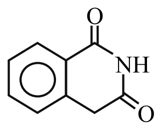
(4) 

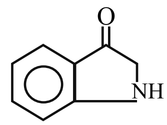
**19.** 

The major product obtained is

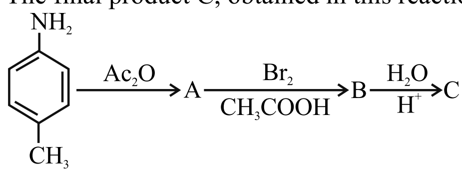
(1) 

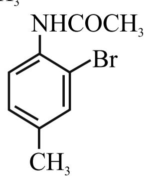
(2) 

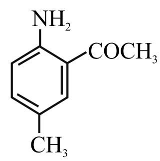
(3) 

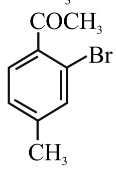
(4) 

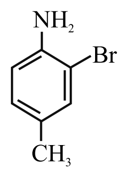
**20.** The final product C, obtained in this reaction



(1) 

(2) 

(3) 

(4) 

**21.** An aromatic amine (X) was treated with alcoholic potash and another compound (Y) then foul smelling gas $C_6H_5NC$ is formed. The compound (Y) was formed by the reaction of compound (Z) with $Cl_2$ in the presence of slaked lime. The compound (Z) is:
(1) $CHCl_3$
(2) $CH_3COCH_3$
(3) $CH_3OH$
(4) $C_6H_5NH_2$

**22.** p-Chloro aniline and anilinium chloride can be distinguished by:
(1) Sandmeyer reaction
(2) Carbylamine reaction
(3) Hinsberg's reaction
(4) $AgNO_3$

**23.** Hoffmann bromamide degradation reaction is shown by___________.
(1) $ArNH_2$ (2) $ArCONH_2$
(3) $ArNO_2$ (4) $ArCH_2NH_2$

**24.** The best reagent for converting, 2-phenylpropanamide into 1-phenylethanamine is______.
(1) Excess $H_2/Pt$ (2) $NaOH/Br_2$
(3) $NaBH_4$/methanol (4) $LiAlH_4$/ether

**25.** In order to prepare a 1° amine from an alkyl halide with simultaneous addition of one $CH_2$ group in the carbon chain, the reagent used as source of nitrogen is ___________.
(1) Sodium amide, $NaNH_2$
(2) Sodium azide, $NaN_3$
(3) Potassium cyanide, KCN
(4) Potassium phthalimide, $C_6H_4(CO)_2N\text{-}K^+$

**26.** Best method for preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain is:
(1) Hoffmann Bromamide reaction
(2) Gabriel phthalimide synthesis
(3) Sandmeyer reaction
(4) Reaction with $NH_3$

**27.** The product formed by the reaction of acetamide with $Br_2$ in presence of NaOH is
(1) $CH_3CN$ (2) $CH_3CHO$
(3) $CH_3CH_2CHO$ (4) $CH_3NH_2$

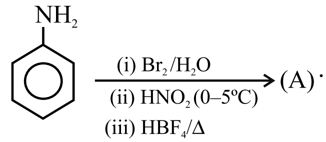
**28.** In the reaction, the product (C) is:

$$C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_2+HCl} (A) \xrightarrow[KCN]{CuCN} (B) \xrightarrow{H^+/H_2O} (C)$$

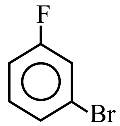
(1) $C_6H_5CH_2NH_2$ (2) $C_6H_5COOH$
(3) $C_6H_5OH$ (4) $C_6H_5CH_2OH$

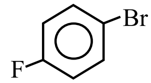
**29.** Benzenediazonium chloride can be converted into benzene on treatment with
(1) $H_3PO_3$ (2) $H_3PO_4$
(3) $H_3PO_2$ (4) $HPO_3$

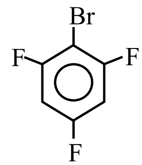
**30.** $C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_2+HCl} X \xrightarrow[\Delta]{H_2O} Y$, the product Y is:
(1) Benzenediazonium chloride
(2) Nitrobenzene
(3) Phenol
(4) Cresol

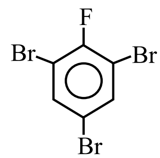
**31.** 

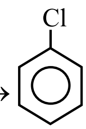
The major product (A) is:

(1) 

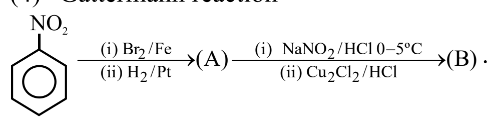
(2) 

(3) 

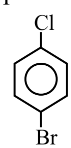
(4) 

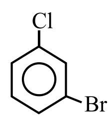

**32.** Diazonium salt + Cu + HCl → 

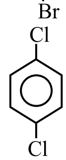
; the reaction is known as:
(1) Chlorination
(2) Sandmeyer's reaction
(3) Perkin reaction
(4) Gattermann reaction

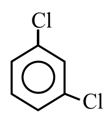
**33.** 

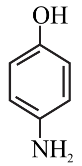
The product (B) is:

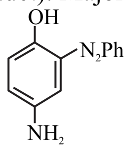
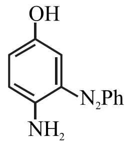
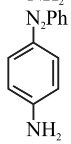
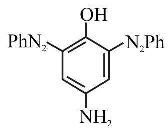
(1) 

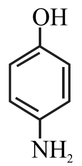
(2) 

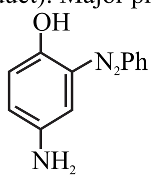
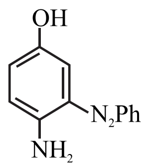
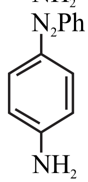
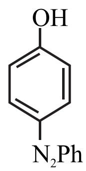
(3) 

(4) 

**34.**  $+ \ Ph-\overset{+}{N}_2 \xrightarrow{pH=4-6} X$ (major product). Major product X will be:

(1) 
(2) 
(3) 
(4) 

**35.**  $+ \ Ph-\overset{+}{N}_2 \xrightarrow{(pH=9-11)} X$ (major product). Major product X will be:

(1) 
(2) 
(3) 
(4) 

**36.** Match List I and List II. Select the correct answer using the codes given below the list:

| | List-I | | List-II |
|---|---|---|---|
| I | $RNH_2 + CHCl_3 + KOH(alc) \xrightarrow{\Delta}$ | P | Schotten-Baumann reaction |
| II | $C_6H_5N_2Cl \xrightarrow[\Delta]{CuBr/HBr}$ | Q | Coupling reaction |
| III | $C_6H_5NH_2 + C_6H_5COCl \xrightarrow{NaOH(aq).}$ | R | Carbylamine reaction |
| IV | $C_6H_5N_2Cl + C_6H_5OH \xrightarrow{pH9-10}$ | S | Sandmeyer reaction |

(1) I-Q ; II-P ; III-S ; IV-R
(2) I-P ; II-Q ; III-R ; IV-S
(3) I-R ; II-S ; III-P ; IV-Q
(4) I-S ; II-R ; III-Q ; IV-P

**37.** Match the reactions given in List I with the statements given in List II. Select the correct answer using the codes given below the list:

| | List-I | | List-II |
|---|---|---|---|
| I | Ammonolysis | P | Amine with lesser number of carbon atoms |
| II | Gabriel phthalimide synthesis | Q | Detection test for primary amines |
| III | Hoffmann Bromamide reaction | R | Reaction of phthalimide with KOH and R–X |
| IV | Carbylamine reaction | S | Reaction of alkyl halide with $NH_3$ |

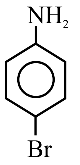
(1) I-P ; II-Q ; III-R ; IV-S
(2) I-S ; II-R ; III-P ; IV-Q
(3) I-Q ; II-P ; III-S ; IV-R
(4) I-R ; II-S ; III-P ; IV-Q

**38.** Match the compounds give in List-I with the items given in List-II. Select the correct answer using the codes given below the list:

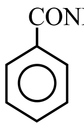
| | List-I | | List-II |
|---|---|---|---|
| I | $C_6H_6 + CH_3CH(Cl)-CH_3 \xrightarrow{\text{anhydrous } AlCl_3}$ | P | Diazocoupling reaction |
| II | $C_6H_5NH_2 + C_6H_5N_2Cl \xrightarrow{\text{di. HCl}}$ | Q | Friedel-Craft reaction |
| III | $C_6H_6 + C_6H_5COCl \xrightarrow{\text{anhydrous } AlCl_3}$ | R | Reimer-Tiemann reaction |
| IV | $C_6H_5OH \xrightarrow{CHCl_3 + KOH}$ | S | Product is Isopropyl benzene |
| | | T | Electrophilic substitution reaction |

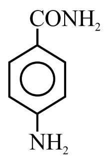
(1) I-S, T ; II-R, S ; III-P, R ; IV-S, T
(2) I-P, T ; II-Q, T ; III-Q, R, T ; IV-P, S
(3) I-R, S, T ; II-Q, R ; III-P, S ; IV-S, T
(4) I-Q, S, T ; II-P, T ; III-Q, T ; IV-R, T

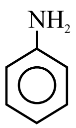
**39.** $(P)\xrightarrow[KOH]{Br_2}(Q)\xrightarrow{CH_3COCl}(R)\xrightarrow[(ii)H_3O^+]{(i)Br_2/CH_3COOH}$

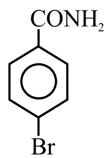


The reactant (P) is:

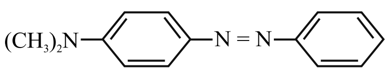
(1) 

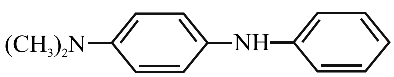
(2) 

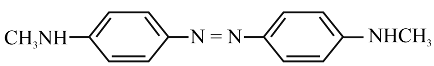
(3) 

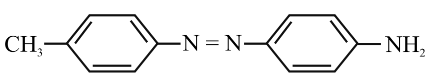
(4) 

**40.** Aniline when diazotized in cold and then treated with dimethyl aniline gives a coloured product. Its structure would be :

(1) 

(2) 

(3) 

(4) 

**41.** In the diazotisation of aniline with sodium nitrite and hydrochloric acid, an excess of hydrochloric acid is used primarily to:

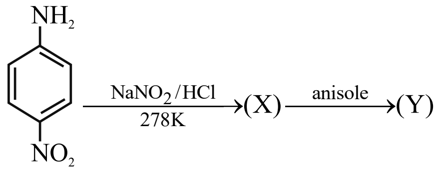
(1) Suppress the concentration of free aniline available for coupling

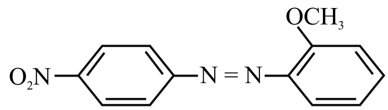
(2) Suppress hydrolysis of phenol

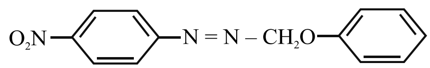
(3) Insure a stoichiometric amount of nitrous acid

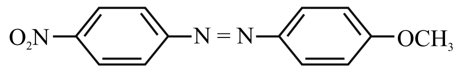
(4) Neutralize the base liberated

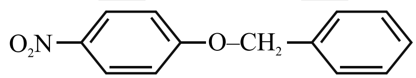
**42.** The structure of the final product (Y) formed in the following reaction sequence is:



(1) 

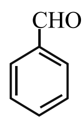
(2) 

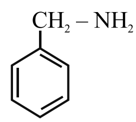
(3) 

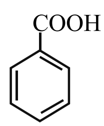
(4) 

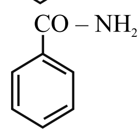
**43.** The major product Y in the following sequence of reaction is:

Aniline $\xrightarrow[(ii)\ CuCN/KCN]{(i)\ NaNO_2/HCl,273K}(X)\xrightarrow[(ii)\ H_2O]{(i)\ DIBAL-H}(Y)$

(1) 

(2) 

(3) 

(4) 

**44.** **Assertion:** In strongly acidic solutions, aniline becomes more reactive towards electrophilic reagents.

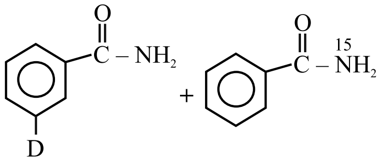
**Reason:** The amino group being completely protonated in strongly acidic solution, the lone pair of electrons on the nitrogen is no longer available for resonance.

(1) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

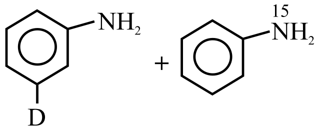
(2) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.

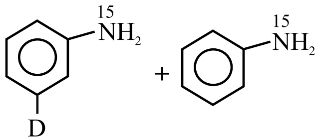
(3) Assertion is true but Reason is false.

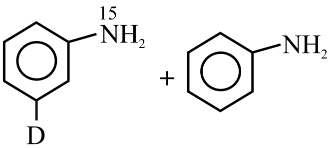
(4) Assertion is false but Reason is true.

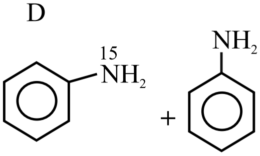
**45.**  under

Hoffmann conditions will give:

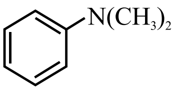
(1) 

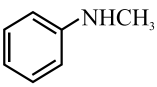
(2) 

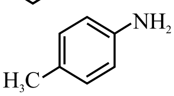
(3) 

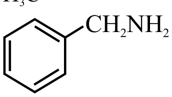
(4) 

**46.** Amongst the compounds given, the one that would form a brilliant colored dye on treatment with $NaNO_2$ in dilute HCl followed by addition to an alkaline solution of $\beta$-naphthol is:

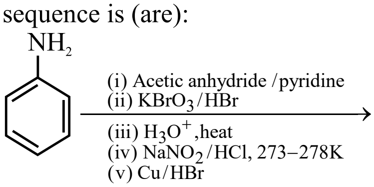
(1) 

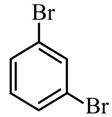
(2) 

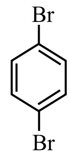
(3) 

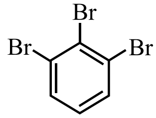
(4) 

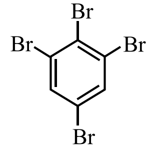
**47.** The product(s) of the following reaction sequence is (are):



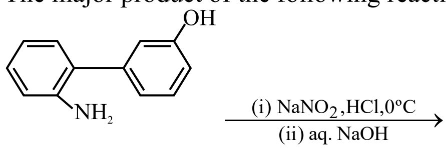
(1) 

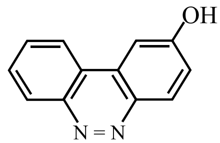
(2) 

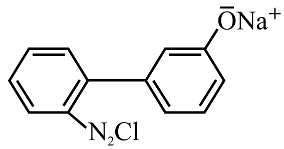
(3) 

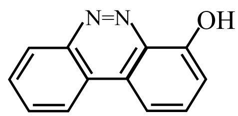
(4) 

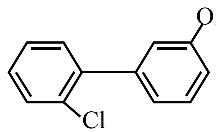
**48.** The major product of the following reaction is:



(1) 

(2) 

(3) 

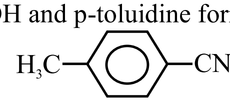
(4) 

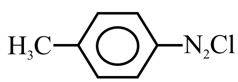
**49.** When primary amine reacts with chloroform in ethanolic KOH then the product is:

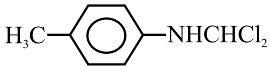
(1) An isocyanide (2) An aldehyde

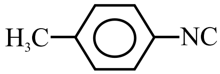
(3) A cyanide (4) An alcohol

**50.** The reaction of chloroform with alcoholic KOH and p-toluidine forms

(1) 

(2) 

(3) 

(4) 

**51.** Fluorobenzene ($C_6H_5F$) can be synthesized in the laboratory

(1) From aniline by diazotisation followed by heating the diazonium salt with $HBF_4$

(2) By direct fluorination of benzene with $F_2$ gas

(3) By reacting bromobenzene with NaF solution

(4) By heating phenol with HF and KF

**52.** In the chemical reaction, $CH_3CH_2NH_2 + CHCl_3 + 3KOH \rightarrow (A) + (B) + 3H_2O$, compounds (A) and (B) are respectively:

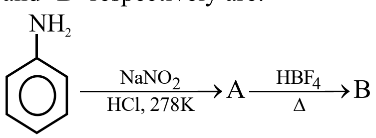
(1) $C_2H_5NC$ and $K_2CO_3$

(2) $C_2H_5NC$ and 3KCl

(3) $C_2H_5CN$ and 3KCl

(4) $CH_3CH_2CONH_2$ and 3KCl

**53.** In the chemical reactions the compounds 'A' and 'B' respectively are:



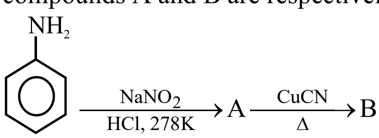
(1) Nitrobenzene and fluorobenzene

(2) Phenol and benzene

(3) Benzene diazonium chloride and fluorobenzene

(4) Nitrobenzene and chlorobenzene

**54.** In the following chemical reactions, the compounds A and B are respectively:



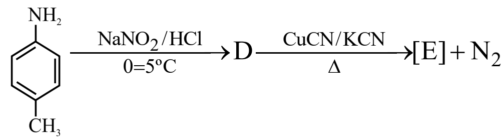
(1) Benzene diazonium chloride and benzonitrile

(2) Nitrobenzene and chlorobenzene

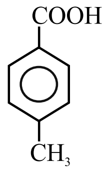
(3) Phenol and bormobenzene

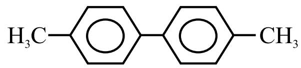
(4) Fluorobenzene and phenol

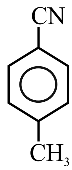
**55.** In the reaction

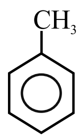


; The product [E] is:

(1) 

(2) 

(3) 

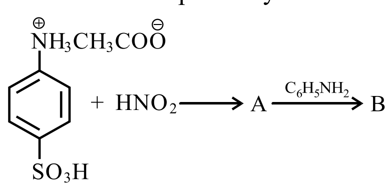
(4) 

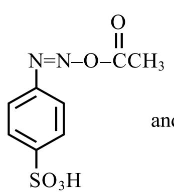
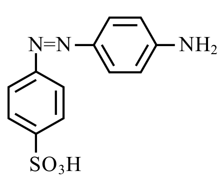
**56.** Fluorination of an aromatic ring is easily accomplished by treating a benzene diazonium salt with $HBF_4$. Which of the following conditions is correct about this reaction

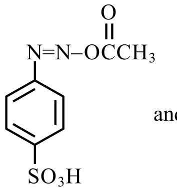
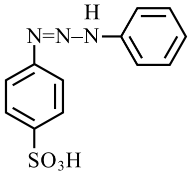
(1) Only heat (2) $NaNO_2$/Cu

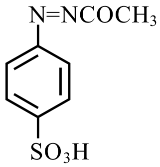
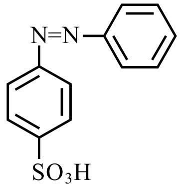
(3) $Cu_2O/H_2O$ (4) NaF/Cu

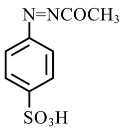
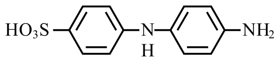
**57.** Products 'A' and 'B' formed in the following reactions are respectively:



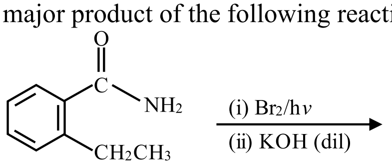
(1)  and 

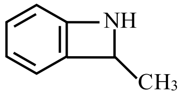
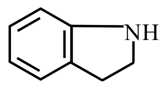
(2)  and 

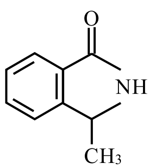
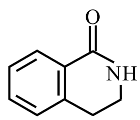
(3)  and 

(4)  and 

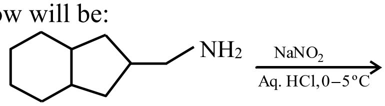
**58**. The major product of the following reaction is:

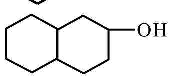


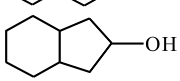
(1) 
(2) 

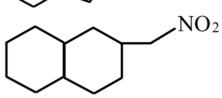
(3) 
(4) 

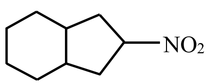
**59**. The major product formed in the reaction given below will be:



(1) 

(2) 

(3) 

(4) 

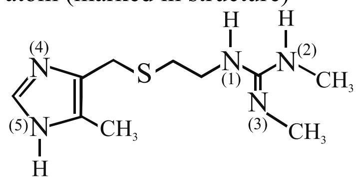
**60**. A compound 'X' on treatment with $Br_2$/NaOH, provided $C_3H_9N$, which gives positive carbylamine test. Compound 'X' is:
(1) $CH_3COCH_2NHCH_3$
(2) $CH_3CON(CH_3)_2$
(3) $CH_3CH_2COCH_2NH_2$
(4) $CH_3CH_2CH_2CONH_2$

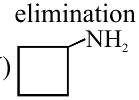
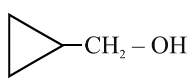
## *Integer Type Questions (61 to 75)*

**61**. What is the molecular mass of the gas evolved when methylamine reacts with nitrous acid.

**62**. How many of the following statement(s) is/are incorrect.
(I) $-NO_2$ is a deactivating group
(II) $-NO_2$ group causes the substitution to occur at meta-position
(III) Nucleophilic ring substitution in nitrobenzene occurs at ortho and para position
(IV) Hydrolysis of picryl chloride requires higher temperature than chlorobenzene

**63.** The cimetidine has several nitrogen atom in its structure. Identify the most basic Nitrogen atom (marked in structure)



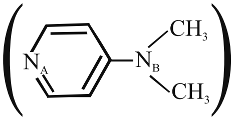
**64.** How many of the following statement(s) is/are incorrect
(I) Fluoro benzene can be synthesized in the laboratory from aniline by diazotisation followed by heating with $HBF_4$
(II) Benzyl amine on reaction with $NaNO_2$ /HCl followed by β-Naphthol in slight basic medium forms a coloured dye.
(III) Quarternary Ammonium hydroxides having β-hydrogen atom give hoffmann elimination on pyrolysis.
(IV)  on reaction with $HNO_2$ produces 

**65.** How many of the following statement(s) is/are incorrect

(I) Pyrrole is more basic than pyridine

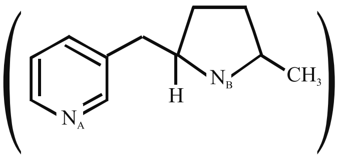
(II) Pyridine is more basic than piperidene

(III) In 4- (N,N-dimethylamino) pyridine




, $N_A$ is more basic than $N_B$.

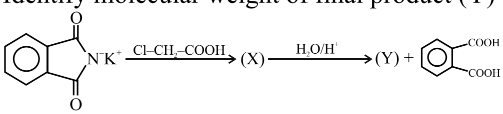
(IV) In nicotine



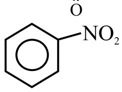

, $N_A$ is more basic than $N_B$.

**66.** What is the maximum number of compounds with the molecular formula $C_4H_{11}N$, which give an alkali soluble precipitate with benzyl sulfonyl chloride?

**67.** Identify molecular weight of final product (Y)



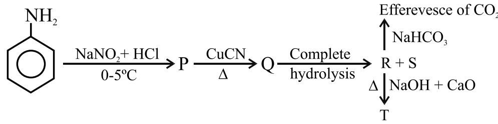

**68.**




$\xrightarrow{Sn/HCl} \xrightarrow[HCl\ 0-5°C]{NaNO_2} \xrightarrow{H_2O,\Delta} Z$ (major product)

Find the molecular weight of Z.

**69.**




Molecular weight of T will be:

**70.**

$Ph-NO_2 \xrightarrow{Sn/HCl} \xrightarrow[HCl, 0°C-5°C]{NaNO_2} \xrightarrow[Ph-OH]{\text{Basic medium}}$

Product Y

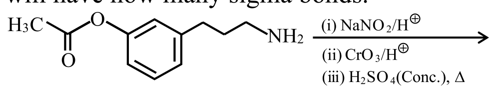
Find the molecular weight of Y and report your answer as $\frac{\text{Molecular weight of Y}}{2}$.

**71.** A compound with molecular mass 180 is acylated with $CH_3COCl$ to get a compound with molecular mass 390. The number of amino groups present per molecule of the former compound is:

**72.** In the Hoffmann bromamide degradation reaction, the ratio of number of moles of NaOH and $Br_2$ used per mole of amine produced is:

**73.** What is the molar mass of the final major product obtained on complete reduction of benzene-diazonium chloride with Zn/HCl.

**74.** The major product of the following reaction will have how many sigma bonds.




**75.** How many chiral centers are present in the major product obtained when 2-Aminobutane is treated with nitrous acid?

# CHAPTER 20

# BIOMOLECULES

## Single Option Correct Type Questions (01 to 60)

**1.** A hexapeptide has the composition Ala, Gly, Phe, Val. Both the N-terminal and C-terminal units are Val. Cleavage of the hexapeptide by chymotrypsin gives two different tripeptides, both having Val as the N-terminal group. Among the products of random hydrolysis is a Ala-Val dipeptide fragment. What is the primary structure of the hexapeptide?

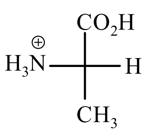
(1) Val-Gly-Phe-Val-Ala-Val

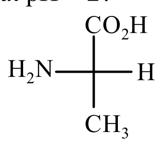
(2) Val-Ala-Phe-Val-Gly-Val

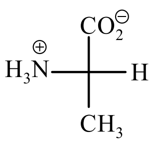
(3) Val-Gly-Ala-Val-Phe-Val

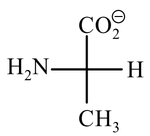
(4) Val-Phe-Val-Ala-Gly-Val

**2.** Which of the following is the major solute species in a solution of alanine at pH = 2?

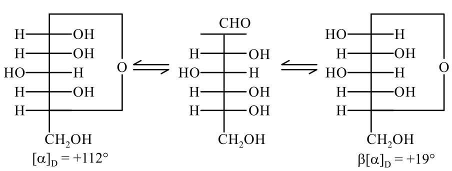
(1) 


(2) 


(3) 


(4) 


**3.**




The above process in which α and β form remain in equilibrium with acyclic form and a change in optical rotation is observed which is known as -

(1) Mutarotation (2) Epimerisation

(3) Condensation (4) Inversion

**4.** In which of the following pairs, both the compounds give positive test with Tollen's reagent?

(1) Glucose and sucrose

(2) Glucose and fructose

(3) Fructose and sucrose

(4) Acetophenone and hexanal

**5.** Test by which starch and cellulose can be distinguished from each other is:

(1) Reducing sugar test

(2) Analysis of products of hydrolysis

(3) Iodine test

(4) Molisch test

**6.** Which of the statements is incorrect.

(1) Fructose on reduction with NaBH4 gives only one product.

(2) Solubility of amino acid at its isoelectric point is minimum.

(3) Guanidine is more basic than diethyl amine.

(4) Mutarotation is observed in the aqueous solution of glucose.

**7.** Which of the following is not reducing sugar

(1) Sucrose (2) Glucose

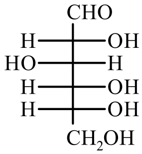
(3) Fructose (4) Maltose

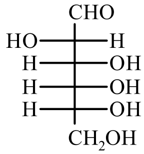
**8.** What is the corresponding m-RNA sequence for the DNA segment AATCAGTT?

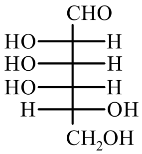
(1) AAUCAGUU (2) CCAUCGAA

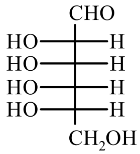
(3) AACUGAUU (4) UUAGUCAA

**9.** Which two of the following compounds, if any, are epimers?


(I)


(II)


(III)


(IV)

(1) I & IV (2) I & III
(3) II & III (4) III & IV

**10.** An amino acid is characterized by two pKa values the one corresponding to the more acidic site is designated as $pKa_1$ and the other corresponding to the less acidic site is designated as $pKa_2$. Some amino acids have side chain with acidic or basic groups. These amino acids have $pKa_3$ value also for the side chain.

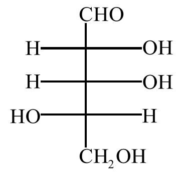
| **Amino acid** | $P^{Ka1}$ | $P^{Ka2}$ | $P^{Ka3}$ **(side chain)** |
|---|---|---|---|
| Aspartic acid | 1.88 | 9.6 | 3.65 |
| Glutamic acid | 2.19 | 9.67 | 4.25 |
| Lysine | 2.18 | 8.95 | 10.53 |
| Arginine | 2.17 | 9.04 | 12.48 |

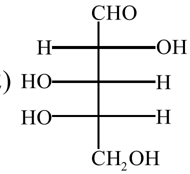
The isoelectric point (pI) of Aspartic acid and lysine will be respectively:
(1) 6.62 & 9.74 (2) 2.77 & 5.6
(3) 2.77 & 9.74 (4) 9.74 & 6.62

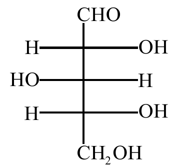
**11.** Fructose reduces Tollen's reagent due to
(1) Presence of ketonic group
(2) Presence of aldehydic group
(3) Rearrangement of fructose into a mixture of glucose, fructose and mannose
(4) Both (2) & (3)

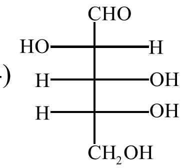
**12.** Acid hydrolysis of sucrose causes
(1) Esterification
(2) Saponification
(3) Inversion
(4) Rosenmund reduction

**13.** (+) Arabinose is (2R, 3S, 4S)-aldopentose which of the following is (+) – arabinose?

(1) 

(2) 

(3) 

(4) 

**14.** Glucose does not give:
(1) Schiff's test
(2) Hydrogensulphite addition product with $NaHSO_3$
(3) 2, 4 DNP test
(4) All of these

**15.** Glucose reacts with HCN to give:
(1) Saccharic acid (2) Cyanohydrin
(3) n-hexane (4) Gluconic

**16.** Which is correct statement?
(1) Starch is a polymer of $\alpha$-glucose
(2) Amylose is a component of cellulose
(3) Proteins are composed of only one type of amino acids
(4) In cyclic structure of pyranose form of glucose, there are five carbons and one oxygen atom

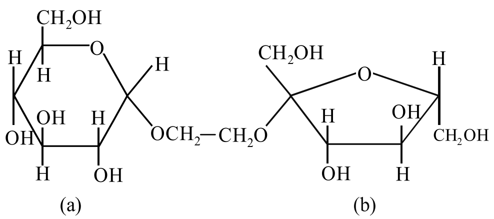
**17.** $\alpha$-helical structure of protein is stabilized by:
(1) Peptide bond (2) Dipeptide bond
(3) Van der Waal's forces (4) Hydrogen bond

**18.** When protein is subjected to denaturation:
(1) It is hydrolysed to constituent amino acids
(2) Electric field has no influence on its migration
(3) Constituent amino acids are separated
(4) It uncoils from an ordered and specific conformation into a more random conformation and precipitates from solution

**19**. Which of the following is incorrect about isoelectric point of amino acid?
(1) At this point, amino acid is present in the form of zwitter ion
(2) At this point, amino acid is electrically neutral
(3) If pH > isoelectric point, amino acid will move toward anode
(4) If pH > isoelectric point, amino acid will move towards cathode

**20**. Complementary bases present in DNA are:
(1) Uracil & Adenine : Cytosine & Guanine
(2) Thymine & Adenine : Guanine & Cytosine
(3) Adenine & Thymine : Guanine & Uracil
(4) Adenine & Guanine : Thymine & Cytosine

**21**. The correct statement about the following disaccharide is:



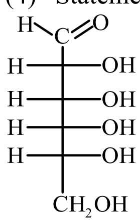

(1) Ring (a) is pyranose with α-glycosidic link
(2) Ring (a) is furanose with α-glycosidic link
(3) Ring (b) is furanose with α-glycosidic link
(4) Ring (b) is pyranose with α-glycosidic link

**22**. **Statement-1:** Glucose and fructose can be differentiated by Fehling's solution. and
**Statement-2:** Glucose is an aldose while fructose is a ketose (having keto functional group).
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**23**. **Statement-1:** D-Glucose and D-Mannose are C-2 epimers and
**Statement-2:** They only have different configuration at carbon number-2.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**24**. **Statement-1:** Glucose gives shining silver mirror with Tollen's reagent.
**Statement-2:** Reaction of glucose with Tollen's reagent gives Ag.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**25**.




Allose, given monosaccharide is a/an?
(1) Aldopentose (2) Aldohexose
(3) Ketopentose (4) Aldoheptose

**26**. α-D-glucose and β-D-glucose differ from each other due to the difference in one of the carbon atoms, with respect to its:
(1) Number of –OH groups
(2) Configuration
(3) Conformation
(4) Size of hemiacetal ring

**27**. Which of the following α-amino acids is not optically active?
(1) Alanine (2) Glycine
(3) Phenylalanine (4) Cysteine

**28**. The force of attraction between the neighbouring peptide chains is
(1) Vander Waal's force (2) Covalent bond
(3) Hydrogen bond (4) Peptide linkage

**29**. Vitamin $B_6$ is known as:
(1) Pyridoxine (2) Thiamine
(3) Tocopherol (4) Riboflavin

**30**. Which of the following statements about DNA is not correct?
(1) It has a double helical structure
(2) It undergoes replication
(3) The two strands in a DNA molecule are exactly similar
(4) It contains the 2-deoxyribose pentose sugar.

**31**. Match List-I with List-II.

| List- I (Polymer) | | List- II (Monomer) | |
|---|---|---|---|
| I | Sucrose | P | Linkage and hydrolysis product D (+) glucose |
| II | Maltose | Q | Linkage and hydrolysis product D (–) fructose |
| III | Lactose | R | D (+) galactose |
| IV | Cellulose | S | $\alpha$ (1 $\rightarrow$ 4) |
| | | T | $\beta$ (1 $\rightarrow$ 4) |

(1) I-R, Q ; II-Q, S ; III-P, S, T ; IV-P, S
(2) I-Q, T ; II-R, P ; III-P, T ; IV-S, R
(3) I-P, S ; II-P, Q ; III-P, R ; IV-P, T
(4) I-P, Q ; II-P, S ; III-P, R, T ; IV-P, T

**32**. Match List-I with List-II.

| List- I | | List- II | |
|---|---|---|---|
| I | $CH_3-\underset{\vert}{\overset{NH_3^+}{C}}H-COO^-$ | P | Acidic amino acid |
| II | Arginine | Q | Neutral amino acid |
| III | Valine | R | Zwitter ion |
| IV | Aspartic acid | S | Basic amino acid |

(1) I-Q, S ; II-P ; III-Q ; IV-S
(2) I-Q, R ; II-S ; III-Q ; IV-P
(3) I-P, S ; II-R ; III-S ; IV-Q
(4) I-P, Q ; II-R ; III-S ; IV-Q

**33**. 3 molecule of phenylhydrazine is used in Osazone formation. The correct statement about the use of phenylhydrazine is:
(1) All the three molecules react in similar manner.
(2) Two molecules reacts in similar manner whereas the third reacts in different way.
(3) All the three molecules react in different way.
(4) Only two react in same manner but the third molecule remains unreacted.

**34**. **Statement-1:** Glucose gives a reddish-brown precipitate with Fehling's solution. because
**Statement-2:** Reaction of glucose with Fehling's solution gives CuO and gluconic acid.
(1) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(2) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(3) Statement-1 is True, Statement-2 is False
(4) Statement-1 is False, Statement-2 is True

**35**. Complete hydrolysis of cellulose gives:
(1) D-fructose (2) D-ribose
(3) D-glucose (4) L-glucose

**36**. The reason for double helical structure of DNA is:
(1) Van der Waal's forces.
(2) Dipole-dipole interaction.
(3) Hydrogen bonding.
(4) Electrostatic attractions.

**37**. Insulin production and its action in human body are responsible for the level of diabetes. This compound belongs to which of the following categories?
(1) A co- enzyme (2) A hormone
(3) An enzyme (4) An antibiotic

**38**. The pyrimidine bases present in DNA are:
(1) Cytosine and guanine
(2) Cytosine and thymine
(3) Cytosine and uracil
(4) Cytosine and adenine

**39**. The term anomers of glucose refers to:
(1) A mixture of (D)–glucose and (L)–glucose
(2) Enantiomers of glucose

(3) Isomers of glucose that differ in configuration at carbon one (C–1)
(4) Isomers of glucose that differ in configurations at carbons one and four (C–1 and C–4)

**40.** The secondary structure of protein refers to:
(1) α-helical or β-pleated backbone.
(2) Hydrophobic interactions.
(3) Sequence of α-amino acids.
(4) Hydrophilic interactions.

**41.** α-D- (+)-glucose and β-D-(+)-glucose are:
(1) Structural isomers (2) Anomers
(3) Enantiomers (4) Conformers

**42.** The change in the optical rotation of freshly prepared solution of glucose is known as:
(1) Racemisation (2) Specific rotation
(3) Mutarotation (4) Tautomerism

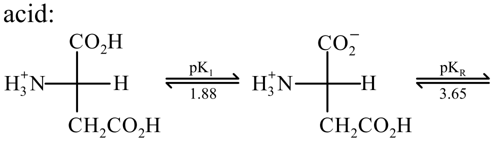
**43.** Which one of the following statements is correct?
(1) All amino acids except lysine are optically active
(2) All amino acids are optically active
(3) All amino acids except glycine are optically active
(4) All amino acids except glutamic acid is optically active

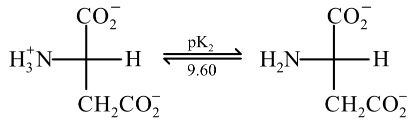
**44.** Which of the vitamins given below is water soluble?
(1) Vitamin C (2) Vitamin D
(3) Vitamin E (4) Vitamin K

**45.** Glucose on prolonged heating with HI gives:
(1) Hexanoic acid (2) 6-iodohexanal
(3) n-Hexane (4) 1-Hexene

**46.** Which of the following will not show mutarotation?
(1) Maltose (2) Lactose
(3) Glucose (4) Sucrose

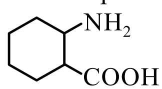
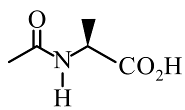
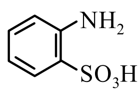
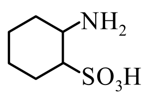
**47.** Consider the following sequence for aspartic acid:





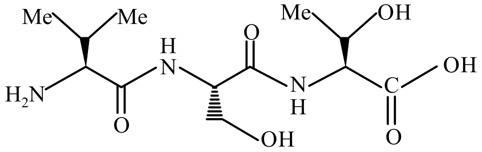
The pI (isoelectric point) of aspartic acid is:
(1) 5.74 (2) 3.65
(3) 2.77 (4) 1.88

**48.** The incorrect statement among the following is:
(1) α-D-glucose and β-D-glucose are anomers.
(2) The penta acetate of glucose does not react with hydroxyl amine.
(3) Cellulose is a straight chain polysaccharide made up of only β-D-glucose units.
(4) α-D-glucose and β-D-glucose are enantiomers.

**49.** Which of the following will not exist in zwitter ionic form at pH = 7?
(1) 
(2) 
(3) 
(4) 

**50.** The increasing order of pI (isoelectronic point) of the following amino acids in aqueous solution is:
Gly, Asp, Lys, Arg
(1) Asp < Gly < Lys < Arg
(2) Arg < Lys < Gly < Asp
(3) Asp < Gly < Arg < Lys
(4) Gly < Asp < Arg < Lys

**51.** The correct sequence of amino acids present in the tripeptide given below is:



(1) Val - Ser - Thr (2) Leu - Ser – Thr

(3) Thr - Ser - Leu (4) Thr - Ser - Val

**52.** The correct match between List- I and List- II is:

| | List- I (Compound) | | List- II (Reagent) |
|---|---|---|---|
| I | Lysine | P | 1-Naphthol |
| II | Furfural | Q | Ninhydrin |
| III | Benzyl alcohol | R | $KMnO_4$ |
| IV | Styrene | S | Ceric ammonium nitrate |

(1) I-R ; II-P ; III-Q ; IV-S

(2) I-Q ; II-P ; III-S ; IV-R

(3) I-Q ; II-R ; III-S ; IV-P

(4) I-Q ; II-P ; III-R ; IV-S

**53.** Ring structure of glucose is due to formation of hemiacetal and ring formation between

(1) $C_1$ and $C_5$ (2) $C_1$ and $C_4$

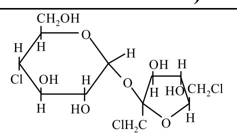
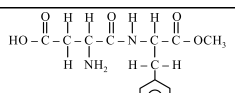
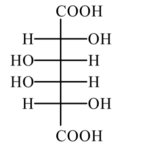
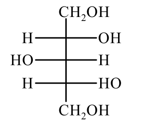
(3) $C_1$ and $C_3$ (4) $C_3$ and $C_4$

**54.** Among the following compounds most basic amino acid is:

(1) Asparagine (2) Serine

(3) Histidine (4) Lysine

**55.** Match the Following:

| | List- I (Artificial sweetners) | | List- II (Characteristics) |
|---|---|---|---|
| I |  (Sucrose) | P | A derivative of dipeptide |
| II |  (Aspartame) | Q | A derivative of disaccharide |
| III |  (Galactoric) (Aldaric acid) | R | Reduction product of an aldopentose |
| IV |  (Xylitol) | S | Oxidation product of aldohexose |

(1) I-Q ; II-P ; III-S ; IV-R

(2) I-P ; II-Q ; III-S ; IV-R

(3) I-R ; II-P ; III-Q ; IV-S

(4) I-Q ; II-R ; III-P ; IV-S

**56.** Which one of the following kinds of bonds are not broken during denaturation of a protein?

(1) Peptide bond (2) Hydrogen bond

(3) Disulphide bond (4) Ionic bond

**57.** The function of proteins is to act as:

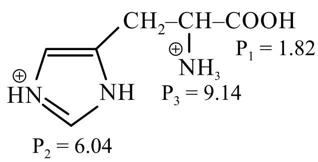
(1) Structural materials of animal tissues

(2) Enzymes and antibodies

(3) Metabolic regulators

(4) All of these

**58.** Observe the pKa values ($P_1 – P_3$) of the given amino acid.

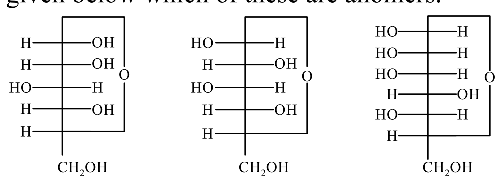



Which form of this amino acid will exist in aqueous solution at pH = 8

(1) As dication (2) As monocation

(3) As zwitter ion (4) As monoanion

**59.** Three cyclic structures of monosaccharides are given below which of these are anomers.



(I) (II) (III)

(1) I and II only
(2) II and III only
(3) I and III only
(4) III is anomer of I and II

**60.** Find true and False from the following statements regarding carbohydrates

**S1:** All monosaccharides whether aldoses or ketoses are reducing sugars.
**S2:** Bromine water can be used to differentiate between aldoses and ketoses
**S3:** A pair of diastereomeric aldoses which differ only in configuration at C-2 are anomers.
**S4:** Osazone formation destroys the configuration at C-2 of an aldose, but does not affect the configuration of the rest of the molecule.

(1) TTTT (2) TFTF
(3) TTFT (4) FTTT

*Integer Type Questions (61 to 75)*

**61.** $pka_1$ and $pka_2$ value for alanine are found to be 2.34 and 9.66. The pH at which isoelectric point is attained is

**62.** A carbohydrate having molecular mass 150, was treated with excess $CH_3-\overset{\overset{\large O}{||}}{C}-Cl$. The precipitate was a derivative of the carbohydrate having molecular mass 318. What is the number of alcoholic –OH groups present in the carbohydrate?

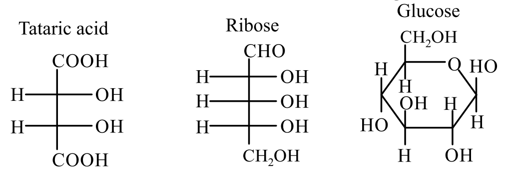
**63.** $$\underset{(\beta)}{HOOC}-CH_2-CH_2-\overset{\overset{\oplus\ (\alpha)}{NH_3}}{\overset{|}{CH}}-\underset{(\gamma)}{COOH}$$

Given above is the form in which an amino acid exists in a strongly acidic medium.
If, $K_a(\alpha) = 10^{-9}$
$K_a(\beta) = 10^{-5}$
$K_a(\gamma) = 10^{-3}$
What will be the pH of the solution at isoelectric point (pI)?

**64.** The number of chiral carbon atoms in D(+) Glucose is.

**65.** Sum of the number $1^0$ alcoholic group present in open chain structure of glucose and fructose

**66.** Sum of the total moles of acetic anhydride ($Ac_2O$) is needed to react completely with 1 mole each of tataric acid, ribose and glucose are



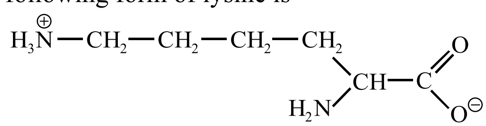

**67.** D-glucose reacts with phenylhydrazine to make osazone. How many molecules of phenylhydrazine are used for this reaction per molecule of D-glucose?

**68.** A tripeptide is composed equally of L-valine, L-tyrosine and L-alanine (one molecule of each). How many isomeric tripeptides of this kind may exist? (consider no repetition is allowed)

**69.** The number of amino acids required to form a tripeptide bond are?

**70.** What is the total number of acidic amino acids found in human proteins?

**71.** The total number of basic groups in the following form of lysine is




**72.** For the structure
$CH_2OH$
$C=O$
$CHOH$
$CHOH$
$CHOH$
$CH_2OH$
, total possible optical isomers are

**73.** What is the number of peptide bonds in a pentapeptide?

**74.** How many moles of acetyl chloride are used per mole of sucrose for esterification.

**75.** Among the following amino acids no. of essential amino acids are
Glycine, Alanine, Valine, Cysteine, Leucine, Isoleucine, Serine, Threonine.

## 01. STOICHIOMETRY AND REDOX REACTIONS

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (4) | 17. | (4) | 25. | (3) | 33. | (1) | 41. | (4) | 49. | (3) | 57. | (2) |
| 2. | (1) | 10. | (4) | 18. | (2) | 26. | (1) | 34. | (3) | 42. | (2) | 50. | (3) | 58. | (2) |
| 3. | (1) | 11. | (2) | 19. | (2) | 27. | (3) | 35. | (4) | 43. | (3) | 51. | (2) | 59. | (1) |
| 4. | (1) | 12. | (1) | 20. | (3) | 28. | (2) | 36. | (3) | 44. | (3) | 52. | (1) | 60. | (3) |
| 5. | (4) | 13. | (3) | 21. | (4) | 29. | (2) | 37. | (4) | 45. | (3) | 53. | (2) | | |
| 6. | (1) | 14. | (1) | 22. | (1) | 30. | (2) | 38. | (2) | 46. | (1) | 54. | (1) | | |
| 7. | (2) | 15. | (3) | 23. | (2) | 31. | (3) | 39. | (2) | 47. | (2) | 55. | (4) | | |
| 8. | (1) | 16. | (4) | 24. | (1) | 32. | (4) | 40. | (1) | 48. | (4) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (3) | 63. | (4) | 65. | (5) | 67. | (1) | 69. | (3) | 71. | (567) | 73. | (18) | 75. | (7) |
| 62. | (9) | 64. | (2) | 66. | (60) | 68. | (5) | 70. | (875) | 72. | (100) | 74. | (333) | | |

## 02. STRUCTURE OF ATOM

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (1) | 17. | (1) | 25. | (4) | 33. | (3) | 41. | (3) | 49. | (4) | 57. | (1) |
| 2. | (3) | 10. | (4) | 18. | (3) | 26. | (3) | 34. | (4) | 42. | (4) | 50. | (2) | 58. | (4) |
| 3. | (4) | 11. | (1) | 19. | (4) | 27. | (1) | 35. | (1) | 43. | (4) | 51. | (4) | 59. | (1) |
| 4. | (2) | 12. | (2) | 20. | (1) | 28. | (1) | 36. | (2) | 44. | (3) | 52. | (4) | 60. | (1) |
| 5. | (3) | 13. | (3) | 21. | (4) | 29. | (1) | 37. | (4) | 45. | (3) | 53. | (1) | | |
| 6. | (2) | 14. | (1) | 22. | (4) | 30. | (3) | 38. | (2) | 46. | (4) | 54. | (4) | | |
| 7. | (3) | 15. | (1) | 23. | (3) | 31. | (1) | 39. | (2) | 47. | (3) | 55. | (3) | | |
| 8. | (1) | 16. | (1) | 24. | (2) | 32. | (1) | 40. | (3) | 48. | (1) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (912) | 63. | (1) | 65. | (759) | 67. | (3) | 69. | (91) | 71. | (53) | 73. | (7) | 75. | (27) |
| 62. | (6) | 64. | (5) | 66. | (984) | 68. | (6) | 70. | (8) | 72. | (5) | 74. | (2) | | |

## 03. CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (3) | 9. | (2) | 17. | (4) | 25. | (1) | 33. | (4) | 41. | (3) | 49. | (4) | 57. | (4) |
| 2. | (4) | 10. | (3) | 18. | (2) | 26. | (3) | 34. | (1) | 42. | (2) | 50. | (1) | 58. | (3) |
| 3. | (3) | 11. | (3) | 19. | (4) | 27. | (2) | 35. | (4) | 43. | (3) | 51. | (4) | 59. | (1) |
| 4. | (1) | 12. | (4) | 20. | (2) | 28. | (3) | 36. | (2) | 44. | (1) | 52. | (4) | 60. | (1) |
| 5. | (4) | 13. | (3) | 21. | (3) | 29. | (3) | 37. | (3) | 45. | (3) | 53. | (3) | | |
| 6. | (2) | 14. | (3) | 22. | (2) | 30. | (2) | 38. | (3) | 46. | (4) | 54. | (3) | | |
| 7. | (2) | 15. | (1) | 23. | (4) | 31. | (4) | 39. | (3) | 47. | (2) | 55. | (3) | | |
| 8. | (1) | 16. | (4) | 24. | (3) | 32. | (3) | 40. | (3) | 48. | (1) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (18) | 63. | (6) | 65. | (115) | 67. | (109) | 69. | (23) | 71. | (3) | 73. | (3) | 75. | (126) |
| 62. | (81) | 64. | (5) | 66. | (25) | 68. | (15) | 70. | (526) | 72. | (1) | 74. | (3) | | |

## 04. CHEMICAL BONDING

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (2) | 17. | (4) | 25. | (3) | 33. | (3) | 41. | (2) | 49. | (2) | 57. | (1) |
| 2. | (2) | 10. | (4) | 18. | (1) | 26. | (1) | 34. | (4) | 42. | (3) | 50. | (2) | 58. | (1) |
| 3. | (2) | 11. | (3) | 19. | (1) | 27. | (2) | 35. | (4) | 43. | (2) | 51. | (3) | 59. | (1) |
| 4. | (4) | 12. | (4) | 20. | (3) | 28. | (4) | 36. | (3) | 44. | (1) | 52. | (2) | 60. | (1) |
| 5. | (3) | 13. | (3) | 21. | (3) | 29. | (3) | 37. | (2) | 45. | (3) | 53. | (1) | | |
| 6. | (1) | 14. | (1) | 22. | (3) | 30. | (3) | 38. | (3) | 46. | (4) | 54. | (2) | | |
| 7. | (4) | 15. | (2) | 23. | (1) | 31. | (4) | 39. | (3) | 47. | (2) | 55. | (1) | | |
| 8. | (3) | 16. | (2) | 24. | (2) | 32. | (3) | 40. | (3) | 48. | (1) | 56. | (4) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (4) | 63. | (17) | 65. | (4) | 67. | (6) | 69. | (5) | 71. | (2) | 73. | (2) | 75. | (2) |
| 62. | (3) | 64. | (6) | 66. | (15) | 68. | (1) | 70. | (1) | 72. | (18) | 74. | (3) | | |

## 05. THERMODYNAMICS

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (2) | 17. | (4) | 25. | (2) | 33. | (4) | 41. | (3) | 49. | (4) | 57. | (3) |
| 2. | (4) | 10. | (3) | 18. | (2) | 26. | (3) | 34. | (2) | 42. | (1) | 50. | (4) | 58. | (1) |
| 3. | (3) | 11. | (4) | 19. | (3) | 27. | (1) | 35. | (3) | 43. | (1) | 51. | (4) | 59. | (1) |
| 4. | (2) | 12. | (2) | 20. | (2) | 28. | (4) | 36. | (4) | 44. | (1) | 52. | (1) | 60. | (4) |
| 5. | (3) | 13. | (3) | 21. | (2) | 29. | (2) | 37. | (1) | 45. | (1) | 53. | (2) | | |
| 6. | (3) | 14. | (2) | 22. | (3) | 30. | (3) | 38. | (4) | 46. | (1) | 54. | (1) | | |
| 7. | (2) | 15. | (2) | 23. | (2) | 31. | (1) | 39. | (3) | 47. | (1) | 55. | (1) | | |
| 8. | (3) | 16. | (2) | 24. | (1) | 32. | (3) | 40. | (4) | 48. | (1) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (213) | 63. | (400) | 65. | (370) | 67. | (352) | 69. | (0) | 71. | (53) | 73. | (1) | 75. | (121) |
| 62. | (0) | 64. | (350) | 66. | (38) | 68. | (44) | 70. | (425) | 72. | (110) | 74. | (270) | | |

## 06. CHEMICAL EQUILIBRIUM

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (1) | 17. | (3) | 25. | (4) | 33. | (1) | 41. | (4) | 49. | (4) | 57. | (1) |
| 2. | (3) | 10. | (2) | 18. | (4) | 26. | (1) | 34. | (3) | 42. | (1) | 50. | (2) | 58. | (2) |
| 3. | (4) | 11. | (4) | 19. | (2) | 27. | (2) | 35. | (3) | 43. | (1) | 51. | (2) | 59. | (1) |
| 4. | (1) | 12. | (1) | 20. | (3) | 28. | (3) | 36. | (2) | 44. | (1) | 52. | (2) | 60. | (1) |
| 5. | (4) | 13. | (1) | 21. | (2) | 29. | (2) | 37. | (2) | 45. | (2) | 53. | (1) | | |
| 6. | (2) | 14. | (1) | 22. | (3) | 30. | (2) | 38. | (4) | 46. | (2) | 54. | (2) | | |
| 7. | (2) | 15. | (4) | 23. | (2) | 31. | (4) | 39. | (4) | 47. | (4) | 55. | (1) | | |
| 8. | (2) | 16. | (1) | 24. | (4) | 32. | (2) | 40. | (3) | 48. | (1) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (16) | 63. | (1) | 65. | (50) | 67. | (50) | 69. | (50) | 71. | (10) | 73. | (18) | 75. | (30) |
| 62. | (6) | 64. | (16) | 66. | (4) | 68. | (400) | 70. | (25) | 72. | (1) | 74. | (36) | | |

## 07. IONIC EQUILIBRIUM

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (1) | 17. | (1) | 25. | (1) | 33. | (3) | 41. | (1) | 49. | (3) | 57. | (4) |
| 2. | (2) | 10. | (1) | 18. | (2) | 26. | (4) | 34. | (1) | 42. | (4) | 50. | (2) | 58. | (2) |
| 3. | (1) | 11. | (2) | 19. | (3) | 27. | (3) | 35. | (1) | 43. | (2) | 51. | (1) | 59. | (1) |
| 4. | (1) | 12. | (2) | 20. | (1) | 28. | (3) | 36. | (3) | 44. | (4) | 52. | (3) | 60. | (2) |
| 5. | (1) | 13. | (1) | 21. | (1) | 29. | (2) | 37. | (4) | 45. | (1) | 53. | (1) | | |
| 6. | (1) | 14. | (2) | 22. | (2) | 30. | (1) | 38. | (1) | 46. | (2) | 54. | (4) | | |
| 7. | (2) | 15. | (1) | 23. | (1) | 31. | (2) | 39. | (1) | 47. | (1) | 55. | (3) | | |
| 8. | (2) | 16. | (1) | 24. | (2) | 32. | (3) | 40. | (3) | 48. | (1) | 56. | (3) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (900) | 63. | (7) | 65. | (20) | 67. | (10) | 69. | (9) | 71. | (4) | 73. | (2) | 75. | (2) |
| 62. | (9) | 64. | (3) | 66. | (50) | 68. | (5) | 70. | (316) | 72. | (9) | 74. | (10) | | |

## 08. ORGANIC CHEMISTRY- SOME BASIC PRINCIPLES & TECHNIQUES

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (1) | 17. | (2) | 25. | (1) | 33. | (3) | 41. | (1) | 49. | (1) | 57. | (1) |
| 2. | (3) | 10. | (2) | 18. | (3) | 26. | (3) | 34. | (1) | 42. | (2) | 50. | (3) | 58. | (1) |
| 3. | (2) | 11. | (2) | 19. | (2) | 27. | (2) | 35. | (2) | 43. | (1) | 51. | (2) | 59. | (1) |
| 4. | (2) | 12. | (2) | 20. | (4) | 28. | (2) | 36. | (4) | 44. | (4) | 52. | (3) | 60. | (3) |
| 5. | (2) | 13. | (1) | 21. | (4) | 29. | (3) | 37. | (2) | 45. | (2) | 53. | (2) | | |
| 6. | (3) | 14. | (4) | 22. | (3) | 30. | (3) | 38. | (1) | 46. | (4) | 54. | (4) | | |
| 7. | (4) | 15. | (3) | 23. | (2) | 31. | (4) | 39. | (1) | 47. | (2) | 55. | (1) | | |
| 8. | (1) | 16. | (4) | 24. | (3) | 32. | (3) | 40. | (2) | 48. | (3) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (50) | 63. | (32) | 65. | (3) | 67. | (1) | 69. | (7) | 71. | (7) | 73. | (9) | 75. | (32) |
| 62. | (16) | 64. | (4) | 66. | (4) | 68. | (22) | 70. | (8) | 72. | (6) | 74. | (2) | | |

## 09. HYDROCARBONS

### SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | **(4)** | **9.** | **(4)** | **17.** | **(3)** | **25.** | **(2)** | **33.** | **(2)** | **41.** | **(2)** | **49.** | **(3)** | **57.** | **(4)** |
| **2.** | **(4)** | **10.** | **(3)** | **18.** | **(3)** | **26.** | **(3)** | **34.** | **(2)** | **42.** | **(1)** | **50.** | **(4)** | **58.** | **(1)** |
| **3.** | **(2)** | **11.** | **(3)** | **19.** | **(2)** | **27.** | **(2)** | **35.** | **(3)** | **43.** | **(1)** | **51.** | **(1)** | **59.** | **(3)** |
| **4.** | **(2)** | **12.** | **(2)** | **20.** | **(3)** | **28.** | **(3)** | **36.** | **(4)** | **44.** | **(3)** | **52.** | **(2)** | **60.** | **(2)** |
| **5.** | **(2)** | **13.** | **(2)** | **21.** | **(2)** | **29.** | **(2)** | **37.** | **(4)** | **45.** | **(3)** | **53.** | **(4)** | | |
| **6.** | **(1)** | **14.** | **(4)** | **22.** | **(3)** | **30.** | **(2)** | **38.** | **(2)** | **46.** | **(3)** | **54.** | **(4)** | | |
| **7.** | **(3)** | **15.** | **(4)** | **23.** | **(1)** | **31.** | **(4)** | **39.** | **(1)** | **47.** | **(3)** | **55.** | **(3)** | | |
| **8.** | **(3)** | **16.** | **(2)** | **24.** | **(4)** | **32.** | **(3)** | **40.** | **(4)** | **48.** | **(4)** | **56.** | **(1)** | | |

### INTEGER TYPE QUESTIONS (61 TO 75)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **61.** | **(5)** | **63.** | **(3)** | **65.** | **(6)** | **67.** | **(6)** | **69.** | **(44)** | **71.** | **(2)** | **73.** | **(30)** | **75.** | **(2)** |
| **62.** | **(1)** | **64.** | **(3)** | **66.** | **(4)** | **68.** | **(2)** | **70.** | **(44)** | **72.** | **(4)** | **74.** | **(3)** | | |

## 10. SOLUTIONS AND COLLIGATIVE PROPERTIES

### SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1.** | **(3)** | **9.** | **(4)** | **17.** | **(4)** | **25.** | **(1)** | **33.** | **(1)** | **41.** | **(1)** | **49.** | **(1)** | **57.** | **(2)** |
| **2.** | **(1)** | **10.** | **(2)** | **18.** | **(2)** | **26.** | **(3)** | **34.** | **(2)** | **42.** | **(1)** | **50.** | **(4)** | **58.** | **(3)** |
| **3.** | **(2)** | **11.** | **(4)** | **19.** | **(3)** | **27.** | **(2)** | **35.** | **(2)** | **43.** | **(3)** | **51.** | **(1)** | **59.** | **(1)** |
| **4.** | **(2)** | **12.** | **(2)** | **20.** | **(4)** | **28.** | **(1)** | **36.** | **(1)** | **44.** | **(3)** | **52.** | **(2)** | **60.** | **(1)** |
| **5.** | **(2)** | **13.** | **(2)** | **21.** | **(2)** | **29.** | **(3)** | **37.** | **(2)** | **45.** | **(1)** | **53.** | **(1)** | | |
| **6.** | **(1)** | **14.** | **(4)** | **22.** | **(3)** | **30.** | **(3)** | **38.** | **(2)** | **46.** | **(4)** | **54.** | **(2)** | | |
| **7.** | **(1)** | **15.** | **(3)** | **23.** | **(4)** | **31.** | **(3)** | **39.** | **(2)** | **47.** | **(4)** | **55.** | **(2)** | | |
| **8.** | **(2)** | **16.** | **(4)** | **24.** | **(1)** | **32.** | **(2)** | **40.** | **(4)** | **48.** | **(2)** | **56.** | **(1)** | | |

### INTEGER TYPE QUESTIONS (61 TO 75)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **61.** | **(30)** | **63.** | **(3)** | **65.** | **(1)** | **67.** | **(350)** | **69.** | **(45)** | **71.** | **(100)** | **73.** | **(72)** | **75.** | **(325)** |
| **62.** | **(260)** | **64.** | **(150)** | **66.** | **(50)** | **68.** | **(93)** | **70.** | **(2)** | **72.** | **(210)** | **74.** | **(293)** | | |

## 11. ELECTROCHEMISTRY

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (1) | 9. | (2) | 17. | (1) | 25. | (4) | 33. | (2) | 41. | (3) | 49. | (3) | 57. | (4) |
| 2. | (4) | 10. | (1) | 18. | (3) | 26. | (4) | 34. | (1) | 42. | (1) | 50. | (1) | 58. | (2) |
| 3. | (2) | 11. | (4) | 19. | (1) | 27. | (1) | 35. | (4) | 43. | (4) | 51. | (3) | 59. | (2) |
| 4. | (1) | 12. | (1) | 20. | (1) | 28. | (1) | 36. | (3) | 44. | (4) | 52. | (1) | 60. | (4) |
| 5. | (2) | 13. | (3) | 21. | (4) | 29. | (3) | 37. | (2) | 45. | (3) | 53. | (3) | | |
| 6. | (3) | 14. | (4) | 22. | (3) | 30. | (2) | 38. | (3) | 46. | (1) | 54. | (2) | | |
| 7. | (1) | 15. | (4) | 23. | (3) | 31. | (2) | 39. | (4) | 47. | (4) | 55. | (4) | | |
| 8. | (4) | 16. | (1) | 24. | (1) | 32. | (1) | 40. | (3) | 48. | (3) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (120) | 63. | (65) | 65. | (94) | 67. | (193) | 69. | (180) | 71. | (392) | 73. | (20) | 75. | (105) |
| 62. | (3) | 64. | (11) | 66. | (26) | 68. | (31) | 70. | (16) | 72. | (39) | 74. | (54) | | |

## 12. CHEMICAL KINETICS

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (4) | 17. | (2) | 25. | (1) | 33. | (1) | 41. | (1) | 49. | (3) | 57. | (2) |
| 2. | (2) | 10. | (2) | 18. | (4) | 26. | (4) | 34. | (1) | 42. | (1) | 50. | (4) | 58. | (4) |
| 3. | (2) | 11. | (3) | 19. | (3) | 27. | (2) | 35. | (4) | 43. | (3) | 51. | (1) | 59. | (1) |
| 4. | (2) | 12. | (4) | 20. | (3) | 28. | (1) | 36. | (4) | 44. | (2) | 52. | (3) | 60. | (4) |
| 5. | (4) | 13. | (1) | 21. | (1) | 29. | (3) | 37. | (3) | 45. | (3) | 53. | (2) | | |
| 6. | (3) | 14. | (1) | 22. | (1) | 30. | (3) | 38. | (3) | 46. | (1) | 54. | (3) | | |
| 7. | (3) | 15. | (1) | 23. | (4) | 31. | (1) | 39. | (4) | 47. | (4) | 55. | (4) | | |
| 8. | (4) | 16. | (2) | 24. | (2) | 32. | (1) | 40. | (3) | 48. | (1) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (11) | 63. | (2) | 65. | (2) | 67. | (2) | 69. | (30) | 71. | (20) | 73. | (32) | 75. | (0) |
| 62. | (15) | 64. | (80) | 66. | (80) | 68. | (3) | 70. | (2) | 72. | (100) | 74. | (1) | | |

## 13. THE p-BLOCK ELEMENTS (GROUP 13 TO 18)

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (1) | 9. | (2) | 17. | (3) | 25. | (1) | 33. | (4) | 41. | (2) | 49. | (3) | 57. | (1) |
| 2. | (2) | 10. | (2) | 18. | (4) | 26. | (1) | 34. | (2) | 42. | (1) | 50. | (4) | 58. | (3) |
| 3. | (3) | 11. | (1) | 19. | (4) | 27. | (1) | 35. | (3) | 43. | (3) | 51. | (1) | 59. | (3) |
| 4. | (4) | 12. | (4) | 20. | (2) | 28. | (4) | 36. | (4) | 44. | (3) | 52. | (3) | 60. | (3) |
| 5. | (3) | 13. | (1) | 21. | (1) | 29. | (4) | 37. | (1) | 45. | (3) | 53. | (2) | | |
| 6. | (4) | 14. | (3) | 22. | (2) | 30. | (1) | 38. | (4) | 46. | (2) | 54. | (1) | | |
| 7. | (4) | 15. | (1) | 23. | (3) | 31. | (2) | 39. | (1) | 47. | (4) | 55. | (1) | | |
| 8. | (4) | 16. | (2) | 24. | (1) | 32. | (4) | 40. | (4) | 48. | (4) | 56. | (4) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (3) | 63. | (3) | 65. | (2) | 67. | (5) | 69. | (3) | 71. | (2) | 73. | (6) | 75. | (26) |
| 62. | (2) | 64. | (3) | 66. | (2) | 68. | (5) | 70. | (4) | 72. | (2) | 74. | (21) | | |

## 14. THE d- AND f- BLOCK ELEMENTS & QUALITATIVE ANALYSIS

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (3) | 17. | (1) | 25. | (3) | 33. | (1) | 41. | (1) | 49. | (2) | 57. | (3) |
| 2. | (4) | 10. | (1) | 18. | (2) | 26. | (1) | 34. | (2) | 42. | (4) | 50. | (2) | 58. | (1) |
| 3. | (1) | 11. | (4) | 19. | (1) | 27. | (1) | 35. | (4) | 43. | (4) | 51. | (1) | 59. | (4) |
| 4. | (1) | 12. | (3) | 20. | (1) | 28. | (1) | 36. | (3) | 44. | (3) | 52. | (1) | 60. | (3) |
| 5. | (1) | 13. | (2) | 21. | (3) | 29. | (1) | 37. | (3) | 45. | (1) | 53. | (2) | | |
| 6. | (1) | 14. | (3) | 22. | (2) | 30. | (1) | 38. | (1) | 46. | (1) | 54. | (2) | | |
| 7. | (3) | 15. | (2) | 23. | (3) | 31. | (1) | 39. | (2) | 47. | (3) | 55. | (1) | | |
| 8. | (1) | 16. | (2) | 24. | (1) | 32. | (1) | 40. | (2) | 48. | (2) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (3) | 63. | (3) | 65. | (22) | 67. | (4) | 69. | (3) | 71. | (9) | 73. | (50) | 75. | (46) |
| 62. | (3) | 64. | (79) | 66. | (22) | 68. | (6) | 70. | (3) | 72. | (2) | 74. | (3) | | |

## 15. COORDINATION COMPOUNDS

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (1) | 9. | (2) | 17. | (3) | 25. | (2) | 33. | (4) | 41. | (4) | 49. | (3) | 57. | (1) |
| 2. | (1) | 10. | (3) | 18. | (3) | 26. | (2) | 34. | (1) | 42. | (1) | 50. | (2) | 58. | (2) |
| 3. | (3) | 11. | (2) | 19. | (4) | 27. | (3) | 35. | (4) | 43. | (4) | 51. | (3) | 59. | (2) |
| 4. | (3) | 12. | (1) | 20. | (4) | 28. | (4) | 36. | (1) | 44. | (1) | 52. | (1) | 60. | (3) |
| 5. | (1) | 13. | (1) | 21. | (4) | 29. | (2) | 37. | (2) | 45. | (2) | 53. | (2) | | |
| 6. | (2) | 14. | (1) | 22. | (3) | 30. | (1) | 38. | (3) | 46. | (4) | 54. | (1) | | |
| 7. | (2) | 15. | (4) | 23. | (3) | 31. | (3) | 39. | (3) | 47. | (1) | 55. | (4) | | |
| 8. | (3) | 16. | (1) | 24. | (1) | 32. | (2) | 40. | (4) | 48. | (3) | 56. | (2) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (1) | 63. | (4) | 65. | (1) | 67. | (3) | 69. | (4) | 71. | (5) | 73. | (240) | 75. | (6) |
| 62. | (2) | 64. | (4) | 66. | (1) | 68. | (3) | 70. | (4) | 72. | (3) | 74. | (2) | | |

## 16. HALOALKANES AND HALOARENES

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (3) | 17. | (4) | 25. | (2) | 33. | (1) | 41. | (3) | 49. | (2) | 57. | (2) |
| 2. | (3) | 10. | (1) | 18. | (4) | 26. | (1) | 34. | (3) | 42. | (3) | 50. | (1) | 58. | (1) |
| 3. | (2) | 11. | (4) | 19. | (3) | 27. | (1) | 35. | (3) | 43. | (3) | 51. | (2) | 59. | (1) |
| 4. | (2) | 12. | (4) | 20. | (3) | 28. | (1) | 36. | (2) | 44. | (4) | 52. | (3) | 60. | (2) |
| 5. | (2) | 13. | (1) | 21. | (1) | 29. | (4) | 37. | (2) | 45. | (1) | 53. | (2) | | |
| 6. | (1) | 14. | (2) | 22. | (4) | 30. | (2) | 38. | (1) | 46. | (2) | 54. | (3) | | |
| 7. | (1) | 15. | (4) | 23. | (4) | 31. | (4) | 39. | (2) | 47. | (2) | 55. | (2) | | |
| 8. | (3) | 16. | (2) | 24. | (1) | 32. | (4) | 40. | (2) | 48. | (3) | 56. | (4) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (6) | 63. | (67) | 65. | (2) | 67. | (4) | 69. | (4) | 71. | (4) | 73. | (4) | 75. | (7) |
| 62. | (3) | 64. | (204) | 66. | (5) | 68. | (2) | 70. | (4) | 72. | (3) | 74. | (4) | | |

## 17. ALCOHOLS, PHENOLS AND ETHERS

### SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (2) | 9. | (2) | 17. | (1) | 25. | (2) | 33. | (2) | 41. | (1) | 49. | (2) | 57. | (4) |
| 2. | (1) | 10. | (1) | 18. | (2) | 26. | (3) | 34. | (2) | 42. | (4) | 50. | (4) | 58. | (1) |
| 3. | (4) | 11. | (2) | 19. | (3) | 27. | (3) | 35. | (2) | 43. | (2) | 51. | (2) | 59. | (3) |
| 4. | (4) | 12. | (4) | 20. | (2) | 28. | (1) | 36. | (4) | 44. | (2) | 52. | (4) | 60. | (2) |
| 5. | (4) | 13. | (2) | 21. | (2) | 29. | (1) | 37. | (2) | 45. | (1) | 53. | (2) | | |
| 6. | (3) | 14. | (1) | 22. | (4) | 30. | (3) | 38. | (2) | 46. | (1) | 54. | (3) | | |
| 7. | (2) | 15. | (1) | 23. | (2) | 31. | (4) | 39. | (1) | 47. | (3) | 55. | (3) | | |
| 8. | (1) | 16. | (3) | 24. | (1) | 32. | (4) | 40. | (3) | 48. | (1) | 56. | (4) | | |

### INTEGER TYPE QUESTIONS (61 TO 75)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (60) | 63. | (3) | 65. | (12) | 67. | (5) | 69. | (78) | 71. | (88) | 73. | (3) | 75. | (5) |
| 62. | (3) | 64. | (5) | 66. | (23) | 68. | (32) | 70. | (3) | 72. | (3) | 74. | (88) | | |

## 18. ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

### SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (3) | 17. | (2) | 25. | (3) | 33. | (2) | 41. | (4) | 49. | (2) | 57. | (2) |
| 2. | (3) | 10. | (3) | 18. | (4) | 26. | (3) | 34. | (4) | 42. | (3) | 50. | (3) | 58. | (2) |
| 3. | (1) | 11. | (2) | 19. | (3) | 27. | (1) | 35. | (3) | 43. | (3) | 51. | (1) | 59. | (4) |
| 4. | (3) | 12. | (1) | 20. | (1) | 28. | (1) | 36. | (1) | 44. | (4) | 52. | (2) | 60. | (1) |
| 5. | (1) | 13. | (1) | 21. | (3) | 29. | (2) | 37. | (1) | 45. | (2) | 53. | (4) | | |
| 6. | (3) | 14. | (3) | 22. | (1) | 30. | (1) | 38. | (1) | 46. | (4) | 54. | (1) | | |
| 7. | (1) | 15. | (2) | 23. | (2) | 31. | (1) | 39. | (3) | 47. | (2) | 55. | (1) | | |
| 8. | (3) | 16. | (1) | 24. | (2) | 32. | (1) | 40. | (4) | 48. | (1) | 56. | (3) | | |

### INTEGER TYPE QUESTIONS (61 TO 75)

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (3) | 63. | (82) | 65. | (103) | 67. | (110) | 69. | (60) | 71. | (96) | 73. | (4) | 75. | (2) |
| 62. | (100) | 64. | (1) | 66. | (1) | 68. | (3) | 70. | (2) | 72. | (1) | 74. | (3) | | |

## 19. AMINES

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (4) | 9. | (4) | 17. | (3) | 25. | (3) | 33. | (2) | 41. | (1) | 49. | (1) | 57. | (1) |
| 2. | (1) | 10. | (1) | 18. | (2) | 26. | (2) | 34. | (2) | 42. | (3) | 50. | (4) | 58. | (3) |
| 3. | (1) | 11. | (2) | 19. | (2) | 27. | (4) | 35. | (1) | 43. | (1) | 51. | (1) | 59. | (1) |
| 4. | (3) | 12. | (1) | 20. | (4) | 28. | (2) | 36. | (3) | 44. | (4 | 52. | (2) | 60. | (4) |
| 5. | (2) | 13. | (3) | 21. | (2) | 29. | (3) | 37. | (2) | 45. | (1) | 53. | (3) | | |
| 6. | (3) | 14. | (4) | 22. | (4) | 30. | (3) | 38. | (4) | 46. | (3) | 54. | (1) | | |
| 7. | (2) | 15. | (1) | 23. | (2) | 31. | (4) | 39. | (1) | 47. | (2) | 55. | (3) | | |
| 8. | (3) | 16. | (1) | 24. | (2) | 32. | (4) | 40. | (1) | 48. | (1) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (28) | 63. | (3) | 65. | (3) | 67. | (75) | 69. | (78) | 71. | (5) | 73. | (93) | 75. | (1) |
| 62. | (1) | 64. | (1) | 66. | (5) | 68. | (94) | 70. | (99) | 72. | (4) | 74. | (20) | | |

## 20. BIOMOLECULES

*SINGLE OPTION CORRECT TYPE QUESTIONS (01 TO 60)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | (1) | 9. | (4) | 17. | (4) | 25. | (2) | 33. | (2) | 41. | (2) | 49. | (2) | 57. | (4) |
| 2. | (1) | 10. | (3) | 18. | (4) | 26. | (2) | 34. | (3) | 42. | (3) | 50. | (1) | 58. | (3) |
| 3. | (1) | 11. | (3) | 19. | (4) | 27. | (2) | 35. | (3) | 43. | (3) | 51. | (1) | 59. | (1) |
| 4. | (2) | 12. | (3) | 20. | (2) | 28. | (3) | 36. | (3) | 44. | (1) | 52. | (2) | 60. | (3) |
| 5. | (3) | 13. | (2) | 21. | (1) | 29. | (1) | 37. | (2) | 45. | (3) | 53. | (1) | | |
| 6. | (1) | 14. | (4) | 22. | (4) | 30. | (3) | 38. | (2) | 46. | (4) | 54. | (4) | | |
| 7. | (1) | 15. | (2) | 23. | (1) | 31. | (4) | 39. | (3) | 47. | (3) | 55. | (1) | | |
| 8. | (1) | 16. | (1) | 24. | (1) | 32. | (2) | 40. | (1) | 48. | (4) | 56. | (1) | | |

*INTEGER TYPE QUESTIONS (61 TO 75)*

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 61. | (6) | 63. | (4) | 65. | (3) | 67. | (3) | 69. | (3) | 71. | (2) | 73. | (4) | 75. | (4) |
| 62. | (4) | 64. | (4) | 66. | (11) | 68. | (6) | 70. | (2) | 72. | (8) | 74. | (8) | | |

# Hints & Solutions

# STOICHIOMETRY AND REDOX REACTIONS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** Let original sample weighs x g

water = $\frac{12}{100}$x, silica = $\frac{45}{100}$x

Impurities = $\frac{43}{100}$x

Let Partially dried sample weighs y g

Water = $\frac{8}{100}$ y

Since no evaporation of silica & impurities. So,

$\frac{45}{100}x + \frac{43}{100}x = \frac{92}{100}y \Rightarrow x = \frac{92}{88}y$

% of silica in partially dried sample = $\frac{\frac{45}{100}\times x}{y}$ × 100 = 47%

**2.** **(1)**

**Sol:** Molar mass of mixture will be

$M_{mix} = \frac{n\times \text{Molar mass of } CH_4 + n\times \text{Molar mass of } C_2H_6}{n+n}$

$M_{mix} = \frac{n(16+30)}{2n} = 23$

Vapour density $\Rightarrow \frac{M_{mix}}{2} = \frac{23}{2} = 11.5$

**3.** **(1)**

**Sol:** $C_X H_Y + O_2 \longrightarrow CO_2 + H_2O$

6g excess

mass of Hydrocarbon = 6 g

mass of carbon = $\frac{12}{44}$ ×mass of $CO_2 = \frac{12}{44} \times 17.6$ = 4.8 g

mass of Hydrogen = $\frac{2}{18}$ × mass of $H_2O$ = $\frac{2}{18}$ × 10.8 = 1.2 g.

Total mass of carbon & Hydrogen = 4.8 + 1.2 = 6 g.

Mass of Hydrocarbon = Total mass of (C + H) = 6 g.

Law of conservation of mass.

**4.** **(1)**

**Sol:** (1) No. of atom of ($C_4H_{10}$) = $\frac{1}{58}$ × 14 $N_a$

(2) No. of atom of ($N_2$) = $\frac{1}{28}$ × 2 $N_a$

(3) No. of atom of (Ag) = $\frac{1}{108}$ × 2 $N_a$

(4) No. of atom of water = $\frac{1}{18}$ × 3 $N_a$

Hence greatest No. of atom = $C_4H_{10}$

**5.** **(4)**

**Sol:** $\frac{4.4}{x} = \frac{2.24}{22.4}$ (where x is mol. wt of gas)

x = 4.4 × 10

x = 44 ($N_2O$ and $CO_2$ both gases may be possible).

**6.** **(1)**

**Sol:** 14 g $N^{3-}$ ions have =8$N_A$ valence electrons

4.2 g of $N^{3-}$ ions have $= \frac{8N_A \times 4.2}{14} = 2.4N_A$

**7.** **(2)**

**Sol:** $n = \frac{M.F.M}{E.F.M} = \frac{120}{30}$

$\Rightarrow n = 4$

$\Rightarrow M.F = n \times CH_2O$

$= 4 \times CH_2O$

$= C_4H_8O_2$

**8.** **(1)**

**Sol:** Urea- $NH_2 - CO - NH_2$

$\because$ 60 g of urea contains 28 g of nitrogen

$\therefore$ 100 g of urea contains

$\frac{28}{60} \times 100 = 46.66\,\%$ Nitrogen

**9.** **(4)**

**Sol:** $C_xH_y + O_2 \longrightarrow CO_2 + H_2O$

POAC on C

$x \times \frac{500}{22400} = 1 \times \frac{2.5}{22.4}$

$x = 5$

POAC on H

$y \times \frac{500}{22400} = 2 \times \frac{3}{22.4}$

$y = 12$

Hence hydrocarbon is $C_5H_{12}$.

**10.** **(4)**

**Sol:** On balancing the reaction,

$C_4H_{10} + \frac{13}{2} O_2 \longrightarrow 4CO_2 + 5H_2O$

$\frac{\text{Mole of } C_4H_{10}}{1} = \frac{\text{Mole of } CO_2}{4 \times 1}$

Hence mole of $CO_2 = 4 \times$ mole of $C_4H_{10}$

$4 \times 0.15 = 0.60$.

**11.** **(2)**

**Sol:** $A + 2B \rightarrow C$

5 8

$\frac{5}{1}$ $\frac{8}{2}$ (B is L.R)

From mole–mole analysis

$\frac{8}{2} = \frac{n_C}{1}$

$n_C = 4$ mole of C.

**12.** **(1)**

**Sol:** LR $\rightarrow$ HCl, so Mole of $H_2 = \frac{\text{Mole of HCl}}{2}$

$= \frac{0.52}{2} = 0.26$

**13.** **(3)**

**Sol:** $M_{final} = \frac{M_1V_1 + M_2V_2}{V_1 + V_2 + V_{water}}$ ; $0.25 = \frac{0.6 \times 250 + 0.2 \times 750}{250 + 750 + V_{water}}$

So, $V_{water} = 200$ ml.

**14.** **(1)**

**Sol:** Total mass of solution = (15 + 35) gram = 50 gram

mass percentage of methyl alcohol

$= \frac{\text{Mass of methyl alcohol}}{\text{Mass of solution}} \times 100 = \frac{15}{50} \times 100 = 30\%$

**15.** **(3)**

**Sol:** $2(+2) + 2x + 7(-2) = 0$

$\therefore \quad x = +5$

**16.** **(4)**

**Sol:** $Br_2$ undergoes disproportionation, i.e. it undergoes both oxidation & reduction.

**17.** **(4)**

**Sol:** In 4th reaction, N undergoes oxidation while Cr undergoes reduction.

**18.** **(2)**

**Sol:** In $H_2O_2$ oxidation state of oxygen is –1.

It can undergo both oxidation as well as reduction

$O^- - e^- \rightarrow O$ (Oxidation)

$O^- + e^- \rightarrow O^{2-}$ (reduction)

Hence it can act both as oxidizing as well as reducing agent.

**19. (2)**

**Sol:** For equal number of sulphate ion in both ferrous and ferric sulphate, we have

$$\frac{Fe^{2+}}{Fe^{3+}} = \frac{1}{2/3}$$

$$\Rightarrow \frac{Fe^{2+}}{Fe^{3+}} = \frac{3}{2}.$$

**20. (3)**

**Sol:** $\frac{\text{mole of H atom}}{\text{mole of O atom}} = \frac{12}{4}$

$$\Rightarrow \text{mole of O atom} = \frac{\text{mole of H atom}}{3}$$

$$\Rightarrow \text{mole of O atom} = \frac{3.18}{3}$$

mole of O atom = 1.06

**21. (4)**

**Sol:** The molecular formula for isobutane & butane is same. that is $C_4H_{10}$.

$$C_4H_{10} + \frac{13}{2} O_2 \rightarrow 4CO_2 + 5H_2O$$

$$1 \text{ Kg } C_4H_{10} = \frac{1000}{58} = 17.24 \text{ moles}$$

$$\text{Moles of } O_2 \text{ required} = 17.24 \times \frac{13}{2}$$

$$\text{Mass of } O_2 \text{ in Kg} = 17.24 \times \frac{13}{2} \times \frac{32}{1000}$$

= 3.58

**22. (1)**

**Sol:** $2VO + 3Fe_2O_3 \longrightarrow 6FeO + V_2O$

Mole $\frac{6.7}{67} = 0.1$ $\quad \frac{4.8}{160} = 0.03$

$\frac{0.1}{2}$ $\frac{0.03}{3}$ ($Fe_2O_3$ is L.R)

mole-mole analysis

$\frac{0.03}{3} = \frac{n_{FeO}}{6}$ (Here n = mole)

$n_{FeO} = 0.01 \times 6$

= 0.06

Mass of FeO = 0.06 × 72 = 4.32 g.

**23. (2)**

**Sol:** (I) 100 g solution contains 40 g NaOH

∴ 50 g solution contains 20 g NaOH

(II) 100 mL solution contains 50 g NaOH

∴ 50 mL solution contains 25 g NaOH

(III) 1000 mL solution contains (15 × 40) g NaOH

∴ 50 g solution contains $\left(\frac{15 \times 40 \times 50}{1000 \times 1}\right)$g

NaOH = 30 g NaOH

**24. (1)**

**Sol:** Let W g water is added to 16 g $CH_3OH$

$$\text{molality} = \frac{16 \times 1000}{W \times 32} = \frac{500}{W}$$

$$\frac{500}{W} = \frac{x_A \times 1000}{(1 - x_A)m_B} = \frac{0.25 \times 1000}{0.75 \times 18}$$

W = 27 g

**25. (3)**

**Sol:** For a completely balanced equation, net charge on reactant side & product side must be equal.

–1 + 4 + x (–1) = 0

x = +3

**26. (1)**

**Sol:** Molar mass = 108 g/mole

| Element | Wt. Ratio | Wt. ratio/Atomic mass | Simple Ratio | Simple Integer ratio |
|---|---|---|---|---|
| C | 9 x | $\frac{9x}{12} = \frac{3x}{4}$ | 3 | 3 |
| H | 1 x | x | 4 | 4 |
| N | 3.5 x | $\frac{3.5x}{14} = \frac{x}{4}$ | 1 | 1 |

∴ $C_3H_4N$

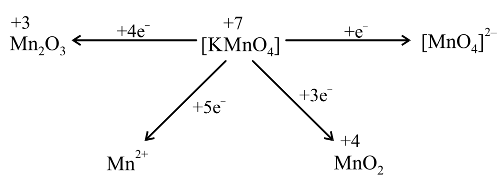
Empirical mass = 12 × 3 + 4 + 14 = 54

$$n = \frac{108}{54} = 2$$

∴ Molecular Formula = $C_6H_8N_2$

**27. (3)**

**Sol:**



**28.** **(2)**

**Sol:** $\text{Molarity} = \dfrac{\text{Moles of solute}}{\text{Vol. of solution (in L)}}$

$= \dfrac{6.02 \times 11^{20} / 6.02 \times 10^{23}}{100/1000} = 0.01\text{ M}$

**29.** **(2)**

**Sol:** $\text{Final Molarity} = \dfrac{M_1V_1 + M_2V_2}{V_1 + V_2}$

$= \dfrac{1.5 \times 480 + 1.2 \times 520}{480 + 520} = 1.344\text{ M}$

**30.** **(2)**

**Sol:** 8 moles of O-atom are contained by 1 mole $Mg_3(PO_4)_2$.

Hence, 0.25 moles of O-atom = $\dfrac{1}{8} \times 0.25$

$= 3.125 \times 10^{-2}$ mole $Mg_3(PO_4)_2$.

**31.** **(3)**

**Sol:** $\text{molality (m)} = \dfrac{M}{1000d - MM_1} \times 1000$

M = Molarity

$M_1$ = Molecular mass of solute

d = density

$= \dfrac{2.05}{(1000 \times 1.02) - (2.05 \times 60)} \times 1000 = 2.28\text{ mol kg}^{-1}$

**32.** **(4)**

**Sol:** $2Al(s) + 6HCl(aq) \longrightarrow 2Al^{3+}(aq) + 6Cl^{-}(aq) + 3H_2(g)$

3 mole $H_2$ from 6 mole HCl consumed.

∴ 1 mole $H_2$ from 2 mole HCl consumed.

1/2 mole (11.2 Lit) $H_2$ from 1 mole HCl consumed.

**33.** **(1)**

**Sol:** 3.6 M solution means 3.6 mole of $H_2SO_4$ is present in 1000 mL of solution

∴ Mass of 3.6 moles of $H_2SO_4$ is = 3.6 × 98 g = 352.8 g

∴ Mass of $H_2SO_4$ in 1000 ml of solution = 352.8 g

Given, 29g of $H_2$ $SO_4$ is present in 100 g of solution

∴ 352.8 g of $H_2SO_4$ is present in $\left(\dfrac{100}{29} \times 352.8\right)$ g of solution

Now density = $\dfrac{\text{Mass}}{\text{Volume}} = \dfrac{100 \times 352.8}{29 \times 1000} = 1.22$ g/mL

**34.** **(3)**

**Sol:** $X_{\text{Methyl alcohol}} = \dfrac{5.2}{5.2 + \dfrac{1000}{18}} = 0.086$

**35.** **(4)**

**Sol:** $\text{Molarity} = \dfrac{\text{mols of solute}}{\text{volume of sol. (in L)}}$

$= \dfrac{120 \times 1.15}{60 \times 1120} \times 1000 = 2.05\text{ M}$

**36.** **(3)**

**Sol:**

$$\underset{vf=5}{MnO_4^-} + \underset{vf=2}{C_2O_4^{2-}} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

Balanced Equation:

$2MnO_4^- + 5C_2O_4^{2-} + 16\,H^+ \longrightarrow 2Mn^{2+} + 10\,CO_2 + 8H_2O$

So, x = 2, y = 5 & z = 16.

**37.** **(4)**

**Sol:** $H_2O_2$ acts as reducing agent when it releases electrons.

i.e. (b) & (d)

**38.** **(2)**

**Sol:** $\dfrac{n_{O_2}}{n_{N_2}} = \dfrac{\dfrac{(m_{O_2})}{(M_{O_2})}}{\dfrac{(m_{N_2})}{(M_{N_2})}} = \left(\dfrac{m_{O_2}}{m_{N_2}}\right)\dfrac{28}{32} = \dfrac{1}{4} \times \dfrac{28}{32} = \dfrac{7}{32}$

**39.** **(2)**

**Sol:** 75 kg person contain 10% hydrogen i.e. 7.5 kg Hydrogen.

If all H atom are replaced by $^2H$, the weight of Hydrogen become twice i.e. it increases by 7.5 kg.

**40. (1)**

**Sol:** $n_A = 0.1$, $n_B = 1$, $n_C = 0.036$

Limiting reagent = C

$\Rightarrow n_{AB_2C_3}$ formed $= \dfrac{0.036}{3} = 0.012$

$\Rightarrow MM_{(AB_2C_3)} = \dfrac{4.8}{0.012} = 400$

$\Rightarrow 60 + 2x + 80 \times 3 = 400$

$x = 50$

**41. (4)**

**Sol:** $C_nH_{2n+2} + \left(\dfrac{3n+1}{2}\right) O_2 \longrightarrow nCO_2 + (n+1)\, H_2O$

5 L 25 L

Since volumes are measured at constant T & P

So, Volume $\propto$ mole

$\therefore\ n_{alkane} = \left(\dfrac{3n+1}{2}\right) \times n_{O_2}$

$5 = \dfrac{3n+1}{2} \times 25$

$\therefore\ n = 3$

$\therefore$ Alkane is propane ($C_3H_8$).

**42. (2)**

**Sol:** 8 g sulphur present in = 100 g of organic compound.

$\therefore$ 32 g sulphur present in $= \dfrac{100}{8} \times 32$

= 400 g of organic compound.

Hence, minimum molecular weight of compound = 400 g/mol

**43. (3)**

**Sol:** In $MnO_4^-$ & $[Cu(CN)_4]^{2-}$, Mn & Cu are in their highest stable oxidation state. i.e +7 and +2 respectively.

**44. (3)**

**Sol:** $\% \text{ of Na} = \dfrac{\text{mass of sodium}}{\text{molecular mass}} \times 100$

$\Rightarrow 7 = \dfrac{23}{M} \times 100$

$M = \dfrac{23 \times 100}{7} = 328.57$ g/mol

**45. (3)**

**Sol:** Mass of NaCl = $10 \times 0.96 = 9.6$ g

moles of NaCl $= \dfrac{9.6}{58.5}$

no. of molecules of NaCl $= \dfrac{9.6}{58.5} \times 6.023 \times 10^{23}$

$\simeq 10^{23}$

**46. (1)**

**Sol:** 1. It is a fact.

2. $2H_2 + O_2 \longrightarrow 2H_2O$

Initial mole 2 3 0

Final mole 0 3-1 =2 2

3. $C + O_2 \longrightarrow CO_2$

$\dfrac{w}{12}$ $\dfrac{w}{32}$

Here C is limiting reagent.

**47. (2)**

**Sol:**

Reduction

$BiO_3^- + Mn^{2+} \longrightarrow Bi^{3+} + MnO_4^-$

Oxidation

(i) $2e^- + 6H^+ + BiO_3^- \longrightarrow Bi^{3+} + 3H_2O$

(ii) $4H_2O + Mn^{2+} \longrightarrow MnO_4^- + 8H^+ + 5e^-$

---

(i) × 5 + (ii) × 2, we get $14\,H^+ + 5\,BiO_3^- + 5Mn^{2+} \longrightarrow 5Bi^{3+} + 2MnO_4^- + 7\,H_2O$

Hence, (2) is the correct balanced reaction.

**48. (4)**

**Sol:** Explanation: Mol. wt. of $NaNO_3 = 85$

70 mg of $Na^+$ are present in 1 mL

50 mL of solution contains $50 \times 70 = 3500$ mg = 3.5 g $Na^+$ ion

23 g of $Na^+$ are present in 85 g of $NaNO_3$

3.5 g of $Na^+$ are present in $\dfrac{85}{23} \times 3.5 = 12.934$ g of $NaNO_3$

**49.** **(3)**

**Sol:** At 4ºC i.e. 277 K density of water = 1 g/ml

∴ 1 kg water ⇒ 1000 ml water = 1 lit.

∴ Molality & molarity remains same.

**50.** **(3)**

**Sol:** Mole of NaCl = $\frac{5.85}{58.5} = 0.1$

Molarity = $\frac{0.1}{1} = 0.1$ M

Moles in 1 ml of solution = MV = $0.1 \times 10^{-3} = 10^{-4}$ mole.

Number of ions in 1 ml = $2 \times 10^{-4} \times 6.023 \times 10^{23} = 1.204 \times 10^{20}$.

**51.** **(2)**

**Sol:** Molarity = M

Let volume of be 1 ltr.

∴ mass of solvent = 1000 d – M × $M_2$

Molality = m = $\frac{M}{1000d - MM_2} \times 1000$

**52.** **(1)**

**Sol:** $C + O_2 \xrightarrow{\Delta} CO_2$

12g C requires 22.4 L $O_2$ at STP

∴ 1000 g C = $\frac{22.4}{12} \times 1000$

or 1866.67 L $O_2$.

**53.** **(2)**

**Sol:** $KClO_3 \rightarrow KCl + O_2$

Applying POAC for O atoms in the eqn.(i),

moles of O in $KClO_3$ = moles of O in $O_2$

3 × moles of $KClO_3$ = 2 × moles of $O_2$

$3 \times \frac{\text{wt.of } KClO_3}{\text{mol.wt.of } KClO_3}$

$= 2 \times \frac{\text{volume of } O_2 \text{ at NTP(mL)}}{22400}$

Wt. of $KClO_3 = \frac{2 \times 146.8 \times 122.5}{3 \times 22400}$

= 0.5352 g.

In the second reaction:

The amount of $KClO_3$ left = 1 – 0.5352

= 0.4648 g.

We have, $KClO_3 \rightarrow KClO_4 + KCl$

0.4648 g.

Applying POAC for O atoms,

moles of O in $KClO_3$ = moles of $KClO_4$

3 × moles of $KClO_3$ = 4 × moles of $KClO_4$

$3 \times \frac{\text{wt.of } KClO_3}{\text{mol.wt.of } KClO_3}$

$= 4 \times \frac{\text{wt.of } KClO_4}{\text{mol.wt.of } KClO_4}$

Wt. of $KClO_4 = \frac{3 \times 0.4648 \times 138.5}{122.5 \times 4} = 0.3941$ g.

......(ii)

Wt. of residue = 1 – wt. of Oxygen

$= 1 - \frac{146.8}{22400} \times 32$ g = 0.7903 g.

∴ % of $KClO_4$ in the residue = $\frac{0.3941}{0.7903} \times 100$

= 49.87%.

**54.** **(1)**

**Sol:** Consider that mass of NaCl = xg

∴ Moles of NaCl will be = $\frac{x}{58.5}$ and Moles of KCl will be = $\frac{64 - x}{74.5}$

By using POAC for Na and K

∵ Moles of NaCl × 1 = Moles of $Na_2SO_4$ × 2

or Moles of $Na_2SO_4$ = Moles of NaCl × $\frac{1}{2}$

∵ Moles of KCl × 1 = Moles of $K_2SO_4$ × 2

or Moles of $K_2SO_4$ = Moles of KCl × $\frac{1}{2}$

Total weight of $Na_2SO_4$ and $K_2SO_4$ is 76 g

Hence $\frac{1}{2} \times \frac{x}{58.5} \times 142 + \frac{1}{2} \times \frac{64 - x}{74.5} \times 174 = 76$

⇒ x = 27.495

% mass of NaCl = $\frac{27.495}{64} \times 100 = 42.96\%$

**55. (4)**

**Sol:** Moles of $Al_2(SO_4)_3$ = M × V = 0.15 × 0.1 = 0.015

Mass of $Al_2(SO_4)_3$ = Mole × Molar mass = 0.015 × 342 = 5.13 g.

Moles of $Al^{3+}$ = 2 × moles of $Al_2(SO_4)_3$ = 2 × 0.015 = 0.03.

No. of $Al^{3+}$ ions = 0.03 × 6.023 × $10^{23}$ = 1.81 × $10^{22}$ ions.

**56. (1)**

**Sol:** No. of carbon atom in glucose = $\frac{1.71}{342} \times 12\ N_a$

$= 3.6 \times 10^{22}$

**57. (2)**

**Sol:** When O. No. decreases i.e. reduced or oxidizing agent.

**58. (2)**

**Sol:** $Fe_3O_4$ can be written as $FeO{\cdot}Fe_2O_3$

$KMnO_4$ oxidises $Fe^{2+}$ to $Fe^{3+}$

**59. (1)**

**Sol:** $2A + 3B \longrightarrow X + 2Y$

2 1 0 0

$\frac{2}{2}$ $\frac{1}{3}$ (L.R.)

$\frac{4}{3}$ 0 $\frac{1}{3}$ $\frac{2}{3}$

**60. (3)**

**Sol:** (I) $[Cl^-] = \frac{50\times3+150\times1\times3}{200} = \frac{600}{200} = 3$ M

(II) molality $= \frac{0.1}{0.9\times18}\times1000 = 6.17$ m

(III) Molality $= \frac{20\times1000}{60\times80} = 4.17$ m (IV)

Molarity of HCl $= \frac{\frac{10.95}{36.5}}{100} \times 1000 = 3$ M

## Integer Type Questions (61 to 75)

**61. (3)**

**Sol:** Gram mol. wt. of $C_6H_{12}O_6$ = 180 g

i.e. wt. of 6.023 × $10^{23}$ molecules of $C_6H_{12}O_6$ = 180 g

So, wt. of 1 molecule of $C_6H_{12}O_6$ = $\frac{180}{6.023\times10^{23}}$ = 2.988 × $10^{-22}$ g.

**62. (9)**

**Sol:** $\frac{\text{wt. of metal hydroxide}}{\text{wt. of metal oxide}} = \frac{EM+EOH^-}{EM+EO^-}$

$= \frac{1.520}{0.995} = \frac{x+17}{x+8} \qquad = 1.520x + 1.520\times8$

$= 0.995x + 0.995\times17$

$1.520x + 12.160 = 0.995x + 16.915$

**or** $0.525x = 4.755$

$x = \frac{4.755}{0.525} = 9$.

**63. (4)**

**Sol:** $194 \times \frac{28.9}{100} = 56.06$ g

No. of Nitrogen = $\frac{56.06}{14} = 4$

**64. (2)**

**Sol:** At NTP, weight of 1 litre gas = 0.178 g

so weight of 22.4 litre gas = weight of 1 mole gas = molar mass of gas = 0.178 × 22.4 gm

vapour denstiy = molar mass of gas / 2

So, V.D. = $\frac{0.178\times22.4}{2}$ = 1.9936 ≈ 2

**65. (5)**

**Sol:** V.D = $\frac{(M.wt)_{(CO)_x}}{2}$

$70 = \frac{28x}{2}$

x = 5

**66. (60)**

**Sol:** $C_2H_4 + 3O_2 \longrightarrow 2CO_2 + 2H_2O$

From Gay lussac's law

$C_2H_4$ & $O_2$ are in 1:3 vol. ratio

i.e $O_2$ will be 60 ml.

**67. (1)**

**Sol:** $M_1V_1 + M_2V_2 = M_R [V_1 + V_2]$

$1 \times 500 + 1 \times 500 = M_R [500 + 500]$

$M_R = 1$.

**68. (5)**

**Sol:** $[Cl^-] = \dfrac{300\times3+200\times4\times2}{500} = \dfrac{2500}{500} = 5$ M

**69. (3)**

**Sol:** Let the oxidation state of Cr is x.

$x + 4(0) + 2(-1) = +1$

$x - 2 = +1$

or, $x = +1 + 2 = +3$.

**70. (875)**

**Sol:** $M_f = \dfrac{M_1V_1 + M_2V_2}{V_1+V_2} = \dfrac{0.5\times\frac{3}{4}+2\times\frac{1}{4}}{1}$

$= 0.875$ M

**71. (567)**

**Sol:** Let the volume of ethanol containing the same number of molecules as are present in 175 ml of $H_2O$ be V ml. As given,

moles of $C_2H_5OH$ in V ml = moles of $H_2O$ in 175 ml

Now, $\dfrac{\text{wt.of } C_2H_5OH}{\text{mol. wt.of } C_2H_5OH} = \dfrac{\text{wt.of } H_2O}{\text{mol. wt.of } H_2O}$

or, $\dfrac{0.789\times V}{46} = \dfrac{1.0\times175}{18}$

$\therefore$ V = 566.82 ml.

**72. (100)**

**Sol:** $0.050 \times 2 = \dfrac{0.10\times2\times V - 50\times0.10\times1}{V+50}$

$\Rightarrow$ V = 100 mL

**73. (18)**

$2Al + \frac{3}{2}O_2 \longrightarrow Al_2O_3$

From mole-mole analysis

$\dfrac{n_{Al}}{2} = \dfrac{n_{O_2}}{3/2}$ (here n= mole)

$n_{Al} = \dfrac{2}{3}$

$mass_{Al} = \dfrac{2}{3} \times 27 = 18$ g.

**74. (333)**

**Sol:** $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

Moles of $H_2$ evolved = 2

$\therefore$ Moles of HCl required = 4

$\therefore$ $\dfrac{V\times1.2\times0.365}{36.5} = 4$ ; V = 333.33 ml

**75. (7)**

**Sol:** Let $Ca_3(PO_4)_2$ is x-mole

$H_3PO_3$ is y-mole

Given, $Ca_2(PO_4)_2$ and $H_3PO_3$ contains same number of 'P' atoms.

$\Rightarrow 2x = y \Rightarrow \dfrac{x}{y} = \dfrac{1}{2}$

$\dfrac{\text{moles of 'O' in } Ca_3(PO_4)_2}{\text{moles of 'O' in } H_3PO_3} = \dfrac{8x}{3y} = \dfrac{4}{3}$

# STRUCTURE OF ATOM

## Single Option Correct Type Questions (01 to 60)

**1.** **(2)**

**Sol:** $E = \frac{nhc}{\lambda} \Rightarrow$ **n = 28**

**2.** **(3)**

**Sol:** For photoelectric effect to take place, $E_{light} \geq W$

$\therefore \frac{hc}{\lambda} \geq \frac{hc}{\lambda_0}$ or $\lambda \leq \lambda_0$.

**3.** **(4)**

**Sol:** Power = $\frac{nhC}{\lambda \times t}$

$40 \times \frac{80}{100} = \frac{n \times 6.62 \times 10^{-34} \times 3 \times 10^{8}}{620 \times 10^{-9} \times 20}$

$\Rightarrow$ $n = 2 \times 10^{21}$

**4.** **(2)**

**Sol:** $E_1$ for $Li^{+2}$ = $E_1$ for H × $Z^2$ = $E_1$ for H × 9

$E_1$ for $He^{+}$ = $E_1$ for H × $Z^2_{He}$ = $E_1$ for H × 4

or $E_1$ for $Li^{+2}$ = $\frac{9}{4}E_1$ for $He^{+}$ = $19.6 \times 10^{-18} \times \frac{9}{4} = 44.10 \times 10^{-18}$ J/atom

**5.** **(3)**

**Sol:** $E_n = \frac{-13.6 Z^2}{n^2}$

$E_1 = -13.6Z^2 = 100$ unit

$E_2 = \frac{-13.6\, Z^2}{4} = 25$ unit

**6.** **(2)**

**Sol:** $E_1$ for $Li^{+2}$ = $E_1$ for H × $Z^2$ [for Li, Z = 3]

$= 13.6 \times 9 = 122.4$ eV

**7.** **(3)**

**Sol:** $\frac{1}{\lambda_{lyman}} = R_H\left(\frac{1}{1}\right)$

$\frac{1}{\lambda_{Balmer}} = R_H\left(\frac{1}{4}\right) \Rightarrow \frac{\lambda_{Balmer}}{\lambda_{Lyman}} = 4$

**8.** **(1)**

**Sol:** $mvr = \frac{n\hbar}{2\pi} = \frac{5\hbar}{2\pi} = 2.5\ \frac{\hbar}{\pi}$

**9.** **(1)**

**Sol:** For third line of Brackett series ($4 \to 7$)

$\frac{1}{\lambda} = R\left(\frac{1}{16} - \frac{1}{49}\right) \Rightarrow \lambda = \frac{784}{33R}$

**10.** **(4)**

**Sol:** For 1st line of Balmer series ($3 \to 2$)

$E_3 - E_2 = \frac{hc}{\lambda}$

**11.** **(1)**

**Sol:** For Balmer series ($n_1 = 2$ ; $n_2 = 3, 4.....\infty$)

**12.** **(2)**

**Sol:** $\lambda = \frac{h}{mv}$ **= 1.33 × 10⁻³ Å**

**13.** **(3)**

**Sol:** $\Delta p \cdot \Delta x = \frac{h}{4\pi}$

$\Rightarrow \Delta x = \frac{6.62 \times 10^{-34}}{4 \times 3.14 \times 1 \times 10^{-5}} = 5.27 \times 10^{-30}$ m.

**14.** **(1)**

**Sol:** $\lambda = \dfrac{h}{mv} = 0.416$ nm

**15.** **(1)**

**Sol:** For a charged particle $\lambda = \dfrac{h}{\sqrt{2mqV}}$,

$\therefore \quad \lambda \propto \dfrac{1}{\sqrt{V}}$.

**16.** **(1)**

**Sol:** $\Delta x \,.\, \Delta p \simeq \dfrac{h}{4\pi} \Rightarrow \Delta v = 3.499 \times 10^{-24}\ ms^{-1}$

**17.** **(1)**

**Sol:**
(1) This set of quantum number is permitted.
(2) This set of quantum number is not permitted as value of 's' cannot be zero.
(3) This set of quantum number is not permitted as the value of 'l' cannot be equal to 'n'.
(4) This set of quantum number is not permitted as the value of 'm' cannot be greater than 'l'.

**18.** **(3)**

**Sol:** M- Shell (n = 3) ; maximum no. of electrons in a shell = $2n^2$.

**19.** **(4)**

**Sol:** $n = 4,\ \ell = 2,\ s = -\dfrac{1}{2}$ or $+\dfrac{1}{2}$

**20.** **(1)**

**Sol:** Magnetic moment = $\sqrt{n(n+2)} = \sqrt{24}$ B.M.

$\therefore$ No. of unpaired electron = 4.

$X_{26}$ : $1s^2\ 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$.

To get 4 unpaired electrons, outermost configuration will be $3d^6$.

$\therefore$ No. of electrons lost = 2 (from $4s^2$).

$\therefore$ n = 2.

**21.** **(4)**

**Sol:** For p-subshell, $\ell = 1$.

**22.** **(4)**

**Sol:** For 1st line of Balmer series

$$\bar{v}_1 = R(3)^2\left[\frac{1}{(2)^2} - \frac{1}{(3)^2}\right] = 9R\left(\frac{5}{36}\right) = \frac{5}{4}R$$

For last line of Pachen series

$$\bar{v}_2 = R_H(3)^2\left[\frac{1}{(3)^2} - \frac{1}{\infty}\right] = R$$

so, $\bar{v}_1 - \bar{v}_2 = \dfrac{5R}{4} - R = \dfrac{R}{4}$.

**23.** **(3)**

**Sol:** $\left.\begin{array}{l} n_1 + n_2 = 4 \\ n_1 - n_2 = 2 \end{array}\right\}$ so $n_1 = 3$ and $n_2 = 1$.

**24.** **(2)**

**Sol:** Shortest wave length of Lyman series of H-atom

$$\frac{1}{\lambda} = \frac{1}{x} = R\left[\frac{1}{(1)^2} - \frac{1}{(\infty)^2}\right] \quad \text{so, } x = \frac{1}{R}$$

For Balmes series

$$\frac{1}{\lambda} = R(1)^2\left\{\frac{1}{(2)^2} - \frac{1}{(3)^2}\right\}$$

$$\frac{1}{\lambda} = \frac{1}{x} \times \frac{5}{36} \qquad \text{so,} \qquad \lambda = \frac{36x}{5}$$

**25.** **(4)**

**Sol:** According to energy, $E_{4\to1} > E_{3\to1} > E_{2\to1} > E_{3\to2}$.

According to energy, Violet > Blue > Green > Red.

$\therefore$ Red line $\Rightarrow$ $3 \to 2$ transition.

**26.** **(3)**

**Sol:** $\Delta x = 2\Delta p$

$$\Delta x \,.\, \Delta p = \frac{\hbar}{2} = \frac{h}{4\pi}$$

$$\Rightarrow \quad 2\Delta p \,.\, m\Delta V = \frac{\hbar}{2}$$

$$\Rightarrow \quad (\Delta V)^2 = \frac{\hbar}{4m^2}$$

or $\quad \Delta V = \dfrac{\sqrt{\hbar}}{2m}$.

**27.** **(1)**

**Sol:**
I. $\ell = 0$
O.A.M = 0
II. Possible Atomic number = 11 or 12.
III. Total spin $= \dfrac{+5}{2}$

**28.** **(1)**

**Sol:** $Mn^{2+}$ has the maximum number of unpaired electrons (5) and therefore has maximum magnetic moment.

**29.** **(1)**

**Sol:** $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}\times1000}{60\times10} = 11.05 \times 10^{-34} = 1.105 \times10^{-33}$ metres.

**30.** **(3)**

**Sol:** For $4f$ orbital electrons, n = 4

$\ell = 3 \left(because\ \underset{0}{s}\ \underset{1}{p}\ \underset{2}{d}\ \underset{3}{f}\right)$ m = + 3, + 2, + 1, 0, –1, –2, –3 s = + 1/2.

**31.** **(1)**

**Sol:** For hydrogen the energy order of orbital is

1s < 2s = 2p < 3s = 3p = 3d < 4s = 4p = 4d = $4f$.

**32.** **(1)**

**Sol:** The electron having same principle quantum number and azimuthal quantum number will have the same energy in absence of magnetic and electric field.

(iv) n = 3, l = 2, m =1

(v) n = 3, l = 2, m = 0

have same n and l value.

**33.** **(3)**

**Sol:** According to Heisenberg's uncertainty principle

$$\Delta x \times \Delta p = \frac{h}{4\pi}$$

$$\Delta x \times (m.\Delta v) = \frac{h}{4\pi} \Rightarrow \Delta x = \frac{h}{4\pi m.\Delta v}$$

$$\Delta v = \frac{0.001}{100} \times 300 = 3 \times 10^{-3}\ ms^{-1}$$

$$\therefore\ \ \Delta x = \frac{6.63\times10^{-34}}{4\times3.14\times9.1\times10^{-31}\times3\times10^{-3}}$$

$= 1.92 \times 10^{-2}$m.

**34.** **(4)**

**Sol:** I.E. = $1.312 \times 10^{6}$ J mol$^{-1}$

The energy required to excite the electron in the atom from n = 1 to n = 2.

$$= 1.312 \times 10^{6} \left[1 - \frac{1}{4}\right] = 1.312 \times 10^{6} \times \frac{3}{4}$$

$= 9.84 \times 10^{5}$ J mol$^{-1}$

**35.** **(1)**

**Sol:** As $\lambda = \frac{h}{mv} = \frac{6.63\times10^{-34}}{1.67\times10^{-27}\times1\times10^{3}} = 3.97 \times 10^{-10}$ M = $0.397 \times 10^{-9}$ M = ~ 0.40 nm.

**36.** **(2)**

**Sol:** $\Delta x \times \Delta P = \frac{h}{4\pi}$

$$\Delta x \times [m\Delta v] = \frac{h}{4\pi}$$

$$\Delta v = \frac{600\times0.005}{100} = 0.03$$

$$\text{So}\ \ \Delta x\,[9.1 \times 10^{-31} \times 0.03] = \frac{6.6\times10^{-34}}{4\times3.14}$$

$$\Delta x = \frac{6.6\times10^{-34}}{4\times3.14\times9.1\times0.03\times10^{-31}} = 1.92 \times 10^{-3}\text{M.}$$

**37.** **(4)**

**Sol:** $Cl–Cl(g) \longrightarrow 2Cl(g)$ ; $\Delta H$ = 242 KJ mol

$$= \frac{242\times10^{3}}{6.02\times10^{23}}\ \text{J molecule}^{-1}$$

$$E = \frac{hc}{\lambda}$$

$$\frac{242\times10^{-23}\times10^{3}}{6.02} = \frac{6.6\times10^{-34}\times3\times10^{8}}{\lambda}$$

$$\lambda = \frac{6.6\times10^{-34}\times3\times10^{8}\times6.02}{242\times10^{-23}\times10^{3}} = \frac{6.6\times3\times6.02}{242} \times 10^{-6}$$

$= 0.494 \times 10^{-6}$

$= 494 \times 10^{-9}$ m = 494 nm

**38.** **(2)**

**Sol:** I.E. of H = $2.18 \times 10^{-18}$ J atom$^{-1}$

I.E. = – $E_1$

$E_1$ for $He^{+}$ is = – $19.6 \times 10^{-18}$ J atom$^{-1}$

**39.** **(2)**

**Sol:** (1) 4 p (2) 4 s (3) 3 d (4) 3 p

Acc. to ($n + \ell$) rule, increasing order of energy

(4) < (2) < (3) < (1)

**40.** **(3)**

**Sol:** $\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

**41.** **(3)**

**Sol:** Total no. of orbitals = $n^2$.

**42.** **(4)**

**Sol:** For shortest 'λ' of hydrogen

$n_1 = 1$ & $n_2 = \infty$

$$\frac{1}{\lambda} = Rz^2\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$\frac{1}{A} = R(1)^2\left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) \Rightarrow R = \frac{1}{A}$$

for longest 'λ' of $He^+$ $n_1 = 3$ $n_2 = 4$

$$\frac{1}{\lambda} = \frac{1}{A}(2)^2\left(\frac{1}{3^2} - \frac{1}{4^2}\right) = \frac{1}{A}\times\frac{7}{36} \text{ or } \lambda = \frac{36A}{7}$$

**43.** **(4)**

**Sol:** $r_n = 52.9\left(\frac{n^2}{1}\right)$ pm = 211.6 pm (for H-atom)

$\therefore n = 2$

Higher orbit to n = 2 ⇒ Balmer series

**44.** **(3)**

**Sol:** On the basis of Pauli's exclusion principle, not more than two electrons can enter in a orbital. Hence seven electrons (as $1s^7$) in an orbital violates Pauli's exclusion principle.

**45.** **(3)**

**Sol:** (1) Energy of ground state of $He^+$

$= -13.6 \times 2^2 = -54.4$ eV (S)

(2) Potential energy of I orbit of H-atom

$= -27.2 \times 1^2 = -27.2$ eV (Q)

(3) Kinetic energy of II excited state of $He^+$

$= 13.6 \times \frac{2^2}{3^2} = 6.04$ eV (P)

(4) Ionisation potential of $He^+$

$= 13.6 \times 2^2 = 54.4$ V (R)

**46.** **(4)**

**Sol:** Total number of nodes = n – 1 = 5 – 1 = 4

Angular node = $\ell$ = 4.

Zero radial node and 4 angular nodes.

**47.** **(3)**

**Sol:** The threshold frequency ($\nu_0$) corresponding to the wavelength 6500 Å is $c/\lambda_0$.

Therefore, the threshold energy = $h\nu_0 = hc/\lambda_0$.

Substituting for h, c and $\lambda_0$ we get, threshold energy = $3.056 \times 10^{-12}$ ergs.

The energy of the incident photons is given by $E = hc/\lambda_0$, since incident wavelength λ = 360 Å. Therefore, incident energy = $55.175 \times 10^{-12}$ ergs.

The kinetic energy of the photoelectrons will be the difference of incident energy and threshold energy,

$\therefore$ KE = $h\nu - h\nu_0 = (55.175 \times 10^{-12}) - (3.056 \times 10^{-12})$ ergs. = $52.119 \times 10^{-12}$ ergs

**48.** **(1)**

**Sol:** Change in P.E. = $-\frac{2x}{4} + (2x) \Rightarrow \frac{3}{2}x$

**49.** **(4)**

**Sol:** $V \propto \frac{Z}{n}$

**50.** **(2)**

**Sol:** $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$; $n_1 = 1$, $n_2 = ?$;

$$\frac{1}{\lambda} = R\left(\frac{1}{1} - \frac{1}{n_2^2}\right) \Rightarrow n_2^2 = \frac{R\lambda}{R\lambda - 1}$$

$$\Rightarrow n_2 = \sqrt{\frac{\lambda R}{\lambda R - 1}}$$

**51.** **(4)**

**Sol:** For II to I transition, $\Delta E = \frac{4E}{3} - E = \frac{hc}{\lambda_{II\to I}}$;

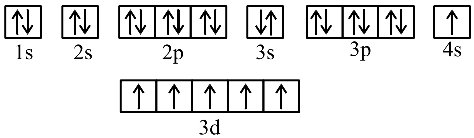
$$\frac{E}{3} = \frac{hc}{\lambda_{II-I}}$$

For III to I transition, $\Delta E = 2E - E = \frac{hc}{\lambda}$ or $E = \frac{hc}{\lambda}$

$\therefore \frac{hc}{3\times\lambda} = \frac{hc}{\lambda_{II-I}}$ $\lambda_{II-I} = 3\lambda$

**52. (4)**

**Sol:**




Out of 6 electrons in 2p and 3p there must have one electron with m = + 1 and s = –1/2 but in 3d-subshell an orbital having m = + 1 may have spin quantum no. $-\frac{1}{2}$ or $+\frac{1}{2}$. Therefore, minimum and maximum possible values are 2 and 3 respectively.

**53. (1)**

**Sol:** Energy associated with a photon of 242 nm = $\frac{6.625\times10^{-34}\times3.0\times10^{8}}{242\times10^{-9}} = 8.21 \times 10^{-19}$ joule

$\because$ 1 atom of Na for ionisation requires = $8.21 \times 10^{-19}$ J

$\therefore$ $6.023 \times 10^{23}$ atoms of Na for ionisation requires

$= 8.21 \times 10^{-19} \times 6.023 \times 10^{23} = 49.45 \times 10^{4}$ J = 494.5 kJ $mol^{-1}$

**54. (4)**

**Sol:** Electronic configuration : $1s^2\ 2s^2\ 2p^6\ 3s^1$

For 3s orbital n = 3 , $\ell$ = 0 , m = 0 , s = +1/2 or –1/2

**55. (3)**

**Sol:** $v \propto \frac{Z}{n}$ ; $r \propto \frac{n^2}{Z}$ ;

frequency of revolution = $\frac{V_n}{2\pi r_n}$ ;

Coulombic force of attraction = $\frac{Ze^2}{(4\pi\varepsilon_0)r^2}$

**56. (2)**

**Sol:** Number of values of $\ell$ = total number of subshells = n.

Value of $\ell$ = 0,1,2........(n – 1).

$\ell = 2 \Rightarrow m = -2, -1, 0, +1, +2$ (5 values)

m = + $\ell$ to – $\ell$ through zero.

**57. (1)**

**Sol:** (I) 2 × K.E. = –P.E

$\frac{PE}{KE} = -2$

(II) $\ell_n \propto n^x$

$\frac{nh}{2\pi} \propto n^x$

x = 1

(III) Potential energy = 2 total energy

(IV) $T_n \propto \frac{n^3}{z^2}$

t = – 2

**58. (4)**

**Sol:** (I) Transition $n \to 6$ to $n \to \infty$ For $Li^{2+}$ sample

(II) Transition $n \to 1$ to $n \to 2$ For H-atom sample

(III) Transition $n \to 1$ to $n \to 3$ For $He^+$ sample

(IV) Transition $n \to 1$ to $n \to \infty$ For H-atom sample

**59. (1)**

**Sol:** The energy levels of H-atom varies from n = 1 to n = ∞.

**60. (1)**

**Sol:** Energy of electrons = $-13.6\frac{Z^2}{n^2}$.

## *Integer Type Questions (61 to 75)*

**61. (912)**

**Sol:** For Lyman series $n_1 = 1$

For shortest 'λ' of Lyman series the energy difference in two levels showing transition should be maximum

(i.e. $n_2 = \infty$) $\frac{1}{\lambda} = R_H\left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$

$= 109678 \Rightarrow \lambda = 911.7 \times 10^{-8} = 911.7$ Å

**62. (6)**

**Sol:** infrared lines = total lines – visible lines – UV lines = $\frac{6(6-1)}{2} - 4 - 5$ = 15 – 9 = 6.
(visible lines = 4 ; 6→2, 5→2, 4→2, 3→2)
(UV lines = 5 ; 6→1, 5→1, 4→1, 3→1, 2→1)

**63.** **(1)**

**Sol:** $\Delta X . \Delta P \cong \frac{h}{4\pi}$

$m(\Delta X . \Delta V) = \frac{h}{4\pi} \Rightarrow m = 0.99 \text{ Kg} \approx 1 \text{ Kg}$

**64.** **(5)**

**Sol:** 3d sub-shell can have maximum 10 electrons with half of the electrons having $S = +\frac{1}{2}$ and other half having $S = -\frac{1}{2}$

**65.** **(759)**

**Sol:** $E_{absorbed} = E_{emitted}$

$\therefore \quad \frac{hc}{300} = \frac{hc}{496} + \frac{hc}{\lambda}$.

$\therefore \quad \lambda = 759$ nm.

**66.** **(984)**

**Sol:** $E_2 - E_1 = 1312 - 1312/4 = 984$ kJ/mol

**67.** **(3)**

**Sol:** Visible lines ⇒ Balmer series ⇒ 3 lines. (5 → 2, 4 → 2, 3 → 2).

**68.** **(6)**

**Sol:** $_{26}Fe = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6, 4s^2$,
$Fe^{++} = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^6$
The number of d -electrons retained in $Fe^{2+}$ = 6.

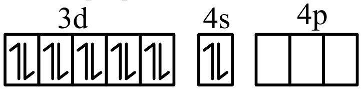
**69.** **(91)**

**Sol:** $\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right) \frac{1}{\lambda} = 1.097 \times 10^7 \text{ m}^{-1} \left(\frac{1}{1^2} - \frac{1}{\infty^2}\right) \quad \therefore \quad \lambda = 91 \times 10^{-9}$ m = 91 m.

**70.** **(8)**

**Sol:** $_{28}Ni \rightarrow [Ar]3d^8\, 4s^2$

3d 4s 4p



Number of unpaired electrons (n) = 2

$\mu = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8}$

**71.** **(53)**

**Sol:** Uncertainty of moving bullet velocity

$$\Delta v = \frac{h}{4\pi \times m \times \Delta v} = \frac{6.625 \times 10^{-34}}{4 \times 3.14 \times .01 \times 10^{-5}}$$

$$= 52.7 \times 10^{-29}\, m/sec$$

**72.** **(5)**

**Sol:** $\phi = \frac{hc}{\lambda_0} \therefore 2.4 = \frac{12400}{\lambda_0} \therefore \lambda_0 \approx 516.7$ nm

For PEE, $\lambda_0 \le \lambda_0$. So, 5 sources (A, B, C, D, E) will exhibit photoelectric effect.

**73.** **(7)**

**Sol:** $1s^2\, 2s^2\, 2p^6\, 3s^1$

m = 0 is for 2 + 2 + 2 + 1 = 7

**74.** **(2)**

**Sol:** No. of radial nodes = n – ℓ – 1

For 3s, x = 3 – 0 – 1 = 2

For 2p, y = 2 – 1 – 1 = 0

**75.** **(27)**

**Sol:** Energy of one photon = $\frac{hc}{\lambda}$

$$= \frac{6.625 \times 10^{-34} \times 3 \times 10^8}{4500 \times 10^{-10}} J$$

$= 4.42 \times 10^{-19}$ J

Energy emitted by the bulb = $150 \times \frac{8}{100} J$

$n \times 4.42 \times 10^{-19} = 150 \times \frac{8}{100}$

$n = 27.2 \times 10^{18}$

# CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

*Single Option Correct Type Questions (01 to 60)*

**1.** **(3)**

**Sol:** Penetration of p-subshell electron is less than s-subshell electrons. In case of Mg, the first electron is to be removed from completely filled $3s^2$ valence shell configuration as compared to partially filled $3p^1$ of Al. These two factors collectively accounts for the higher ionisation energy of Mg than that of Al. Therefore, (3) option is correct.

**2.** **(4)**

**Sol:** There is more interelectronic repulsion in 2p-subshell of fluorine than chlorine (3p). So extra electron will be added easily in 3p-subshell of chlorine as compared to 2p-subshell of fluorine.

**3.** **(3)**

**Sol:** Both statement (1) and (2) are correct.

**4.** **(1)**

**Sol:**
(I) Have same number of electrons – So isoelectronic species
(II) Has metallic as well as non-metallic properties semi metal
(III) Exist as monoatomic molecules & are held together by weak van der Waal's forces so radius is defined as van der Waal's radius
(IV) Energy required to remove an electron from valence shell of an isolated gaseous atom is called I.E.

**5.** **(4)**

**Sol:** For isoelectronic species, as Z increases, $Z_{eff}$ increases (and vice versa).

**6.** **(2)**

**Sol:** Inert pair effect.

**7.** **(2)**

**Sol:** Across the period size decreases and down the group size increases. So, $Cs^+$ has largest ionic radius.

**8.** **(1)**

**Sol:** Atomic radii of zero group elements are expressed as their van der Waal's radii.

$r_{\text{van der Waal's}} > r_{\text{covalent}}$ .

**9.** **(2)**

**Sol:** Completely filled electronic configurations and half-filled electronic configurations are expected to have higher ionization energies. $ns^2 np^5$ will have higher first ionization energy than $ns^2 np^4$ on account of smaller size of atom and higher nuclear charge.

**10.** **(3)**

**Sol:**
(i) Down the group, size increases and therefore, ionization energy decreases. Hence, the order is correct.
(ii) Cation is smaller but anion is bigger than its parent atom. As charge on cation increases the ionic radius decreases. Similarly, as charge on anion increases the ionic radius increases.

$$IE \propto \frac{1}{\text{Atomic / ionic radius}}$$ and IE1 < IE2 < IE3. Hence the order is correct.

(iii) N has stable half-filled electronic configuration thus has higher ionization energy than O. Hence the order is correct.
(iv) The correct order is Mg > Al < Si. Mg ($3s^2$) has higher ionization energy than Al ($3s^2 3p^1$) because s-sub shell electrons have higher penetration power than that of p-subshell electrons. Further across the period size decreases and nuclear charge increases and therefore, ionization energy increases.

**11.** **(3)**

**Sol:** Electron affinity is the measure of the ease with which an atom receives the additional electron in its valence shell in gaseous phase.

Generally, down the group, the electron affinity decreases due to increase in atomic size.

**12.** **(4)**

**Sol:** In chlorine, the addition of additional electron to larger 3p-subshell experiences less electron-electron repulsion than smaller 2p-subshell of fluorine. Phosphorus has very low electron affinity because there is high electron repulsion when the incoming electron enters an orbital that is already half filled.

**13.** **(3)**

**Sol:** Electronegativity values are as given below N = 3.0; C = 2.5; Si = 1.8; P = 2.1

**14.** **(3)**

**Sol:** The addition of extra electron is difficult to the atom having stable electronic configuration So electron affinity will be less or zero. Similarly, the removal of electron is quite difficult for an atom having stable electronic configuration So ionization energy is higher.

**15.** **(1)**

**Sol:** The elements of s-block and p-block are collectively known as representative elements.

Al – p-block element and Mg – s-block element. Cr – d-block element and Zn – d-block element.

Ag – d-block element and At – p-block element. La – f-block element and Th – f-block element.

**16.** **(4)**

**Sol:** As last electron enters in d-orbital. So it belongs to d-block. For d-block element group number = 5 + 1 = 6.

**17.** **(4)**

**Sol:** The d-sub shells are not filled with electrons monotonically with increase in atomic number. There are some exceptions like Cr, Cu etc.

**18.** **(2)**

**Sol:** Fe, Co, Ni have nearly same atomic radii on account of cumulate effect of increased nuclear charge and shielding effect across the period. (Electrons are filled in d-subshell which has poor shielding effect).

**19.** **(4)**

**Sol:** Isoelectronic species have same number of electrons but different nuclear charge.

$$\text{Ionic radius} \propto \frac{1}{\text{Nuclear charge}}$$

**20.** **(2)**

**Sol:** ‘N’ has higher first ionization energy than that of ‘O’ because of extra stable half-filled electronic configuration of nitrogen.

**21.** **(3)**

**Sol:** There is a large jump in ionization energy from second to third one. Alkaline earth metals have the electron configuration [noble gas] $ns^2$; third electron is to be removed from the electron configuration [noble gas] which will require very high energy. These data are of beryllium.

**22.** **(2)**

**Sol:** O has exceptionally smaller value of electron affinity ($-141$ kJ $mol^{-1}$) due to smaller atomic size than sulphur (weaker electron-electron repulsion in 3p-subshell).

**23.** **(4)**

**Sol:**
(1) As electronegativity increases the non-metallic character increases and tendency to form anion increases.
(2) It is based on their SRP values. (Oxidising power may be cumulative effect of hydration energies, electro- negativities, bond dissociation energies and electron gain enthalpies).
(3) C = –121; Si = – 135 ; P = – 72 ; N ≈ 0 (all values are in kJ /mole) . It depends on various factors like size of atom, nuclear charge, partially filled, half filled and completely filled electronic configurations.

**24.** **(3)**

**Sol:** Due to fully filled electronic configuration of He($1s^2$).

**25.** **(1)**

**Sol:** Due to lanthanide contraction ionic radii order : $Yb^{+3} < Pm^{+3} < Ce^{+3} < La^{+3}$

**26. (3)**

**Sol:** According to modified modern periodic law, the properties of elements are periodic functions of their atomic numbers.

**27. (2)**

**Sol:** Number of electrons in $N^{3-} = 7 + 3 = 10$.
Number of electrons in $F^- = 9 + 1 = 10$
Number of electrons in $Na^+ = 11 - 1 = 10$.

**28. (3)**

**Sol:** $O^{2-}$ and $F^-$ have two shells while $Li^+$ and $B^{3+}$ have only one shell. Also, $O^{2-} > F^-$ (for isoelectronic species, as Z increases, size decreases).

**29. (3)**

**Sol:** The addition of second electron in an atom or ion is always endothermic because of repulsion between two negative charges.

**30. (2)**

**Sol:** Nitrogen has half-filled stable electronic configuration, $ns^2np^3$. So, ionization enthalpy of nitrogen is greater than oxygen. On moving down the group, metallic radius increases due to increase in number of shells.

**31. (4)**

**Sol:** Lanthanide contraction is due to poor shielding of one of 4*f* electron by another in the sub-shell.

**32. (3)**

**Sol:** The atomic radii of the second and third transition series are almost the same. This phenomenon is associated with the intervention of the 4f orbitals which must be filled before the 5d series of elements begin. The filling of 4f before 5d orbital results in a regular decrease in atomic radii called Lanthanide contraction which essentially compensates for the expected increase in atomic size with increasing atomic number. The net result of the lanthanide contraction is that the second and the third transition series exhibit similar radii (e.g., Zr 160 pm, Hf 159 pm).

**33. (4)**

**Sol:**

| Element : | B | S | P | F |
|---|---|---|---|---|
| I.E.($kJ\ mol^{-1}$) : | 801 | 1000 | 1011 | 1681 |

In general as we move from left to right in a period, the ionization enthalpy increases with increasing atomic number. The ionization enthalpy decreases as we move down a group. P ($1s^2$, $2s^2$, $3s^2$ $3p^3$) has a stable half-filled electronic configuration than S ($1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^4$). For this reason, ionization enthalpy of P is greater than S.

**34. (1)**

**Sol:** Down the group, ionic radii increases with increasing atomic number because of the increase in the number of shells. But across the period, the ionic radii decreases due to increase in effective nuclear charge as electrons are added in the same shell. $Li^+$ and $Mg^{2+}$ are diagonally related but $Mg^{2+}$ having higher charge is smaller than $Li^+$, so correct order is $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$.
$Be^{2+} = 0.31$ Å
$Mg^{2+} = 0.72$ Å
$Li^+ = 0.76$ Å
$Na^+ = 1.02$ Å

**35. (4)**

**Sol:** For isoelectronic species, ionic radii $\propto \dfrac{1}{\text{nuclear charge}}$.
So, correct order of ionic radii is $8O^{2-} > 9F^- > 11Na^+ > 12Mg^{2+} > 13Al^{3+}$.

**36. (2)**

**Sol:** As we move in a group from top to bottom, electron gain enthalpy becomes less negative because the size of the atom increases and the added electron would be at larger distance from the nucleus.
Negative electron gain enthalpy of F is less than Cl. This is due to the fact that when an electron is added to F, the added electron goes to the smaller n = 2 energy level and experiences significant repulsion from the other electrons present in this level. In Cl, the electron goes to the larger n = 3 energy level and consequently occupies a larger region of space leading to much less electron-electron repulsion. So the correct order is Cl > F > Br > I.

**37.** **(3)**

**Sol:** Order of ionic radii $Ca^{2+} < K^+ < Cl^- < S^{2-}$

In isoelectronic species, as Z increases, size decreases.

**38.** **(3)**

**Sol:** Order of increasing: $\Delta H_{IE_1}$ Ba < Ca < Se < S < Ar

Ba < Ca ; Se < S : On moving top to bottom in a group, size increases. So ionisation enthalpy decreases.

Ar: Maximum value of ionisation enthalpy, since it is an inert gas.

**39.** **(3)**

**Sol:** These are isoelectronic species.

As negative charge increases, ionic radius increases

**40.** **(3)**

**Sol:** I.P1 = Sc > Na > K > Rb

**41.** **(3)**

**Sol:** Statement (3) is correct due to half-filled electronic configuration of group 15 elements.

**42.** **(2)**

**Sol:** $_4Be^-$ - $1s^2\ 2s^2\ 2p^1$ Addition of an electron to a completely filled stable electronic configuration, so least stable.

**43.** **(3)**

**Sol:** This is a characteristic feature of transition metals.

**44.** **(1)**

**Sol:** 52 (p-block), 56 (s-block), 57 (d-block), 60 (f-block)

**45.** **(3)**

**Sol:** The order of penetration effect of different orbitals depends upon the different energies of the various sub-shells for the same energy level, e.g., electrons in s-subshell will have lowest energy and thus will be closest to the nucleus and will have highest penetration power, while p-subshell electrons will penetrate the electron cloud to lesser extent and so on.

**46.** **(4)**

**Sol:** Boron is a metalloid

**47.** **(2)**

**Sol:** Atomic radius increases on moving top to bottom in a group due to increasing number of shells. However, it decreases on moving left to right in a period due to increasing Zeff and addition of electrons to the same shell.

For H; cation is smaller than parent atom while anion is bigger than parent atom. $H^-$ and $Li^+$ are isoelectronic species. So, ionic size $\propto \dfrac{1}{\text{nuclear charge}}$. Hence the correct order is

$H^+ < Li^+ < H^-$.

**48.** **(1)**

**Sol:** In carbon family with an increase in atomic number, there atomic size decreases.

**49.** **(4)**

**Sol:** As elements are ionized, the proton to electron ratio increases, so the attraction between valence shell electron and nucleus increases and as a result the size decreases. Therefore, the removal of electron from smaller cation requires higher energy. Hence the second ionisation enthalpy is greater than its first ionisation enthalpy.

**50.** **(1)**

**Sol:** The increasing order of 1st ionisation energy is f < d < p < s because of the increasing order of the penetration of the electrons as f < d < p < s if all other factors are same.

**51.** **(4)**

**Sol:** I.E increases on moving left to right in a period.

**52.** **(4)**

**Sol:**
(1) The elements having large negative values of electron gain enthalpy generally act as strong oxidising agents. E.g. Halogens.
(2) The elements having low values of ionisation enthalpies act as strong reducing agents.E.g. Alkali metals.
(3) The formation of $S^{2-}(g)$ from S(g) is an endothermic process. ($\Delta egH1$ = small negative value, $\Delta egH2$ = large positive value).

**53.** **(3)**

**Sol:** Additional electrons are repelled more effectively by 2p electrons in F atom than by 3p electrons in Cl atom.

**54.** **(3)**

**Sol:** Be has completely filled stable $2s^2$ orbital and thus Be has higher ionisation energy than B. 2s orbital has less energy than 2p orbital. (From $(n + \ell)$ rule)

**55.** **(3)**

**Sol:** Electronegativity decreases on moving down the group.

**56.** **(2)**

**Sol:** $N^{3-}$ and $Mg^{2+}$ are isoelectronic, so $Mg^{2+}$ (Z = 12) is smaller than $N^{3-}$ (Z = 7); as ionic size $\propto \dfrac{1}{\text{Nuclear charge}}$, $Mg^{2+}$ and $Li^{+}$ are diagonally related. Hence $Mg^{2+}$ is smaller than $Li^{+}$ because of higher positive charge (i.e. +2).

**57.** **(4)**

**Sol:** Manganese has stable $[Ar]^{18}\,3d^5\,4s^2$ configuration.

**58.** **(3)**

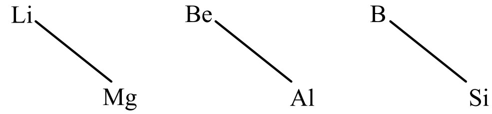
**Sol:**
(1) This electronic configuration corresponds to fluorine (atomic number 9). Across the period size decreases with increase in nuclear charge. Hence it has higher first ionisation energy but less than next noble gas.
(2) This electronic configuration correspond to silicon ($3^{rd}$ period).
(3) This corresponds to first element of $3^{rd}$ period i.e. Na. Na is bigger than Si. So it has lower ionisation energy then Si.
(4) This electronic configuration corresponds to the inert gas i.e. Ne, which will have the highest ionisation energy.
Hence, the correct increasing order of first ionisation energies is (3) < (2) < (1) < (4).

**59.** **(1)**

**Sol:** $X_{(g)} + e^- \rightarrow X^-_{(g)}$ $EA_1$. (Fluorine has higher electron affinity value)

**60.** **(1)**

**Sol:** Diagonal relationship is shown by following pairs.




## *Integer Type Questions (61 to 75)*

**61.** **(18)**

**Sol:** Total 18 elements are present in $5^{th}$ period (Rb to Xe)

**62.** **(81)**

**Sol:** At. wt. of Br = $\dfrac{35.5+127}{2} \approx 81$

**63.** **(6)**

**Sol:** $[Kr]^{36}\,5s^1$

Last electron enters in 5s, so it belongs to $5^{th}$ period.

For s-block group number = number of valence electron(s).

Sum = 5 + 1 = 6

**64.** **(5)**

**Sol:** Na, Zn, F, Mg, Li do not show +3 oxidation state

**65.** **(115)**

**Sol:** Z = 80, Hg and Z = 35, Br, both exist as liquid. Sum = 80 + 35

**66.** **(25)**

**Sol:** Mn shows +7 oxidation state.

**67.** **(109)**

**Sol:** Atomic number of unnilennium is 109.

**68.** **(15)**

**Sol:** $M \longrightarrow M^+ + e^-$ $I^{st}$ I.E. = 15 eV

$M^+ + e^- \longrightarrow M$ Electron gain enthalpy of $M^+$

Because reaction is reverse, so:

$\Delta_{eg}H = -15\text{ eV} = -x \Rightarrow 15$

**69.** **(23)**

**Sol:** Atomic Numbers = 15 Valence Electron = 5

Valency = 3 Group Numbers = 15

Hence, Sum = 15 + 5 + 3 = 23

**70.** **(526)**

**Sol:** $Mg \rightarrow Mg^+ + e^-$ $\Delta H_1 = 178$ Kcal mol$^{-1}$

$Mg^+ \rightarrow Mg^{2+} + e^-$ $\Delta H_2 = 348$ Kcal mol$^{-1}$

So, $\Delta H$ of $Mg \longrightarrow Mg^{2+} + 2e^-$ is $\Delta H_1 + \Delta H_2$

= 178 + 348 = 526 Kcal mol$^{-1}$.

**71.** **(3)**

**Sol:** Since in d-orbital maximum 10 electrons can be filled.

(i), (iii) and (iv) are correct.

**72.** **(1)**

**Sol:** The first member of the lanthanide series is Cerium (Z = 58).

Only (iv) option is wrong.

**73.** **(3)**

**Sol:** (i), (ii) and (iv) are correct.

(i) Across the period size decreases as electrons are added in the same shell and nuclear charge increases by one unit for addition of each successive element.

In contrary, the ionization energy increases as size of atom decreases and nuclear charge increases.

(ii) Electron enthalpy values of halogens are exothermic (negative) and that of noble gases are endothermic (positive)

(iii) $IE_1$ of phosphorus is greater than that of sulphur on account of stable half-filled electron configuration; P=1060 kJ mol$^{-1}$ and S=1005 kJ mol$^{-1}$

(iv) Isoelectronic series of ion; all have the xenon electronic configuration.

$$\text{Ionic radius} = \frac{1}{\text{nuclear charge}}$$

Atomic number: Te = 52; I = 53; Cs = 55; Ba = 56.

**74.** **(3)**

**Sol:** Density increases across the period as volume decreases and atomic weight increases, and generally increase down the group due to increase in atomic weight as compared to atomic volume.

Only (ii), (iii) and (iv) are correct.

**75.** **(126)**

**Sol:** In present setup of long form of periodic table, element with atomic number > 118 can not be accommodated.

# CHEMICAL BONDING

*Single Option Correct Type Questions (01 to 60)*

**1.** **(2)**

The conditions required for the formation of an ionic bond are:

(i) ionization enthalpy $[M(g) \rightarrow M^{+}(g) + e^{-}]$ of electropositive element must be low.

(ii) negative value of electron gain enthalpy $[X(g) + e^{-} \rightarrow X^{-}(g)]$ of electronegative element should be high.

**2.** **(2)**

Cs has lowest $IE_1$ amongst the metals and F has higher electron affinity. So Cs and F form most ionic compound.

**3.** **(2)**

The ease of formation of ionic compounds i.e. stability to form ionic compounds increases as net ionization energy of electropositive element decreases. Hence, the correct order is $Na^{+} > Mg^{2+} > Al^{3+}$.

**4.** **(4)**

Lattice energy $\propto$

$$\frac{1}{(\text{Interionic distance})^2}, \text{LE} \propto \frac{1}{\text{Size of anion}}$$

$$\text{LE} \propto \frac{1}{r_+ + r_-}$$

**5.** **(3)**

As charge on cations increases, their polarizing power increase and thus covalent character increase.

$$\overset{+}{Li}Cl < \overset{2+}{Be}Cl_2 < \overset{3+}{B}Cl_3 < \overset{4+}{C}Cl_4$$

**6.** **(1)**

As $F^{-}$ has lowest polarisability on account of smallest size among $O^{2-}$, $N^{3-}$ and $C^{4-}$, it causes less polarisation and, therefore, has lowest covalent character. Hence, $AlF_3$ is the most ionic.

**7.** **(4)**

In $SF_6$, $PCl_5$ and $IF_7$, the valence shell has 12, 10 and 14 electrons. As all contain more than 8 electrons in their valence shell. They are example of super octet molecules.

**8.** **(3)**

(1) and (2) have negative overlap while (3) has positive overlap. Thus (3) will show effective overlapping.

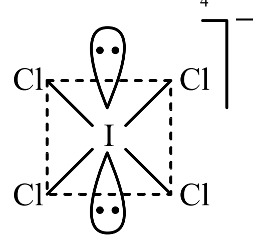
**9.** **(2)**

(1) $\sigma$ bond is formed by axial over lapping.

(2) p-orbital have both axial and side-ways overlapping

**10.** **(4)**

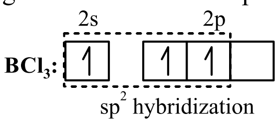
$BF_4^{-}$, $NH_4^{+}$ and $XeO_4$ are tetrahedral with $sp^3$ hybridization. But $ICl_4$– is square planar.



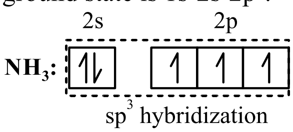

Square planar ($sp^3d^2$)

**11.** **(3)**

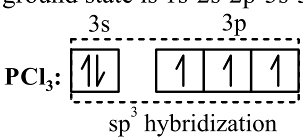
(a) Electronic configuration of boron in ground state is $1s^2 2s^2 2p^1$.



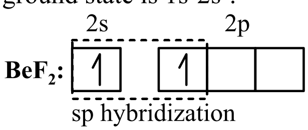

(b) Electronic configuration of nitrogen in ground state is $1s^2 2s^2 2p^3$.



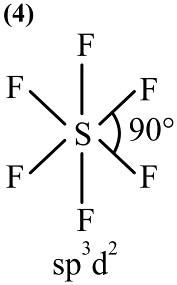

(c) Electronic configuration of phosphorus in ground state is $1s^2 2s^2 2p^6 3s^2 3p^3$.




(d) Electronic configuration of boron in ground state is $1s^2 2s^2$.




**12.** **(4)**

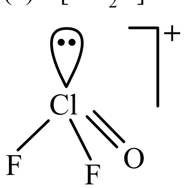


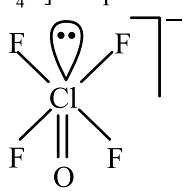

**13.** **(3)**

(1) both are $sp^3d$

(2) both are $sp^3d$

(3) $[ClF_2O]^+$ is $sp^3$ but $[ClF_4O]^-$ is $sp^3d^2$



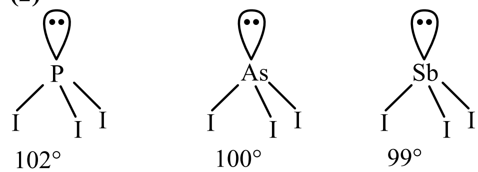




(4) both are $sp^3d^2$

**14.** **(1)**

Atomic size arguments can be used for these species. Larger outer atoms result in larger angles due to steric repulsion.

**15.** **(2)**



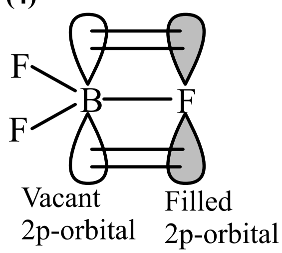

Phosphorus is the most electronegative of the central atoms. Consequently, it exerts the strongest pull on shared electrons, concentrating these electrons near P and increasing bonding pair-bonding pair repulsions–hence, the largest angle in $PI_3$. Sb, the least electronegative central - atoms, has the opposite effect : Shared electrons are attracted away from Sb, reducing repulsions between the Sb–I bonds. The consequence is that the effect of the lone pair is greatest in $SbI_3$, which has the smallest angle.

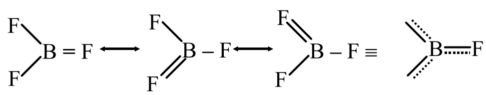
Atomic size arguments can also be used for these species. Larger outer atoms result in larger angles ; larger central atoms result in smallest angles.

**16.** **(2)**

Diborane ($B_2H_6$) is an electron deficient compound.

**17.** **(4)**




Decrease in B–F bond length is due to delocalized pπ–pπ bonding between filled p-orbital of F atom and vacant p-orbital of B atom.

**18. (1)**
Because of pπ-dπ delocalisation of lone pair of electrons present on N atoms. Therefore, $(SiH_3)_3N$ is planar.

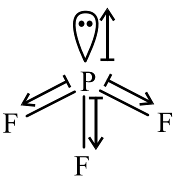
**19. (1)**
$O_2^+$ : B.O. = $\frac{10-5}{2}$ = 2.5 ; NO : B.O.= $\frac{10-5}{2}$ = 2.5 ; $NO^{2+}$ : B.O. = $\frac{9-4}{2}$ = 2.5 ; CN : B.O. = $\frac{9-4}{2}$ = 2.5.

**20. (3)**
$N_2$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\sigma 2p_z)^2$
The bond order of $N_2$ is 1/2(10 – 4) = 3.
$N_2^+$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\sigma 2p_z)^1$
The bond order of $N_2^+$ is 1/2(9 – 4) = 2.5.
$O_2$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^*2p_x^1 = \pi^*2p_y^1)$
The bond order of $O_2$ is 1/2 (10 – 6) = 2.
$O_2^-$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^*2p_x^2 = \pi^*2p_y^1)$
The bond order of $O_2$ is 1/2 (10 – 7) = 1.5.
$NO^+$ derivative of $O_2$ and isoelectronic with $O_2^{2+}$ ; so $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$
The bond order of $NO^+$ is 1/2 (10 – 4) = 3.
NO derivative of $O_2$ and isoelectronic with $O_2^+$ ; $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$, $(\pi^*2p_x)^1$
The bond order of NO is 1/2 (10 – 5) = 2.5.
bond order $\propto$ 1/bond length $\propto$ bond dissociation energy.

**21. (3)**

| | **Bond order** | **Unpaired electron** |
|---|---|---|
| $O_2^+$ | 2.5 | 1 |
| NO | 2.5 | 1 |
| $N_2^+$ | 2.5 | 1 |

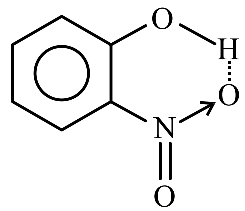
**22. (3)**



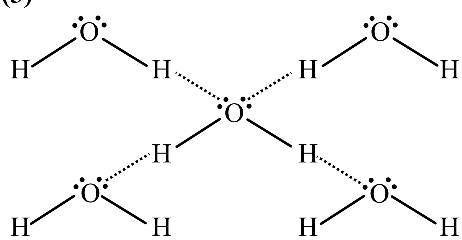

$\mu \neq 0$ ; $SiF_4$ , $BF_3$ and $PF_5$ are symmetrical molecules thus $\mu = 0$.

**23. (1)**
$H_2O$, $\mu = 6.17 \times 10^{-30}$ Cm; $NH_3$, $\mu = 4.90 \times 10^{-30}$ Cm;
$NF_3$, $\mu = 0.80 \times 10^{-30}$ Cm; $CH_4$, $\mu$ = zero.

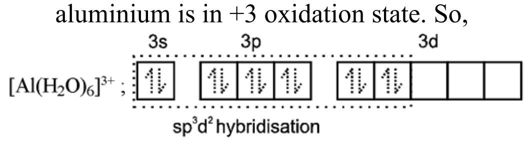
**24. (2)**
It has intramolecular H-bonding




**25. (3)**



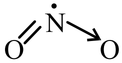
**26. (1)**
Both are correct and Reason is the correct explanation of Assertion. In $[Al(H_2O)_6]^{3+}$ , aluminium is in +3 oxidation state. So,

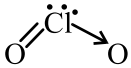


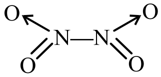

**27. (2)**
According to Fajan's rules polarisation of bond $\propto \frac{\text{Charge on cation}}{\text{Size of cation}}$.
Polarisation of bond $\propto$ covalent character of bond.

**28.** **(4)**

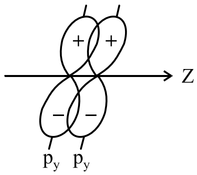
(1) $:\dot{N} = O$

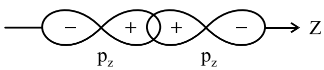
(2) 

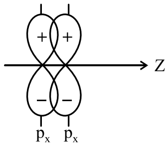
(3) 

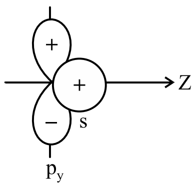
(4) 

**29.** **(3)**

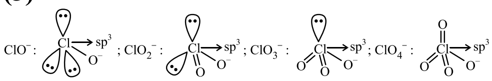
(1) 

(2) 

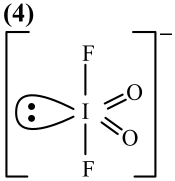
(3) 

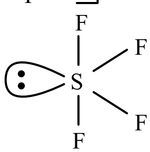
(4)  **Zero overlap**

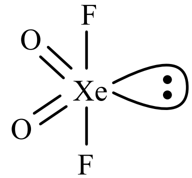
**30.** **(3)**

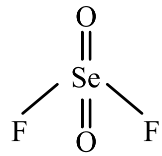


**31.** **(4)**



(1) 

(2) 

(3) 

**32.** **(3)**

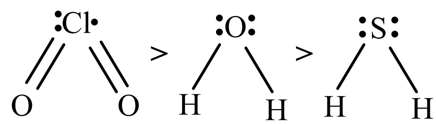
(1) According to VSEPR theory as electronegativity of central atom decreases, bond angle decreases. So bond angle of $H_2O > H_2S > H_2Se > H_2Te$

(2) $C_2H_2 > C_2H_4 > CH_4 > NH_3$ . In $NH_3$ there is bp-lp repulsion so bond angle decreases to 107º from 109.5º.

| sp | $sp^2$ | $sp^3$ | $sp^3$ |
|---|---|---|---|
| 180º | 120º | 109.5º | 107º |

(3) $NH_3 < H_2O < OF_2$ in this case bond angle of $NH_3$ is highest because lp - lp repulsion is absent in. it.

(4) $ClO_2 > H_2O > H_2S$



| $sp^2$ | $sp^3$ | $sp^3$ |
|---|---|---|
| (≈117°) | (104.5°) | (92°) |

**Note:** It is supposed that in $H_2S$ the hybrid orbitals do not participate in bonding but pure p-atomic orbitals participate in bonding.

**33.** **(3)**

$O_2$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^*2p_x^1 = \pi^*2p_y^1)$

$O_2^-$ : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^*2p_x^2 = \pi^*2p_y^1)$

**34.** **(4)**

M.O for $C_2 = \sigma 1s^2 < \sigma^*1s^2 < \sigma 2s^2 < \sigma^*2s^2 <$

$$\underbrace{\pi 2p_y^2 = \pi 2p_z^2}_{\text{HOMO}} < \underset{\text{LUMO}}{\sigma 2p_x}$$

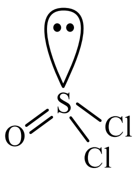
It is important to note that double bond in $C_2$ consists of both pi bonds because of the presence of four electrons in two pi molecular orbitals $C_2^{2-}$ $\left[C \overset{\pi}{\underset{\sigma}{\overset{\pi}{\equiv}}} C\right]^{2-}$.

**35.** **(4)**

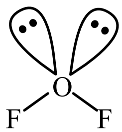
**Nitrogen molecule ($N_2$):** $(\sigma 1s)^2 (\sigma^*1s)^2 (\sigma 2s)^2 (\sigma^*2s)^2 (\pi 2p_x^2 = \pi 2p_y^2) (\sigma 2p_z)^2$

The bond order of $N_2$ is 1/2(10 – 4) = 3. It contains one sigma and two π bonds.

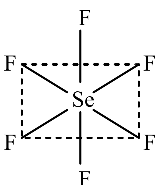
**36.** **(3)**

(1) 

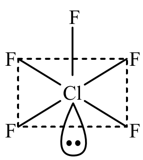
$\mu \neq 0$

(2) 

$\mu \neq 0$

(3) 

$\mu = 0$

(4) 

$\mu \neq 0$

**37.** **(2)**

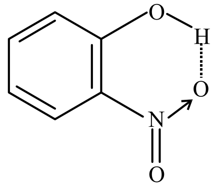
(% ionic character

$$= \frac{\text{Observed dipole moment}}{\text{Theoretical dipole moment}} \times 100)$$

Theoretical dipole moment of a 100% ionic character

$= e \times d = (1.6 \times 10^{-19} C) \times (1.41 \times 10^{-19} m) = 2.256 \times 10^{-29}$ Cm

**38.** **(3)**



o-nitro phenol

o-nitrophenol has lower boiling point (i.e. more volatile) because it exists as discrete molecules than its para-derivative, where association of molecules takes place using intermolecular H-bonding.

**39.** **(3)**

When ice is formed from liquid water, The tetrahedral structure around each oxygen atom with two regular bonds to hydrogen and two hydrogen bonds to other molecules requires a very open structure with large spaces between ice molecules.

$$D_{H_2O(s)} < D_{H_2O(l)} : V_{H_2O(s)} > V_{H_2O(l)}$$

**40.** **(3)**

(1) The sulphur is in $sp^2$ hybridization but due to lp-bp repulsion the bond angle decreases to 119.5°.

(2) The oxygen is in $sp^3$ hybridization but due to lp-lp repulsion the bond angle decreases to 104.5°.

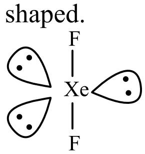
(3) It is believed that pure p atomic orbitals participate in bonding and due to lp-lp repulsion the bond angle decreases to 92.5°.

(4) The nitrogen is in $sp^3$ hybridization but due to lp-bp repulsion the bond angle decreases to 107°.

| | $SO_2$ | $OH_2$ | $SH_2$ | $NH_3$ |
|---|---|---|---|---|
| Bond angle: | 119.5° | 104.5° | 92.5° | 107° |

**41.** **(2)**

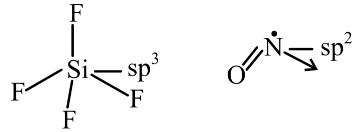
(1) $CF_4$ is tetrahedral whereas $SF_4$ is T-shaped.

(2) , O = C = O both linear according to VSEPR.

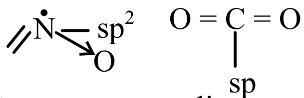
(3) $BF_3$ is trigonal planar and $PCl_3$ is tetrahedral.

(4) $PF_5$ is trigonal bipyramidal and $IF_5$ is square pyramidal.

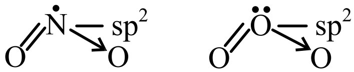
**42. (3)**

(1) 

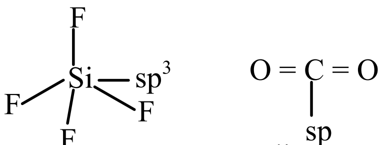
tetrahedral, $\mu = 0$ bent, $\mu \neq 0$

(2) 

bent, $\mu \neq 0$ linear, $\mu = 0$

(3) 

bent, $\mu \neq 0$ bent, $\mu \neq 0$

(4) 

tetrahedral, $\mu = 0$ linear, $\mu = 0$

**43. (2)**

NO and $NO^+$ are derivative of $O_2$.

NO (isoelectronic with $O_2^+$) : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p^2_x = \pi 2p^2_y)$ $(\pi^*2p_x^1 = \pi^*2p_y)$

Bond order = 1/2(10 – 5) = 2.5.

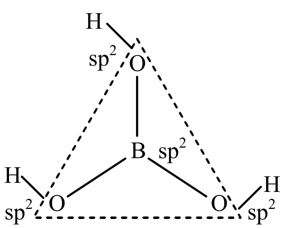
$NO^+$(isoelectronic with $O_2^{2+}$) : $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2p_z)^2$ $(\pi 2p^2_x = \pi 2p^2_y)$ $(\pi^*2p_x = \pi^*2p_y)$

Bond order = 1/2(10 – 4) = 3.

Bond order $\propto$ 1/bond length.

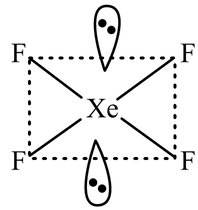
So, $NO^+$ has shorter bond length.

**44. (1)**

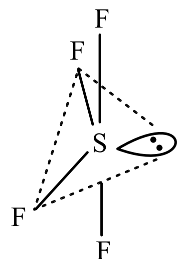


For planar $BO_3$ groups, the B–O bond length is usually close to 1.36 Å but for tetrahedral $BO_4$ groups the length increases to about 1.48 Å. This suggests that in the planar grouping π-bonding involving lone pairs of electrons from the oxygen atoms occurs; this π-bonding is necessarily lost in the tetrahedral group, in which a lone pair from the extra oxygen atom occupies the previously empty orbital on the boron atom.

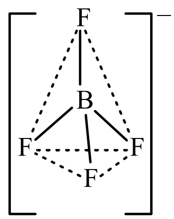
**45. (3)**

(1) 

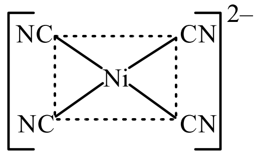
square planar

(2) 

see-saw shaped

(3) 

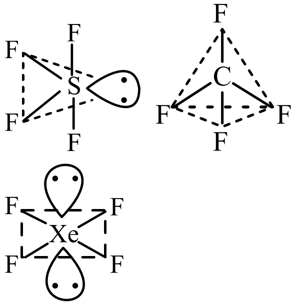
regular tetrahedral

(4) 

square planar

**46.** **(4)**

According to VSEPR theory




$\ell$p = 1 $\ell$p = 0 $\ell$p = 2

sp$^3$ d-hybridisation sp$^3$-hybridisation sp$^3$d$^2$-hybridisation

see-saw shape tetrahedral shape square planar shape

**47.** **(2)**

$He_2^+ \rightarrow \sigma (1s)^2\ \sigma^* (1s)^1$, one unpaired electron.

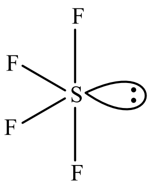
$H_2 \rightarrow (1s)^2\ \sigma^* (1s)^0$, no unpaired electron.

$H_2^+ \rightarrow\ \sigma (1s)^2\ \sigma^* (1s)^0$, one unpaired electron.

$H_2^- \rightarrow \sigma (1s)^2\ \sigma^* (1s)^1$, one unpaired electron.

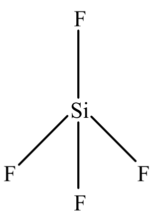
**48.** **(1)**

(1)



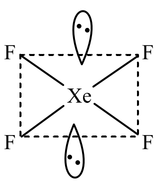

see-saw

(2)



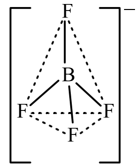

regular tetrahedral

(3)



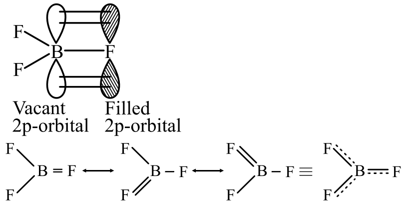

square planer

(4)




regular tetrahedral

**49.** **(2)**




Decrease in B – F bond length which results in the higher bond dissociation energy of B – F in $BF_3$ is due to delocalized pπ–pπ bonding between filled p-orbital of F atom and vacant p-orbital of B atom.

**50.** **(2)**

$NO_2^+$ Number of electron pairs = 2

Number of bond pairs = 2

Number of lone pair = 0

So, the species is linear with sp hybridization.

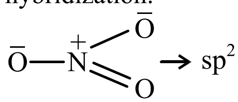
$O = \underset{sp}{\overset{+}{N}} = O$

$NO_3^-$ Number of electron pairs = 3

Number of bond pairs = 3

Number of lone pair = 0

So, the species is trigonal planar with sp$^2$ hybridization.

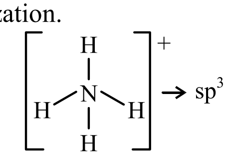



$NH_4^+$ Number of electron pairs = 4

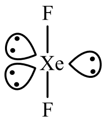
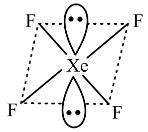
Number of bond pairs = 4

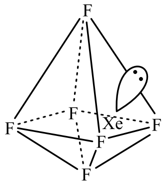
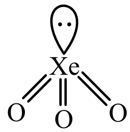
Number of lone pair = 0

So, the species is tetrahedral with sp$^3$ hybridization.



**51.** **(3)**

$XeF2$:  ;$XeF_4$: 

$XeF_6$:  ;$XeO_3$: 

**52.** **(2)**

$Li_2$: $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2$

Bond order = 1

$Li_2^+$: $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^1$

Bond order = 0.5

$Li_2^-$ : $(\sigma 1s)^2\ (\sigma^* 1s)^2\ (\sigma 2s)^2\ (\sigma^* 2s)^1$

Bond order = 0.5

Stability order $Li_2 > Li_2^+ > Li_2^-$

**53.** **(1)**

(1) CO $\longrightarrow \sigma 1s^2,\ \sigma^* 1s^2,\ \sigma\ 2s^2,\ \sigma^* 2s^2,$ $\left[\pi 2p_x^2 = \pi 2p_y^2\right], \sigma 2p_z^2$

All electrons are paired so diamagnetic

(2) $O_2 \longrightarrow \sigma 1s^2,\ \sigma^* 1s^2, \sigma\ 2s^2,\ \sigma^* 2s^2, \sigma 2p_z^2,$ $\left[\pi 2p_x^2 = \pi 2p_y^2\right], \left[\pi^* 2p_x^1 = \pi^* 2p_y^1\right]$

Unpaired electron = 2 (Paramagnetic)

(3) $B_2 \longrightarrow \sigma 1s^2,\ \sigma^* 1s^2,\ \sigma 2s^2,\ \sigma^* 2s^2,$ $\left[\pi 2p_x^1 = \pi 2p_y^1\right]$ (Paramagnetic)

(4) NO $\longrightarrow \sigma 1s^2,\ \sigma^* 1s^2, \sigma 2s^2,\ \sigma^* 2s^2, \sigma 2p_z^2,$ $\left[\pi 2p_x^2 = \pi 2p_y^2\right], \left[\pi^* 2p_x^1 = \pi^* 2p_y^0\right]$

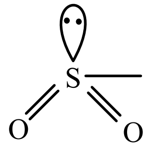
(Paramagnetic)

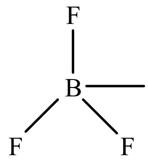
**54.** **(2)**

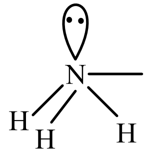
Ionic character $\propto$ charge on cation $\propto \dfrac{1}{\text{Size of cation}}$

**55.** **(1)**

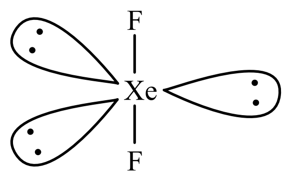
(I) $S = \underset{sp}{C} = S$ (linear)

(II)  $sp^2$ (bent)

(III)  $sp^2$ (trigonal planar)

(IV)  $sp^3$ (trigonal pyramidal)

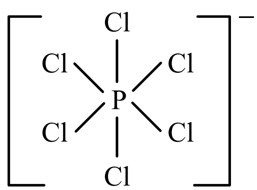
**56.** **(4)**

(I) 

$sp^3d$

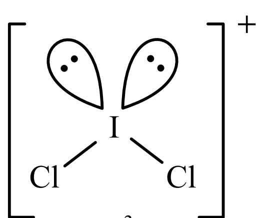
(II) $[N = \overset{+}{\underset{sp}{N}} = N]^{2-}$

(III) $PCl_5$ (s) exists as $[PCl_4]^+$ and $[PCl_6]^-$;



$sp^3d^2$

(IV) $I_2Cl_6(\ell) \rightleftharpoons [ICl_2]^+ + [ICl_4]^-$ ;



$sp^3$

Self-ionization

**57.** **(1)**

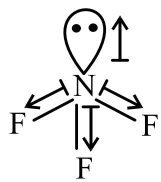
Steric no. of $IO_2F_2^-$ = 4 + 1 = 5, $sp^3d$; Steric no. of $F_2SeO$ = 3 + 1 = 4, $sp^3$;

Steric no. of $SO_2$ = 2 + 1 = 3, $sp^2$; Steric no. of $XeF_5^+$ = 5 + 1 = 6, $sp^3d^2$

**58.** **(1)**

Bonding molecular orbital results in increased electron density between nuclei due to constructive interference of combining electron waves.

**59.** **(1)**

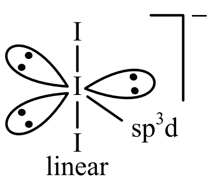



Bond dipoles of N—F bonds are counter balanced to some extent by the dipole moment of lone pair of electron acting in opposite direction. This reduces both the dipole moment and its donor power.

**60.** **(1)**

Assertion and Reason both are correct statement and Reason is the correct explanation of Assertion, e.g., $NO_2^+$ and $I_3^-$ have different hybridisation but on account of stability they have linear shape as given below.

$O = \overset{+}{\underset{sp}{N}} = O$ (linear) and




*Integer Type Questions (61 to 75)*

**61.** **(4)**
$(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\sigma 2p_z)^2$ ; number of anti bonding electrons in $N_2$ is 4.
* represents antibonding molecular orbitals.

**62.** **(3)**
OF is derivative of $O_2$ and isoelectronic with $O_2^-$.
So, $(\sigma 1s)^2$ $(\sigma^*1s)^2$ $(\sigma 2s)^2$ $(\sigma^*2s)^2$ $(\sigma 2pz)^2$ $(\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^*2p_x^2 = \pi^*2p_y^1)$
The bond order of 'OF' is 1/2(10 – 7) = 1.5

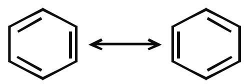
**63.** **(17)**
Dipole moment = $4.8 \times 10^{-10} \times 1.275 \times 10^{-8}$ = $4.8 \times 1.275 \times \times 10^{-18} = 4.8 \times 1.275$ D

% ionic character = $\dfrac{1.03 \times 100}{1.275 \times 4.8} \approx 17\%$

**64.** **(6)**
In $N_2$ molecule each nitrogen atom contributes three electrons so total number of electrons are 6.

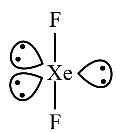
**65.** **(4)**
Covalency of nitrogen in $HNO_3$ is 4.

**66.** **(15)**

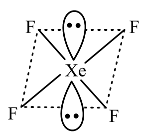


∴ Bond order = 1.5

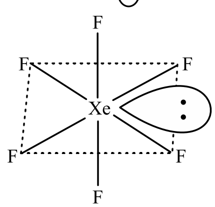
**67.** **(6)**

$XeF_2$ 

; XeF



; $XeF_6$ (g)



**68.** **(1)**

Number of electrons in $HeH^+ = 2 + 0 = 2$ ;

$(\sigma 1s)^2 (\sigma^* 1s)^0$. So, B.O. $= \dfrac{2-0}{2} = 1$.

**69.** **(5)**

$1D = 10^{-18}$ esu cm

$$\delta = \frac{0.38\times 10^{-18}}{1.61\times 10^{-8}\times 4.802\times 10^{-10}} = 0.049$$

**70.** **(1)**

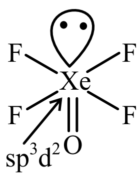
According to VSEPR theory,

total number of electron pairs = 6.

total number of bond pairs = 5.

so total number of lone pair = 1.

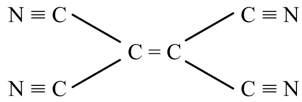
There is one Xe—O double bond. The π-electrons of double bond create more repulsion than single covalent bond. To minimize the repulsions the lone pair and Xe—O double bond are trans to each other in octahedral geometry.




**71.** **(2)**

The species in which central atoms has higher valencies than their normal valencies are called as hypervalent species.

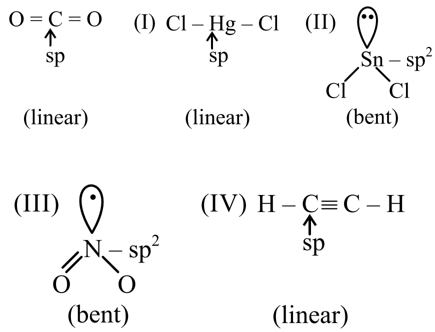
**72.** **(18)**



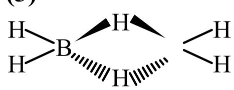

;

9 σ and 9 π bonds.

**73.** **(2)**




**74.** **(3)**




**75.** **(2)**

$$\text{Bond order} = \frac{\text{Total number of bonds between atoms}}{\text{Total number of resonating structure}}$$

$= \dfrac{5}{4} = 1.25$ ; Formal charge on each 'O' atom

$= \dfrac{-3}{4} = -0.75$

# THERMODYNAMICS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(2)**

$SO_2$ ($\gamma$ = 1.33), $N_2O$ ($\gamma$ = 1.4), He ($\gamma$ = 1.67)

As $\gamma$ increases, for compression, graph rises up.

**2.** **(4)**

$\Delta G = (\Delta H) - T(\Delta S)$

$\downarrow$ $\downarrow$

–ve –ve

Since both are –ve, the reaction would have a –ve $\Delta G$ below a temperature of

$\frac{33000}{58}$ K (= 569K)

**3.** **(3)**

S is state function hence $\Delta S$ will be independent of type of process (reversible / irreversible) for $A \rightarrow B$.

**4.** **(2)**

I. Molar entropy of gas is much greater than that of solid and liquid.

II. Entropy change is positive if $\Delta n_g$ is positive.

III. Molar entropy of a crystalline solid will be zero at absolute zero.

IV. In irreversible process both system and surroundings are not restored if path is reversed.

V. Refractive index and molarity are intensive properties.

**5.** **(3)**

Extensive properties: The properties of the system which depends upon the quantity of matter contained in it are called extensive properties e.g., mass, volume, energy, heat capacity etc. Intensive properties: The properties which are independent of the quantity of matter present in it are called intensive properties e.g., temperature, pressure, refractive index, viscosity, specific heat, density, surface tension etc.

**6.** **(3)**

A thermos- flask is approximately an isolated system.

**7.** **(2)**

PV = constant for isothermal process

$PV^\gamma$ = constant for adiabatic process

So more value of $\gamma$, more decrease in pressure as volume increases.

**8.** **(3)**

The total heat content of a system is equivalent to the internal energy and work done, at constant pressure

$\Delta H = \Delta E + W$

**9.** **(2)**

From 1st law of thermodynamics $\Delta E = Q + W$ where Q = 0 for adiabatic process.

**10.** **(3)**

$\Delta n_g$ is + ve

**11.** **(4)**

$$\Delta S_{system} = nC_v \ell n\left(\frac{T_2}{T_1}\right) + nR\,\ell n\left(\frac{V_2}{V_1}\right)$$

**12.** **(2)**

$\Delta G = \Delta H - T\Delta S$

$\downarrow \quad \downarrow \qquad\qquad \downarrow$

$-ve \quad -ve \qquad\qquad +ve$

**13.** **(3)**

Enthalpy of reaction ($\Delta H$) is defined as heat exchanged during any chemical reaction

$\Delta H = H_P - H_R$

For exothermic reaction $H_P < H_R$

$\therefore$ $\Delta H$ is –ve.

**14.** **(2)**

From Kirchoff's equation: $y - x = (C_{P,\ vapour} - C_{P,\ ice})(T_2 - T_1) < 0$.

**15.** **(2)**

Combustion reaction of solid boron

$$B(s) + \frac{3}{4} O_2(g) \longrightarrow \frac{1}{2} B_2O_3$$

$$\Delta H°_r = \Delta H°_c = \frac{1}{2} \Delta H°_f (B_2O_3, s) - \Delta H°_f (B, s) - \frac{3}{4} \Delta H°_f (O_2, g)$$

$\Delta H_f°$ of element in stable state of aggregation is assumed to be zero.

$$\Delta H°_C = \frac{1}{2} \Delta H°_f (B_2O_3)$$

**16.** **(2)**

$\Delta G$ for $3Fe(s) + 2O_2(g) \longrightarrow Fe_3O_4(s)$ can be obtained by taking

$$[(2) + 4 \times (1)] \times \frac{1}{3}$$

Hence, we get $\Delta G_f = [-19 + 4 \times (-177)] \times \frac{1}{3}$

$= -242.3$ k cal for 1 mole $Fe_3O_4$

**17.** **(4)**

$$CS_2(\ell) + 3O_2(g) \longrightarrow CO_2(g) + 2SO_2(g)$$

$\Delta H = -256$ Kcal

Let $\Delta H_f (CO_2, g) = -4x$ and $\Delta H_f (SO_2, g) = -3x$

$\Delta H_{reaction} = \Delta H_f (CO_2, g) + 2\Delta H_f (SO_2, g) - \Delta H_f (CS_2, \ell)$

$-265 = -4x - 6x - 26$

$x = +23.9$

$\therefore \Delta H_f (SO_2, g) = 3x = -71.7$ Kcal / mol.

**18.** **(2)**

$$\Delta S = nC_V \ln\left(\frac{T_f}{T_i}\right) + nR \ln\left(\frac{V_f}{V_i}\right)$$

**19.** **(3)**

In an isolated system, there is no exchange of energy or matter between the system and surrounding. For a spontaneous process in an isolated system, the change in entropy is positive, i.e. $\Delta S > 0$.

Most of the spontaneous chemical reactions are exothermic. A number of endothermic reaction are spontaneous e.g melting of ice (an endothermic process) is a spontaneous reaction.

The two factors which are responsible for the spontaneity of process are

(i) Tendency to acquire minimum energy

(ii) Tendency to acquire maximum randomness.

**20.** **(2)**

$\Delta G^o = \Delta H^o - T\Delta S^o$

For a spontaneous process $\Delta G^o < 0$

$\Rightarrow \Delta H^o - T\Delta S^o < 0$

$\Rightarrow T\Delta S^o > \Delta H^o$

$$\Rightarrow T > \frac{\Delta H^o}{\Delta S^o} \Rightarrow T > \frac{179.1 \times 1000}{160.2}$$

$\Rightarrow T > 1117.9 \text{ K} \approx 1118 \text{ K}$.

**21.** **(2)**

$\Delta S°$ reaction $= 50 - \frac{1}{2}(60) - \frac{3}{2}(40) = -40\ JK^{-1}$

For reaction to be at equilibrium

$\Delta G = 0$

$$\Delta H - T\Delta S = 0 \Rightarrow T = \frac{\Delta H}{\Delta S} = \frac{30000}{40} = 750 \text{ K}$$

**22.** **(3)**

$CH_3OH\ (\ell) + \frac{3}{2} O_2\ (g) \longrightarrow CO_2(g) + 2H_2O\ (\ell)$

$\Delta G_r = \Delta G_f\ (CO_2,\ g) + 2\Delta G_f\ (H_2O,\ (\ell)) - \Delta G_f\ (CH_3OH,\ (\ell)) - \frac{3}{2}\Delta G_f\ (O_2,\ g)$

$= -394.4 + 2\ (-237.2) - (-166.2) - 0 = -394.4 - 474.4 + 166.2 = -868.8 + 166.2$

$\Delta G_r = -702.6$ kJ

% efficiency $= \frac{702.6}{726} \times 100 = 97\%$.

**23.** **(2)**

$\Delta G = \Delta H - T\Delta S$

For spontaneous reaction $\Delta G$ must be negative

At equilibrium temperature $\Delta G = 0$

to maintain the negative value of $\Delta G$

T should be greater than $T_e$.

**24.** **(1)**

$\Delta S = nR \ln \frac{V_2}{V_1}$

$= 2.303\ nR \log \frac{V_2}{V_1}$

$= 2.303 \times 2 \times 8.314 \times \log \frac{100}{10}$

$= 38.3\ J\ mol^{-1}\ K^{-1}$

**25.** **(2)**

$C_2H_5OH\ (\ell) + 3O_2\ (g) \rightarrow 2CO_2(g) + 3H_2O\ (\ell)$

$\Delta n_g = 2 - 3 = -1$

$\Delta U = \Delta H - \Delta n_g RT$

$= -1366.5 - (-1) \times \frac{8.314}{10^3} \times 300$

$= -1366.5 + 0.8314 \times 3 = -1364$ KJ

**26.** **(3)**

$\Delta G^o = \Delta H^o - T\Delta S^o$

$-RT\ln K = \Delta H^o - T\Delta S^o$

$\ln K = -\frac{\Delta H^o - T\Delta S^o}{RT}$

**27.** **(1)**

The process is isothermal expansion

Hence, $q = -w$ $\qquad \Delta u = 0$

$q = +208$ J

$w = -208$ J (expansion work)

**28.** **(4)**

$2\Delta G^\circ_{f\ (NO_2)} - [2\Delta G^o_{f(NO)} + \Delta G^\circ_{f\ (O_2)}]$

$= \Delta G^o_r = -RT\ell n\ K_p$

$2\Delta G^\circ_{f\ (NO_2)} - [2 \times 86,600 + 0] = -RT\ell n\ K_p$

$\Delta G^\circ_{f\ (NO_2)} = 0.5[2 \times 86,600 - R\ (298)\ \ell n(1.6 \times 10^{12})]$

**29.** **(2)**

$C_{(graphite)} + O_2(g) \longrightarrow CO_2(g)$

$\Delta H_r = -393.5$ kJ/mol $= \Delta H_f\ CO_2(g)$

$H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(\ell)$

$\Delta H_r = -285.8$ kJ/mol $= \Delta H_f\ H_2O(\ell)$

$CO_2(g) + 2H_2O\ (\ell) \longrightarrow CH_4(g) + 2O_2(g)$

$\Delta H_r = \Delta H_f\ (CH_4) - \Delta H_f\ CO_2(g) - 2\Delta H_f\ H_2O\ (\ell)$

$= 890.3$

$\Rightarrow \quad \Delta H_f\ CH_4 + 393.5 + 2 \times 285.8 = 890.3$

$\Rightarrow \quad \Delta H_f\ CH_4(g) = -74.8$ kJ/mol

**30.** **(3)**

$C_{(graphite)} + 2H_2\ (g) \longrightarrow CH_4\ (g)$

**31.** **(1)**

$\Delta G = \Delta H - T.\Delta S$

If $\Delta H$ & $\Delta S$ are both positive, then $\Delta G$ may be negative at high temperature hence reaction becomes spontaneous at high temperature.

**32.** **(3)**

$2H_2O_2(l) \rightleftharpoons 2H_2O(l) + O_2(g)$

$W = -P_{ext}\ (\Delta V) = -(n_{O_2})\ RT$

$\because \quad$ 100 mol $H_2O_2$ on decomposition will give 50 mol $O_2$

$\Rightarrow \quad W = -(50)(8.3)(300)J = -124500$ J

$W = -124.5$ kJ

$\Rightarrow \quad$ Work done by $O_2(g) = 124.5$ kJ Ans.

**33.** **(4)**

$$\Delta H = \Delta H_{H_2O_{(\ell)}} + \Delta H_{fus} + \Delta H_{H_2O_{(s)}}$$

$$= n_{C_P \Delta T} + \Delta H_{fus} + n_{C_P \Delta T}$$

$= 1\times75.3\times5 + 6000 + 1\times 36.8\times5$

$= 6560.5$ J $mole^{-1}$ or 6.56 kJ $mol^{-1}$

**34.** **(2)**

$\Delta H = nC_P\Delta T = O$

$$\Delta S = nR\ \ell n\left(\frac{V_f}{V_i}\right) \qquad (\because V_f > V_i)$$

$\therefore$ Enthalpy remains constant but entropy increases.

**35.** **(3)**

In a reversible process, the driving and the opposite forces are nearly equal, hence the system and the surroundings always remain in equilibrium with each other.

**36.** **(4)**

At equilibrium $\Delta G$ (Gibbs energy) = 0 but $\Delta G^\circ$ (standard Gibbs energy) may or may not be zero.

As $\Delta G$ (Gibbs energy) is more negative reaction will be more spontaneous.

**37.** **(1)**

Statement 2 is II$^{nd}$ law of thermodynamics which concludes that total heat can never be converted into equivalent amount of work.

**38.** **(4)**

Heat (q) and work (w) are path functions.

**39.** **(3)**

$\Delta_r C_p = 0,$

$\therefore \quad \Delta H_{300} = \Delta H_{310}$

**40.** **(4)**

$$H_2C_2O_4(\ell) + \frac{1}{2}O_2(g) \rightarrow H_2O(\ell) + 2CO_2(g);$$

$\Delta n_g = 3/2$

$$\Delta U_c = -\frac{0.312\times8.75}{1}\times 90 = -245.7 \text{ kJ/mol}$$

$\Delta H = \Delta U + \Delta n_g RT$

$$= -245.7 + \frac{3}{2}\times\frac{8.314\times300}{1000}$$

$= -241.947$ kJ/mol.

**41.** **(3)**

For same amount of gas at constant temperature, lesser is the volume, lower will be the entropy.

**42.** **(1)**

$$C_2H_4 + H_2 \longrightarrow C_2H_6$$

| | | |
|---|---|---|
| 50 ml | 50 ml | 0 |
| X | X | 50 ml |

$\Delta H = \Delta U + P(\Delta V)$

$-0.31 = \Delta U + 1.5 \times 1.01 \times 10^5 (-50 \times 10^{-6}) \times 10^{-3}$

$\Delta U = -0.3024$ kJ.

**43.** **(1)**

$\Delta E = q + w$

$$W_{BC} = \frac{1}{2}(2V^\circ - V^\circ)(P^\circ - 3P^\circ) + (2V^\circ - V^\circ)(0 - P^\circ) = -2P^\circ V^\circ$$

$$\Delta E = nC_V\Delta T = 1\times\frac{3}{2}R\left(\frac{P^\circ 2V^\circ}{R} - \frac{3P^\circ V^\circ}{R}\right)$$

$$= -\frac{3}{2}P^\circ V^\circ$$

$$q_{BC} = \Delta E - W = -\frac{3}{2}P^\circ V^\circ + 2P^\circ V^\circ = \frac{1}{2}P^\circ V^\circ$$

**44.** **(1)**

$$H^+(aq) + OH^-(aq) \longrightarrow H_2O(\ell)$$

So, $\Delta H^\circ = -57.3 = -285.8 - \Delta H_f^\circ(H+, aq) - \Delta H_f^\circ(OH^-, aq)$

So, $\Delta H_f^\circ(OH^-, aq) = -228.5$ kJ/mole (as $\Delta H_f^\circ(H^+, aq) = 0$)

**45.** **(1)**

Since, expansion occurred at constant temperature,

$$\Delta S = nR\ \ln\frac{V_2}{V_1} = \frac{1}{32}\times 8.314\ \ln\frac{3.0}{0.75} = 0.36 \text{ JK}^{-1}$$

Since, this is case of free expansion, $P_{ext} = 0$.

$\Rightarrow \quad -W = P_{ext}\Delta V = 0, q = 0$

Also, since, $\Delta T = 0 \Rightarrow \quad \Delta H = \Delta E = 0$.

**46. (1)**

$$\Delta S_f = \frac{\Delta H_f}{T_f}$$

$$\Delta S_f = \frac{2930\ J\ mol^{-1}}{300\ K} = 9.77\ JK^{-1}\ mol^{-1}$$

**47. (1)**

$$CH_4 + \frac{1}{2}O_2 \longrightarrow CH_3OH(\ell)$$

$\therefore$ $\Delta H$ = –[($\Delta H$ of combustion of $CH_3OH$) – ($\Delta H$ of combustion of $CH_4$)]

= – [(– y) – (– x)]

= – [ – y + x] = y – x

$\therefore$ x > y

**48. (1)**

In closed insulated container a liquid is stirred with a paddle to increase the temperature, therefore No heat exchange with surrounding, so for it q = 0.

Hence, from first law of thermodynamics

$\Delta E = q + W$

if, q = 0

$\therefore$ $\Delta E$ = W but not equal to zero.

$\therefore$ $\Delta E = W$

**49. (4)**

$$C = \frac{q}{n(T_2 - T_1)}$$

Given that,

C = 75 $JK^{-1}\ mol^{-1}$,

q = 1.0 kJ = 1000 J

$$75 = \frac{1000}{5.55\ x\ \Delta T} \left(n = \frac{100}{18} = 5.55\right)$$

$$\therefore \Delta T = \frac{1000}{5.55 \times 75} = 2.4\ K$$

**50. (4)**

For the reaction,

$C_3H_8(g) + 5O_2(g) \longrightarrow 3CO_2(g) + 4H_2O\ (\ell)$

$\Delta n$ = number of gaseous moles of products – number of gaseous moles of reactants

= 3 – 6 = – 3

$\therefore$ $\Delta H = \Delta E + \Delta nRT$

or, $\Delta H - \Delta E = \Delta nRT$

$\therefore$ $\Delta H - \Delta E = -3RT$

**51. (4)**

For the reaction

$H_2(g) + Br_2(g) \longrightarrow 2HBr(g)$ $\Delta H° = ?$

$\Delta H°$ = – [(2 x bond energy of HBr) – (bond energy of $H_2$ + bond energy of $Cl_2$)]

$\Delta H°$ = – [(2 x (364) –( 433 + 192)] kJ

= –[ 728 – (625)] kJ

**52. (1)**

For spontaneous process, $\Delta S$ must be positive.

In reversible process

$\Delta S_{system} + \Delta S_{surrounding} = 0$

Hence, system is present in equilibrium.

(i.e, it is not spontaneous process)

While in irreversible process

$\Delta S_{system} + \Delta S_{surrounding} > 0$

Hence, in process $\Delta S$ is positive.

**53. (2)**

The spontaneity of a reaction is based upon the negative value of $\Delta G$ and $\Delta G$ is based upon T, $\Delta S$ and $\Delta H$ according to following equation (Gibb's-Helmholtz equation)

$\Delta G = \Delta H - T\Delta S$

If the magnitude of $\Delta H - T\Delta S$ is negative, then the reaction is spontaneous.

When $T\Delta S > \Delta H$ and $\Delta H$ and $\Delta S$ +ve, then $\Delta G$ is negative.

**54. (1)**

Heat of neutralization of strong acid and strong base is –57.33 kJ·MgO is weak base while HCl is strong acid, so the heat of neutralization of MgO and HCl is lower than –57.33 kJ because MgO requires some heat for ionisation, then net released amount of heat is decreased.

**55.** **(1)**

As we know that

$\Delta H = \Delta E + p\Delta V$

Or $\Delta H = \Delta E + \Delta nRT$

Where, $\Delta n \rightarrow$ no. of gaseous mole of product – no. of gaseous moles of reactant

If $\Delta n = 0$ (for reactions in which the number of moles of gaseous product are equal to number of moles of gaseous reactants), therefore $\Delta H = \Delta E$

So, for reaction (1) $\Delta n = 2 - 2 = 0$

Hence, for reaction (1) = $\Delta H = \Delta E$

**56.** **(1)**

(I) $\Delta V = 0$ ; $W = 0$

(II) $\Delta T = 0$ ; $\Delta U = 0$

(III) In vacuum, $P_{ext} = 0$

(IV) At M.P, $\Delta U > 0$.

**57.** **(3)**

For adiabatic process, $q = 0$ ;

For Isoenthalpic process, $\Delta H = 0$

For Isothermal process, $\Delta T = 0$ ;

For Isoentropic process, $\Delta S = 0$

**58.** **(1)**

$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(g)$ ;

$\Delta H_f = -\varepsilon_1$, ....(i)

$H_2O(g) \longrightarrow H_2O(l)$ ;

$\Delta H_f = -\varepsilon_2$, ....(ii)

and (i) and (ii).

$H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$. ; $\Delta H = -(\varepsilon_1 + \varepsilon_2)$.

**59.** **(1)**

Reversible adiabatic process is also called on Isoentropic process.

**60.** **(4)**

For spontaneity. $\Delta G < 0$.

## Integer Type Questions (61 to 75)

**61.** **(213)**

From 1st law of thermodynamics

$\Delta U = q + W$

$Q = +800$ J

$W = -P(V_2 - V_1)$

$= -1(20 - 10) = -10\ dm^3\ atm = -10 \times 101.3$ J

$W = -1013$ J

$\Delta U = 800\ J + (-1013\ J) = -213$ J

**62.** **(0)**

When an ideal gas expands in vacuum the work done is zero as in vacuum there is no force of attraction or repulsion

**63.** **(400)**

$\frac{1}{2}A-A + \frac{1}{2}B-B \rightarrow AB,\ \Delta H = -100$ KJ/mole

$\frac{1}{2}x + \frac{1}{2}(0.5x) - x = -100$

$\Rightarrow \frac{x}{2} + 0.25x - x = -100$

$\Rightarrow -0.25x = -100$

$\Rightarrow x = \frac{100}{25} \times 100$

$\Rightarrow x = 400$ kJ/mol

**64.** **(350)**

$nCH_2 = CH_2 \longrightarrow (-CH_2 - CH_2-)_n$

$\Delta H = -100$ KJ/mole

$n[C=C] + n[C-H]4 - n[C-H]4 - n[C-C] \times 2 = -100n$

$n[C=C] - 2n[C-C] = -100$

$\Rightarrow [C=C] - 2[C-C] = -100$

$\Rightarrow +600 - 2[C-C] = -100$

$\Rightarrow -2[C-C] = -700$ KJ/mole

$\Rightarrow (C-C) = -350$

**65.** **(370)**

$\Delta n_g = 0$

$\Rightarrow \Delta H^o = \Delta U^o$

For 2 mole $\Delta U^o = -370$ kJ.

**66.** **(38)**

$\Delta U = \Delta H - \Delta nRT$

$= 41000 - 1 \times 8.314 \times 373 = 41000 - 3101.122$

$= 37898.878 \text{ J mol}^{-1} = 37.9 \text{ kJ mol}^{-1}$.

**67.** **(352)**

$\frac{1}{2} N_2(g) + \frac{3}{2} H_2(g) \longrightarrow NH_3(g)$ ;

$\Delta H_f^o = -46.0 \text{ kJ mol}^{-1}$

$2H(g) \rightarrow H_2(g)$ ; $\Delta H_f^o = -436 \text{ kJ mol}^{-1}$

$2N(g) \rightarrow N_2(g)$ ; $\Delta H_f^o = -712 \text{ kJ mol}^{-1}$

$NH_3(g) \rightarrow \frac{1}{2} N_2(g) + \frac{3}{2} H_2(g)$ ; $\Delta H = +46$

$\frac{3}{2} H_2 \longrightarrow 3H$ ; $\Delta H = +436 \times \frac{3}{2}$

$\frac{1}{2} N_2 \longrightarrow N$ ; $\Delta H = +712 \times \frac{1}{2}$

$NH_3(g) \rightarrow N(g) + 3H(g)$; $\Delta H = +1056 \text{ kJ mol}^{-1}$

Average bond enthalpy of N–H bond $= \frac{1056}{3}$

$= +352 \text{ kJ mol}^{-1}$

**68.** **(44)**

$\Delta H = \Delta U + \Delta(PV)$

$\Rightarrow \quad \Delta H = 30 + (P_2V_2 - P_1V_1)$

$= 30 + (4 \times 5 - 2 \times 3) = 30 + 14 = 44$ L atm.

**69.** **(0)**

$\because$ H = E + PV and $\Delta H = \Delta E + P\Delta V$

$P\Delta V = nRT$.

$\therefore \Delta H = \Delta E + nR\Delta T$

For isothermal and reversible process

$\Delta T = 0$. $\quad \therefore \Delta H = \Delta E + 0$.

$\because \quad \Delta E = 0$.

$\because \quad \Delta H$ is also equal to zero.

**70.** **(425)**

$\Delta_f H_{(HCl)} = -90 = \frac{1}{2} \times 430 + \frac{1}{2} \times 240 - \Delta H_{BE(HCl)}$

**71.** **(53)**

Enthalpy of neutralization is defined as amount of heat liberated when one mole of a strong acid is completely neutralized by one mole of a strong base. Its value is less in case of weak acid or weak base because small amount of heat is utilized in ionising the weak acid/base.

$\Delta H$ for ionisation of $CH_3COOH$ = Heat of neutralization for $CH_3COOH$ – Heat of neutralization of strong acid

$= -50.6 - (-55.9)$ kJ / mol = + 5.3 kJ / mol

**72.** **(110)**

$C(s) + O_2(g) \rightarrow CO_2(g)$ ; $\Delta H = -393.5$ kJ/mol.

$CO(g) + \frac{1}{2} O_2(g) \rightarrow CO_2(g)$;

$\Delta H = -283.5$ kJ/mol.

$C(s) + \frac{1}{2} O_2(g) \rightarrow CO(g)$ ;

$\Delta H = -393.5 + 283.5$ kJ/mol $= -110$ kJ/mol.

**73.** **(1)**

$\Delta G^o = \Delta H^o - T.\Delta S^o = -29.8 + 298 \times (0.1)$

$= -29.8 + 29.8$

$\because \Delta G^o = 0$

Apply relation between $\Delta G^o$ & $K_{eq}$

$\Delta G^o = -RT \ell n K_{eq}$

$\therefore K_{eq} = 1$

**74.** **(270)**

$\Delta H = \Delta U + \Delta n_g RT$

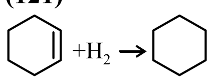
$= 2.1 + \frac{2 \times 2 \times 300}{1000} = 3.3$

$\Delta G = \Delta H - T\Delta S$

$= 3.3 - 300 \times \frac{20}{1000}$

$= 3.3 - 6 = -2.7$ K cal $= -270$ cal.

**75.** **(121)**




$\Delta H = -[\Delta H$ of combustion of cyclohexane – ($\Delta H$ of combustion of cyclohexene + $\Delta H$ of combustion of $H_2$)]

$= -[-3920 - (-3800 - 241)]$ kJ

$= -[-3920 + 4041]$ kJ $= -[121]$ kJ $= -121$ kJ

# CHEMICAL EQUILIBRIUM

## Single Option Correct Type Questions (01 to 60)

**1.** **(2)**

**Sol:** $\log \frac{K_P}{K_C} + \log RT = 0$

$\log\left(\frac{K_P}{K_C}.\ RT\right) = 0$

$K_P = K_C (RT)^{-1}$

$\because\ K_P = K_C (RT)^{\Delta n}$ ; $\Delta n = -1$

This is possible one for option (2)

**2.** **(3)**

**Sol:** $K = \frac{r_f}{r_b}$

$\Rightarrow\ 1.5 = \frac{r_f}{7.5\times10^{-4}}$

$\Rightarrow\ r_f = 1.12 \times 10^{-3}$.

**3.** **(4)**

**Sol:** $K_p = K_c (RT)^{\Delta n}$, $\Delta n^2\ 4 - 3 = 1$

$.05 = K_c\ R \times 1000$

$K_c = 5 \times 10^{-5} \times R^{-1}$

$K_c = \frac{5\times10^{-5}}{R}$

**4.** **(1)**

**Sol:** Concentration of reactant & product remains const. w.r.t time.

At Equilibrium the rate of forward reaction ($r_f$) = rate of backward reaction.

**5.** **(4)**

**Sol:** $SO_2(g) + 1/2O_2(g) \rightleftharpoons SO_3(g)$

$K_p = 4\times10^{-3}$

$SO_3 \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

$K^1{}_p = \frac{1}{Kp}$

$K^1{}_p = \left(\frac{1}{4\times10^{-3}}\right)$

$2SO_3 \rightleftharpoons 2SO_2 + O_2(g)$

$K^{II}{}_p = (K^I{}_p)^2 = \left[\frac{1}{4\times10^{-3}}\right]^2$

$= \left[\frac{1000}{4}\right]^2 = 6.25\times10^4$ atm.

**6.** **(2)**

**Sol:** $C_2H_5OH(\ell) + CH_3COOH(\ell) \rightleftharpoons CH_3COOC_2H_5(\ell) + H_2O(\ell)$.

| | | | |
|---|---|---|---|
| a | a | 0 | 0 |
| a 0.33a | a – 0.33a | 0.33a | 0.33a |

$K_C = \frac{(0.33a)\times(0.33a)}{(0.67a)\times(0.67a)} = K_C = 1/4$.

**7.** **(2)**

**Sol:** $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

| | | | |
|---|---|---|---|
| t = 0 | 1.5 | 1.5 | 0 |
| $t = t_{eq}$ | 1.5 – x | 1.5 – x | 2x |

We know, 1.5 – x = 1.25, or x = .25

$K_c = \frac{(.5)^2}{(1.25)^2} = .16$

**8.** **(2)**

**Sol:** $N_2 + 3H_2 \rightleftharpoons 2NH_3$, $K_P = 4.28 \times 10^{-5}\ atm^{-2}$

Reaction Quotient, $Q_P = \dfrac{P^2_{NH_3}}{P_{N_2}(PH_2)^3} = \dfrac{3^2}{1\times(2)^3}$

$= \dfrac{9}{8}$ $\quad Q_P > K_P$,

$\therefore$ Reaction will go Backward.

**9.** **(1)**

**Sol:** $Q = \dfrac{[C]^3}{[A]^2[B]} = \dfrac{(3/3)^3}{(2/3)^2(1/3)} = 6.75$

$Q < K_C$

The reaction will proceed in forward direction to attain equilibrium.

**10.** **(2)**

**Sol:** $N_2O_4(g) \rightleftharpoons 2NO_2(g)$

| | $N_2O_4(g)$ | $2NO_2(g)$ |
|---|---|---|
| Initially, t = 0 | a | 0 |
| | a – aα | 2aα |

$K_P = \dfrac{4\alpha^2}{1-\alpha^2}$

$P = 380\ torr = \dfrac{380}{760} = .5\ atm$

$\dfrac{\alpha^2}{1-\alpha^2} = .335$, $\alpha^2 = .25$, $\alpha = .5$

**11.** **(4)**

**Sol:** Since inert gas addition has no effect at const. volume.

**12.** **(1)**

**Sol:** (I) $\Delta n_g$ is +ve so as P is increased, backward shifting will take place.

(II) No change as $\Delta n_g = 0$.

(III) Forward shifting will take place.

**13.** **(1)**

**Sol:** $2CO_2 \rightleftharpoons 2CO + O_2$

| | $2CO_2$ | $2CO$ | $O_2$ |
|---|---|---|---|
| t = 0 | 2 | 0 | 0 |
| t = $t_{eq.}$ | $2 - 2\times\dfrac{40}{100}$ | $2\times\dfrac{40}{100}$ | $\dfrac{40}{100}$ |

Total moles at equilibrium

$= n_{CO_2} + n_{O_2} + n_{CO}$

$= 2 - 2\times\dfrac{40}{100} + 2\times\dfrac{40}{100} + \dfrac{40}{100} = 2.4$

**14.** **(1)**

**Sol:** $2P(g) + Q(g) \rightleftharpoons 3R(g) + S(g)$

| | 2P(g) | Q(g) | 3R(g) | S(g) |
|---|---|---|---|---|
| t = 0 | 2 | 2 | 0 | x/2 |
| t = teq | 2 – x | 2 – x/2 | 3/2 x | x/2 |

From above, at equilibrium $2 - x < 2 - x/2$

$\therefore$ [P] < [Q] at equilibrium

**15.** **(4)**

**Sol:** Equilibrium constant (K) depends on the stoichiometry of the reaction.

**16.** **(1)**

**Sol:** $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

| | $PCl_5(g)$ | $PCl_3(g)$ | $Cl_2(g)$ |
|---|---|---|---|
| t=0 | 1 | 0 | 0 |
| t=$t_{eq}$ | 1 – x | x | x |

Total moles = 1 + x

Given $\dfrac{1-x}{1+x} = 0.4$

$x = \dfrac{3}{7}$

$x_{PCl_3} = \dfrac{\frac{3}{7}}{1+\frac{3}{7}} = 0.3.$

**17.** **(3)**

**Sol:** $SO_2 + \dfrac{1}{2}O \rightleftharpoons SO_3$

5 moles $\quad$ 5 moles 0

$5 - 5\times\dfrac{60}{100}\quad 5 - \dfrac{1}{2}\times 5\times\dfrac{60}{100}\quad 5\times\dfrac{60}{100}$

= 2 + 3.5 + 3 = 8.5 moles

**18.** **(4)**

**Sol:** Suppose $NO_2$ = xg. Then $N_2O_4$ = (100 – x) g

Moles of $NO_2 = \dfrac{x}{46}$, Moles of $N_2O_4 = \dfrac{100-x}{92}$

Mole fraction of $NO_2$

$$= \frac{x/46}{x/46 + (100-x)/92} = \frac{x}{46} \times \frac{92}{100+x}$$

$$= \frac{2x}{100+x}$$

Mole fraction of $N_2O_4$

$$= 1 - \frac{2x}{100-x} = \frac{100-x}{100+x}$$

Molar mass of mixture $= \frac{2x}{100+x} \times 46 + \frac{100-x}{100+x} \times 92 = \frac{9200}{100+x}$

$$\therefore \quad \frac{9200}{100+x} = 2 \times 38.3 = 76.6$$

or $76.6x = 9200 - 7660 = 1540$

or $x = 20.10$ g

$\therefore$ Moles of $NO_2 = \frac{20.10}{46} = 0.437$

**19. (2)**

**Sol:** At equilibrium $\Delta G = 0$

Given $\Delta G^0 = 0$

Gibbs equation $\Delta G = \Delta G^o - RT \ln K$

$0 = 0 - RT\ln K$

$\Rightarrow K = e^0 = 1$

**20. (3)**

**Sol:** $\ln \frac{K_2}{K_1} = \frac{\Delta H}{2.303R}\left[\frac{1}{11} + \frac{1}{12}\right]$

**21. (2)**

**Sol:** $2A(s) + 3B(g) \rightleftharpoons 3C(g) + D(g) + O_2$

If pressure on system is reduced to half its original value then equilibrium will shift in forward direction to increase no. of moles of gas to compensate reduction of pressure.

$\therefore$ Amounts of C & D will increase

**22. (3)**

**Sol:** If total pressure is decrease equilibrium will shift in the direction in which no. of moles of gas will increase.

$N_2O_2 \rightleftharpoons 2NO_2$

**23. (2)**

**Sol:** If P↑, then V↓, then equilibrium will shift in a direction so as to increase volume i.e. forward direction more $H_2O$ ($\ell$) will form.

**24. (4)**

**Sol:** Rate of catalytic reaction is fast & yield is also appreciable for this exothermic reaction at this temperature.

**25. (4)**

**Sol:** $aA + bB \rightleftharpoons cC + dD$

At high temp. & low pressure equilibrium is shifting in backward direction. It means $(a + b) > (c + d)$.

**26. (1)**

**Sol:** $K_1 = \frac{(SO_3)}{(SO_2)(O_2)^{1/2}}$

$K_2 = \frac{(SO_2)^4(O_2)^2}{(SO_3)^4} = \frac{1}{(K_1)^4}$

$\Rightarrow K_2 = \frac{1}{(K_1)^4}$

**27. (2)**

**Sol:** $K_{C_3} = \frac{1}{K_{C_1} \times K_{C_2}^2}$

**28. (3)**

**Sol:**

| | $N_2 +$ | $3H_2$ | $\rightleftharpoons 2NH_3$ |
|---|---|---|---|
| t = 0 | 2 | 4 | 0 |
| $t = t_{eq}$ | 2–x | 4–3x | 2x |

$2x = 2$ mole of $NH_3$

$x = 1$

So, $n_{N_2} = 2 - x = 2-1 = 1$

$n_{H_2} = 4 - 3x = 4 - 3\times1 = 1$

$n_{NH_3} = 2x = 2$

**29.** **(2)**

**Sol:** $A \rightleftharpoons B + C$

1 0 0

$1-\alpha$ $\alpha$ $\alpha = (1+\alpha)$

$$Kp_1 = \frac{\alpha^2}{1-\alpha^2} \cdot p_1$$

$D \rightleftharpoons 2E$

1 0

$1-\alpha$ $2\alpha = (1+\alpha)$

$$K_{p_2} = \frac{4\alpha^2}{1-\alpha^2} \cdot p_2$$

$$\frac{K_{p_1}}{K_{p_2}} = \frac{p_1}{4p_2}$$

So, $\frac{p_1}{p_2} = 4 \cdot \frac{Kp_1}{Kp_2} = 4 \times 9 = 36 : 1.$

**30.** **(2)**

**Sol:** $2SO_3(g) \rightleftharpoons 2SO_2(g) + O_2(g)$

t=0 1 0 0

$t=t_{eq.}$ $(1-\alpha)$ $\alpha$ $\left(\frac{\alpha}{2}\right)$

Total mole at eq. = $\left(1+\frac{\alpha}{2}\right)$

$$P_{SO_3} = \left(\frac{1-\alpha}{1+\frac{\alpha}{2}}\right) P_0 = \left[\frac{2(1-\alpha)}{2+\alpha}\right] \times P^o$$

$$P_{SO_2} = \left(\frac{\alpha}{1+\frac{\alpha}{2}}\right) P_0 = \left(\frac{2\alpha}{2+\alpha}\right) \times P^o$$

$$K_P = \frac{\frac{4\alpha^2 (P^o)^2}{(2+\alpha)^2} \times \left(\frac{\alpha}{2+\alpha}\right) \times P^o}{\frac{4(1-\alpha)^2}{[2+\alpha]^2} \times (P_0)^2}$$

$$K_P = \left[\frac{\alpha^3 P^o}{(2+\alpha)(1-\alpha)^2}\right]$$

**31.** **(4)**

**Sol:** $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

2 0 0

$2-\frac{40}{100}\times 2$ 0.8 0.8

$2-0.8 = 1.2$

So, $[PCl_5]\ \frac{1.2}{2} = 0.6$

$$[PCl_3] = \frac{0.8}{2} = 0.4$$

$$[Cl_2] = \frac{0.8}{2} = 0.4$$

$$K_C = \frac{[PCl_3]\ [Cl_2]}{[PCl_5]} = \frac{0.4 \times 0.4}{0.6} = \frac{1.6}{0.6} = 0.267$$

**32.** **(2)**

**Sol:** $N_2 + 3H_2 \rightleftharpoons 2NH_3$

t = 0 1 mole 2 mole 0

t = eq $1-x$ $2-3x$ $2x = 0.8$

x = 0.4

Mole of $N_2$ = 0.6

Mole of $H_2$ = 0.8

**33.** **(1)**

**Sol:** Low temperature and high pressure

**34.** **(3)**

**Sol:** $N_2 + 3H_2 \rightleftharpoons 2NH_3$

In this reaction, the volume of product is less than that of reactants. Hence, according to Le-Chatelier's principle, the reaction will proceed in forward direction on increasing the pressure.

**35.** **(3)**

**Sol:** On increasing pressure, volume decreases and density increases, ie, equilibrium will shift towards densar side

**36.** **(2)**

**Sol:** Addition of inert gas at constant volume has no effect on equilibrium concentrations.

**37.** **(2)**

**Sol:** High press & high temp.

$H_2O(s) \rightarrow$ ice $\rightarrow$ has low density & high volume

$H_2O(\ell) \rightarrow$ has high density & low volume.

So, low volume $\rightarrow$ high pressure.

As reaction is endothermic high temperature is required.

**38.** **(4)**

**Sol:** If in the reaction the ratio of number of moles of reactants to products in same i.e., 1 : 1, then change in volume will not alter the number of moles.

**39.** **(4)**

**Sol:** $K_p = K_c (RT)^{\Delta n}$ ; $\Delta n = 1 - \left(1 + \frac{1}{2}\right) = 1 - \frac{3}{2} = -\frac{1}{2}$

$\therefore \frac{K_c}{K_p} = (RT)^{1/2}$

**40.** **(3)**

**Sol:** $C_{[N_2O_4]} = 4.8 \times 10^{-2}$ mol $L^{-1}$, $C_{[NO_2]} = 1.2 \times 10^{-2}$ mol $L^{-1}$

$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{1.2 \times 10^{-2} \times 1.2 \times 10^{-3}}{4.8 \times 10^{-2}} = 0.3 \times 10^{-2} = 3 \times 10^{-3}$ mol $L^{-1}$

**41.** **(4)**

**Sol:** $K_p = K_c (RT)^{\Delta n}$ $\qquad \Delta n = 3 - 2 = 1.$

$K_p = K_c (0.0821 \times 457)^1$ . $K_p > K_c$.

**42.** **(1)**

**Sol:** $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$

| | | | |
|---|---|---|---|
| Initial presence | 0 | 0.5 | 0 |
| At equilibrium | 0 | 0.5+x | x |

Total pressure = 0.5 + 2x = 0.84

$\therefore$ x = 0.17 atm

$K_p = P_{NH_3} \times P_{H_2S} = 0.11$ atm$^2$.

**43.** **(1)**

**Sol:** $K_P = \frac{(P_{SO_3})^2}{(P_{SO_2})^2 (P_{O_2})}$; Since $P_{SO_3} = P_{SO_2}$

$\Rightarrow P_{O_2} = \frac{1}{K_P} = \frac{1}{3.5} = 0.285$ atm

**44.** **(1)**

**Sol:** $N_2 + O_2 \rightleftharpoons 2NO$

Here, $\Delta n = O$

So, Increase in pressure at equilibrium has no effect on the Reaction.

Both, Assertion Reason are true and Reason is a correct explanation of Assertion.

**45.** **(2)**

**Sol:** $\Delta G = \Delta G° + RT \ln Q$

$= 2494.2 + 8.314 \times 300 \ln 4$

= positive

$\Delta G = RT \ell n \frac{Q}{K}$

Since, $\Delta G$ is positive so, Q > K, so reaction shifts in reverse direction.

**46.** **(2)**

**Sol:**

| | A + | B $\rightleftharpoons$ | C + | D |
|---|---|---|---|---|
| t = 0 | 1 | 1 | 1 | 1 |
| $t_{eq}$ | 1–x | 1–x | 1 + x | 1 + x |

$\Rightarrow \frac{(1+x)^2}{(1-x)^2} = 100 \Rightarrow \frac{1+x}{1-x} = 10$

$\Rightarrow 1 + x = 10 - 10x \Rightarrow 11x = 9$

$\Rightarrow x = \frac{9}{11} \qquad \Rightarrow [D] = 1 + \frac{9}{11}$

$\Rightarrow [D] = 1.818$

**47.** **(4)**

**Sol:** On increasing pressure, reaction shifts in the direction of increasing density. Water has higher density than ice.

So, reaction shifts in forward direction.

**48.** **(1)**

**Sol:** Addition/ removal of a solid component from an equilibrium system causer no shift in equilibrium (Both Q & K remain unaffected)

**49.** **(4)**

**Sol:** $K_P = K_C (RT)^{\Delta ng}$

$\Rightarrow K_C = \frac{K_P}{(RT)^{\Delta ng}} = \frac{1.44 \times 10^{-5}}{(0.082 \times 773)^{-2}}$

**50.** **(2)**

**Sol:** $N_2 + 3H_2 \rightleftharpoons 2NH_3$

| | $N_2$ | $3H_2$ | $2NH_3$ |
|---|---|---|---|
| t = 0 | 1 mole | 2 mole | 0 |
| t = eq | 1–x | 2–3x | 2x = 0.8 |

x = 0.4

mole of $N_2$ = 0.6

mole of $H_2$ = 0.8

**51.** **(2)**

**Sol:** Reaction quotient Q, has the same form as the equilibrium constant $K_{eq}$. It is evaluated using any concentration. If Q is not equal to equilibrium, then a reaction will occur.

Here both Assertion and Reason are correct but Reason is not a correct explanation or Assertion.

**52.** **(2)**

**Sol:** $CO + H_2O \rightleftharpoons CO_2 + H_2$

| | CO | $H_2O$ | $CO_2$ | $H_2$ |
|---|---|---|---|---|
| t = 0 | 1 | 1 | 1 | 0 |
| $t = t_{eq}$ | 1 – x | 1 – x | 1 + x | x |

At equilibrium, only $CO_2$ has (1 + x) moles.

**53.** **(1)**

**Sol:** $2A_8 \rightleftharpoons 2A_3 + 3A_2 + A_4$

| | $2A_8$ | $2A_3$ | $3A_2$ | $A_4$ |
|---|---|---|---|---|
| t = 0 | 2 | 0 | 0 | 0 |
| $t = t_{eq}$ | 2 – 2α | 2α | 3α | α |

$n_T = 2 + 4\alpha$

given mole fraction of $A_2$ is = 0.36.

$$0.36 = \frac{3\alpha}{2+4\alpha}$$

α = 0.46

$$\text{Mole fraction of } A_8 = \frac{2-2\alpha}{2+4\alpha} = \frac{2-2\times 0.46}{2+4\times 0.46}$$

= 0.28

**54.** **(2)**

**Sol:** Let x is partial pressure of A and y is partial pressure of C when both equilibrium simultaneously established in a vessel

$X(s) \rightleftharpoons A(g) + 2B(g)$

X (2x + 2y)

$Y(s) \rightleftharpoons C(g) + 2B(g)$

Y (2y + 2x)

$$\frac{K_{P_1}}{K_{P_2}} = \frac{x}{y}$$

⇒ x = 2y

$K_{P_1} = x(2x + 2y)^2$

⇒ x = 0.1 atm;

∴ y = 0.05 atm

Total pressure of gases = $P_A + P_B + P_C$

= 3(x + y)

= 0.45 atm.

**55.** **(1)**

**Sol:** A catalyst does not influences the values of equilibrium constant but Catalysts influence the rate of both forward and backward reactions equally

**56.** **(1)**

**Sol:** $NO + \frac{1}{2}O_2 \rightleftharpoons NO_2$

$\Delta G^{\circ} = 52 - 87 = -35$ kJ

⇒ $\Delta G^{o} = -RT\ln K_{eq}$

$$\Rightarrow \ln K_{eq} = \frac{35000}{8.314\times 298}.$$

**57.** **(1)**

**Sol:** $2H_2O(g) + 2Cl_2(g) \rightleftharpoons 4HCl(g) + O_2(g)$

$K_p = 0.03$

T = 477°c = 700 K

$K_p = K_c(RT)^1$

$$K_c = \frac{K_p}{RT} = \left[\frac{0.03}{0.082\times 700}\right]$$

⇒ $K_c = 5.23\times 10^{-4}$

**58.** **(2)**

**Sol:** $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

At equilibrium $\frac{P}{3}$ P $\frac{P}{3} + P + P_{NH_3} = 2P$

$$P_{NH_3} = \frac{2\ P}{3}$$

$$K_p = \frac{\frac{2}{3}P \times \frac{2}{3}P}{\frac{P}{3} \times P^3} = \frac{1}{P^2}.\frac{4}{3}$$

$$\Rightarrow K_p = \frac{4}{3\ P^2}$$

**59.** **(1)**

**Sol:** $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

1mole 2mole 3mole

$$K_C = \frac{(3)^2}{1 \times 2} = \left(\frac{9}{2}\right).$$

Let a mole of $O_2$ is added, Then,

| | $N_2(g)$ + | $O_2(g)$ $\rightleftharpoons$ | $2NO(g)$ |
|---|---|---|---|
| | 1mole | 2mole | 3mole |
| t=0 | 1 | (2 + a) | 3 |
| | (1–x) | (2 + a)–x | (3 + 2x) |

$$[NO] = \left[\frac{3+2x}{100}\right] = 0.04; \quad (3 + 2x) = 4.$$

$2x = 1, \quad x = 0.5.$

$$K_C = \frac{(3+2x)^2}{(1-x)(2+a-x)} = \frac{9}{2}.$$

$$K_C = \frac{(4)^2}{0.5[(1.5)-a]} = \frac{9}{2} = \frac{16}{0.5(1.5+a)} = \frac{9}{2}$$

$$= \frac{35}{4.5} = [1.5 + a]$$

$7.11 = 1.5 + a$ .

$$a = \frac{101}{18} = 5.61$$

**60.** **(1)**

**Sol:** As pressure is increased at $eq^m$, the reaction will shift towards the formation of a denser product.

## *Integer Type Questions (61 to 75)*

**61.** **(16)**

**Sol:** Since, $K_p$ is temperature dependent only.

**62.** **(6)**

**Sol:** $\Delta G^o = -RT \ln K_{eq}$

$$15000 = -\frac{25}{3} \times 300 \ln K_{eq}$$

$K_{eq} = e^{-6} = e^{-x}$

$$\ln K_{eq} = -\frac{15000}{2500} = -6,$$

$\Rightarrow x = 6$

**63.** **(1)**

**Sol:** $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

| | $H_2(g)$ | $I_2(g)$ | $2HI(g)$ |
|---|---|---|---|
| t = 0 | 4.5 | 4.5 | 0 |
| $t = t_{eq.}$ | 4.5 – x | 4.5 – x | 2x |
| put | x = 1.5 | | |
| | 4.5 – 1.5 ↓ 3 | 4.5 – 1.5 ↓ 3 | 2 × 1.5 = 3 ↓ 3 |

$$K_C = \frac{(3)^2}{3 \times 3} = 1$$

**64.** **(16)**

**Sol:** $C(s) + CO_2(g) \rightleftharpoons 2CO(g)$

P–P/2 $\quad P = \frac{3P}{2} = 12$

$$\text{So, } K_P = \frac{P^2}{(P/2)} = 2P = 2 \times 8 = 16 \text{ atm.}$$

**65.** **(50)**

**Sol:** $P_{C_2} = 2.80 - (0.80 + 0.40) = 1.60$ atm,

$$k_p = \frac{P_{C_2}^2}{P_{A_2} \times P_{B_2}^3} = \frac{(1.60)^2}{0.80 \times (0.40)^3} = 50$$

**66.** **(4)**

**Sol:** $\alpha \propto \frac{1}{\sqrt{P}}$ If v increase 16 time ⇒ P because P/16

⇒ α becomes 4 times.

**67.** **(50)**

**Sol:** $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$

$$K_c = \frac{[NO]^2}{[N_2][O_2]} = 4 \times 10^{-4}$$

$NO(g) \rightleftharpoons \frac{1}{2}N_2(g) + \frac{1}{2}O_2(g)$

$K_c = \frac{[N_2]^{1/2}[O_2]^{1/2}}{[NO]}$

$= \frac{1}{\sqrt{K_c}} = \frac{1}{\sqrt{4\times10^{-4}}} = \frac{1}{2\times10^{-2}} = \frac{100}{2} = 50$

**68. (400)**

**Sol:** $SO_3(g) \rightleftharpoons SO_2(g) + \frac{1}{2}O_2(g)$

$\frac{[SO_2][O_2]^{1/2}}{[SO_3]} = K_C = 5 \times 10^{-2}$ ..........(i)

$SO_3(g) + 1/25\ O_2(g) \rightleftharpoons SO_3(g)$ .........(ii)

$\frac{[SO_3]}{[SO_2][O_2]^{1/2}} = K'_C = \frac{1}{5\times10^{-2}}$

For $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

$\frac{[SO_3]^2}{[SO_2]^2[O_2]} = K_C{}^2 = \frac{1}{5\times5\times10^{-4}} = \frac{10000}{25} = 400$

**69. (50)**

**Sol:** $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

$K = 2 \times 10^{-2}$

$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$

$K' = \frac{1}{2\times10^{-2}} = 50$

**70. (25)**

**Sol:** $XY(s) \rightleftharpoons X(g) + Y(g)$

At eq. P P

Total pressure = 2P = 10 bar $\Rightarrow$ P = 5

Now, $K_P = (P_X)(P_Y) = P^2 = 25$

**71. (10)**

**Sol:** $\Delta G^o = \Delta H^o - T\Delta S^o = -54.07 \times 1000 - 298 \times 10$

$= -54070 - 2980 = -57050$

$\Delta G^o = -2.303\ RT \log_{10} K - 57050$

$= -2.303 \times 298 \times 8.314 \log_{10}K$

$= -5705 \log_{10} K \Rightarrow \log_{10} K = 10$

**72. (1)**

**Sol:**

| | A | + | B | $\rightleftharpoons$ | C | + | D |
|---|---|---|---|---|---|---|---|
| t = 0 | 4 | | 4 | | 0 | | 0 |
| t = teq | 4 – 2 | | 4 – 2 | | 2 | | 2 |

$K_C = \frac{2\times2}{2\times2} = 1$

**73. (18)**

**Sol:** $2NO \rightleftharpoons N_2 + O_2$   $\alpha = 10\%$

| | 2NO | $N_2$ | $O_2$ | |
|---|---|---|---|---|
| t = 0 | 4 – 0.4 | 0.2 | 0.2 | |
| | 3.6 | 0.2 | 0.2 | $\Delta n = 0$, |

$\therefore K_P = K_C,\ K_C = \frac{(.2/V)^2}{(3.6/V)^2} = \frac{4}{36\times36}$

$= \frac{1}{(18)^2} = x^{-2} \Rightarrow x = 18$

**74. (36)**

**Sol:** $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$

0.5 atm   0.5–p   2p

Total pressure = 0.5 – P + 2P = 0.8   P = 0.3

$K_p = \frac{P_{CO}^2}{P_{CO_2}} = \frac{(2P)^2}{(0.5-P)} = \frac{(0.6)^2}{(0.5-0.3)}$

$K_p = 1.8 = \frac{x}{20} \Rightarrow x = 36$

**75. (30)**

**Sol:** $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

$K_C = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$ Concentration in gram mole/litre, therefore

$[SO_3] = \frac{48}{80\times1}$

(Where 80 is molecular weight of $SO_3$)

$[SO_2] = \frac{12.8}{64\times1}$

(Where 64 is molecular weight of $SO_2$)

$[O_2] = \frac{9.6}{32\times1}$

(Where 32 is molecular weight of $O_2$)

Thus, $K_C = \frac{\left(\frac{48}{80}\right)^2}{\left(\frac{12.8}{64}\right)^2\left(\frac{9.6}{32}\right)} = 3$

# IONIC EQUILIBRIUM

*Single Option Correct Type Questions (01 to 60)*

**1.** **(2)**

$$NaOH + H_2SO_4 \longrightarrow NaHSO_4 + H_2O$$

| | NaOH | $H_2SO_4$ | $NaHSO_4$ | $H_2O$ |
|---|---|---|---|---|
| initial m mole : | 10 | 5 | 0 | |
| reacted mole : | 5 | 0 | 5 | |

$$NaOH + NaHSO_4 \longrightarrow Na_2SO_4 + H_2O$$

| NaOH | $NaHSO_4$ | $Na_2SO_4$ |
|---|---|---|
| 5 | 5 | 0 |
| 0 | 0 | 5 |

$$pH = 7 + \frac{1}{2}\left[2 + \log\frac{5}{200}\right]$$

$$= 7 + \frac{1}{2}\left[2 + \log 5 - \log 200\right]$$

$$= 7 + \frac{1}{2}\,[2 + 0.7 - 0.3 - 2] = 7.2$$

**2.** **(2)**

There will be cationic hydrolysis of $NH_4Cl$, solution will be acidic.

**3.** **(1)**

$$HA + NaOH \longrightarrow NaA + H_2O$$

Weak acid, Strong base → Salt of weak acid & strong base.

Upon 50 % neutralization the amount of weak acid left and that of salt formed will be same and the system will act as an acidic buffer.

$$HA + NaOH \longrightarrow NaA + H_2O$$

Upon 50% Neutralization: a/2 a/2

$$pH = pK_a + \log\frac{[Salt]}{[Acid]}$$

$$= 4 + \log\frac{a/2}{a/2} = 4$$

**4.** **(1)**

Initial, pH = 12 ; pOH = 2 ; $[OH^-]$

$= 10^{-2}$ M

Final, pH = 11 ; pOH = 3 ; $[OH^-]$

$= 10^{-3}$ M

Moles of NaOH removed = 0.01 – 0.001

= 0.009 mol

**5.** **(1)**

| **Salts** | **pH** |
|---|---|
| NaA | 7 |
| NaB | 8 |
| NaC | 9 |
| NaD | 10 |

$A^-$ is the weakest conjugate base. Hence, HA will be the strongest acid.

**6.** **(1)**

$$H_3X \rightleftharpoons H^+ + H_2X^-$$

C  0  0

$C(1-\alpha_1)$  $C\alpha_1$  $C\alpha_1$

$$H_2X^- \rightleftharpoons H^+ + HX^{2-}$$

$C\alpha_1$  0  0

$C\alpha_1(1-\alpha_2)$  $C\alpha_2\alpha_1$  $C\alpha_2\alpha_1$

$$HX^{2-} \rightleftharpoons H^+ + X^{3-}$$

$C\alpha_2\alpha_1$  0  0

$C\alpha_2\alpha_1(1-\alpha_3)$  $C\alpha_1\alpha_2\alpha_3$  $C\alpha_1\alpha_2\alpha_3$

$$[H^+] = (3\times10^{-3}) + \left(3\times10^{-3}\times\frac{1}{3}\right) + 3\times10^{-3}\times 0$$

$$= 4\times10^{-3}\text{ M}$$

$pH = 3 - \log 4 \approx 2.4$

**7.** **(2)**

$$pOH = pK_b + \log\frac{\left[NH_4^+\right]}{[Base]}$$

$$5.74 = 4.74 + \log\frac{n_{NH_4^+}}{0.005}$$

$$1 = \log\frac{n_{NH_4^+}}{0.005}$$

$n_{NH_4^+} = 0.05$ mole

Moles of $(NH_4)_2SO_4$ added = 0.025 mole

**8.** **(2)**

$\because \quad pH = \frac{1}{2}pK_W + \frac{1}{2}pK_a - \frac{1}{2}pK_b = 7$

And $\alpha = \sqrt{\frac{K_W}{K_a K_b}} = \sqrt{\frac{10^{-14}}{10^{-12}}} = 0.1$ or % $\alpha$

= 10 %

**9.** **(1)**

(i) Solubility of AB = $\sqrt{K_{sp}} = 2\times10^{-10}$ M

(ii) Solubility of $A_2B = \sqrt[3]{\frac{K_{sp}}{4}} = 2\times10^{-4}$ M

(iii) Solubility of $AB_3 = \left[\frac{K_{sp}}{27}\right]^{1/4} = 10^{-8}$ M

$\therefore$ (i) < (iii) < (ii)

**10.** **(1)**

pH of $NaHCO_3$ solution = 9

Now $H^+ + HCO_3^- \longrightarrow H_2CO_3$

$\therefore$ No. of milli moles of HCl remaining

= 1 – 0.1 = 0.9 m mol

$\therefore pH = -\log\left(9\times10^{-3}\right) = -2\log 3 + 3$

$\Delta pH = 9 - (3 - 2\log 3) = 6 + 2\log 3$

**11.** **(2)**

$N_2H_4$ and $NH_2OH$ are related to $NH_3$ and are formed by the replacement of H in $NH_3$ by a $NH_2$ group or by OH group respectively.

In each case the electronegative substituent makes the nitrogen lone pair less readily available for protonation and results in weaker Bronsted bases (and hence stronger acidity for conjugate acids) than $NH_3$.

**12.** **(2)**

$CH_3COOH + HF \rightleftharpoons CH_3COOH_2^+ + F^-$.

HF gives $H^+$ to $CH_3COOH$ & forms $F^-$, so, it is a conjugate base of HF.

**13.** **(1)**

NaCl is the strongest electrolyte.

**14.** **(2)**

The substance which can accept a proton is called Bronsted base and which can donate proton is called Bronsted acid.

**15.** **(1)**

T $\uparrow$, $[H^+]\uparrow$, pH $\downarrow$

**16.** **(1)**

$\alpha = \sqrt{\frac{K_a}{C}} \therefore K_a = C\alpha^2 = 1\times(10^{-4})^2 = 10^{-8}$

**17.** **(1)**

In a weak electrolyte, the degree of dissociation, $\alpha = \sqrt{\frac{K}{C}}$, so it increases with increasing dilution.

**18.** **(2)**

pH = 1

$\Rightarrow \quad [H^+] = 10^{-1}M$

$[H^+]$ in resultant solution

$$= \frac{10^{-1}\times10 - 40\times10^{-2}}{10+40} = \frac{6\times10^{-1}}{50}$$

$= 1.2\times10^{-2}M$

$pH = -\log(1.2\times10^{-2}) = 2 - \log(1.2)$

= 2 – 0.07 = 1.93

**19. (3)**

As the solution is acidic, pH < 7. This is because $[H^+]$ from $H_2O$ cannot be neglected in comparison to $10^{-8}$ M.

**20. (1)**

$$K_{a_1} = \frac{[HS^-](0.05\times 2)}{(0.1)} = [HS^-]$$

**21. (1)**

Anion ($PO_4^{3-}$) of weak acid ($H_3PO_4$)will undergo anionic hydrolysis.

**22. (2)**

$$pH = 7 + \frac{1}{2}(pK_a - pK_b) = 7 + \frac{1}{2}[0]$$

pH = 7.

**23. (1)**

$$h = \sqrt{\frac{K_w}{K_a.K_b}}$$

$$= \sqrt{\frac{10^{-14}}{(1.8\times 10^{-5})^2}} = 5.55\times 10^{-3}$$

**24. (2)**

Higher is pH, lesser is acidic nature. $NH_4Cl$ (aq) is acidic and NaCN (aq) is basic.

$\therefore NH_4Cl < NaCN$ (pH)

**25. (1)**

Acetic acid will dissociate less due to common ion effect of $CH_3COO^-$

So, $H^+$ concentration will decrease hence pH will increase.

**26. (4)**

$$pOH = pK_b + \log\frac{[Salt]}{[Base]}$$

$$5 = -\log(1.8\times 10^{-5}) + \log\frac{[Salt]}{1}$$

5 – 4.74 = log [Salt]

[Salt] = 1.8 M

**27. (3)**

$CH_3COONH_4$ is a salt of weak acid and weak base and can act as simple buffer

**28. (3)**

50 mL is half neutralization point, pH = $pK_a$.

When 100 mL NaOH is added we obtain a weak acid-strong base salt.

$$pH = \frac{1}{2}[14 + pK_a + \log C] = \frac{1}{2}\left[14 + 4.2 + \log\frac{0.02}{2}\right] = \frac{1}{2}[14 + 4.2 - 2] = 8.1$$

**29. (2)**

$$H_2SO_4 + 2H_2O \longrightarrow 2H_3O^+ + SO_4^{2-}$$

$$NaOH \longrightarrow Na^+ + OH^-$$

1 mole of $H_2SO_4$ acid gives 2 moles of $H_3O^+$ ions. So, 2 moles of $OH^-$ are required for complete neutralization.

**30. (1)**

Solution become, acidic and methyl orange act, on acidic pH.

**31. (2)**

Strong acid can be used to titrate both strong and weak base.

**32. (3)**

Given

pH = 8

$\Rightarrow$ pOH = 6 i.e $[OH^-] = 10^{-6}$ M

$$Cd(OH)_2 \rightleftharpoons \underset{s}{Cd^{+2}} + \underset{10^{-6}}{2OH^-}$$

$[s]\,[10^{-6}]^2 = 2.5\times 10^{-14}$

$[s] = 2.5\times 10^{-2}$

[s] = 0.025M

**33. (3)**

$K_{sp}(MgC_2O_4) = 7\times 10^{-7}$

$$\Rightarrow Q_{sp}(MgC_2O_4) = \left(\frac{0.01}{2}\right)\times\left(\frac{0.02}{2}\right) = \frac{1}{2}\times 10^{-4}$$

($>K_{sp}$). So precipitation occurs.

So, 0.01 mol of $MgCl_2$ will remain in the final solution.

$$\Rightarrow [Mg^{2+}] = \frac{0.01}{2} = 0.005\text{ M.}$$

**34.** **(1)**

$$\alpha = \frac{\text{number of moles dissociated}}{\text{total moles present}}$$

$$= \frac{10^{-7}}{1000/18} = 1.8 \times 10^{-9} = 1.8 \times 10^{-7}\,\%$$

(Total moles of $H_2O$ in 1litre $= \frac{1000}{18}$ )

**35.** **(1)**

Moles of $OH^-$ $= 1 \times \frac{4}{40} = 0.1$ mol ; Moles of $H^+ = \frac{4.9}{98} \times 2 = 0.1$ mol

Thus, both are neutralised by each other i.e. pH = 7.

**36.** **(3)**

For precipitation, $Q_{sp} > K_{sp}$

$$[Fe^{3+}][OH^-]^3 \geq 8 \times 10^{-13}$$

$$[0.1][OH^-]^3 \geq 8 \times 10^{-13}$$

$$[OH^-] \geq 0.2 \text{ mmol.}$$

**37.** **(4)**

Buffer action of given solution will vary when moles of HCl added to the solution equal to moles of $CH_3COONa$.

$$CH_3COONa + HCl \longrightarrow CH_3COOH + NaCl$$

**38.** **(1)**

pH = 7 at equivalence point

**39.** **(1)**

Solution is acidic in nature but not a buffer solution.

**40.** **(3)**

We know that for acids at 25ºC, pH must be less than 7.

**41.** **(1)**

When rain is accompanied by a thunderstorm,

$$N_2 + O_2 \longrightarrow NO \longrightarrow NO_2 \xrightarrow{H_2O} HNO_2 + HNO_3$$

**42.** **(4)**

$$MX_4 \text{ (solid)} \rightleftharpoons M^{4+}_{(aq)} + 4X^-_{(aq)}$$

Solubility product, $K_{sp} = s \times (4s)^4 = 256\, s^5$

$$\therefore \quad s = \left(\frac{K_{sp}}{256}\right)^{1/5}$$

**43.** **(2)**

$$MX_2 \text{ (s)} \rightleftharpoons M^{2+} \text{ (aq)} + 2X^- \text{ (aq)}$$

$K_{sp} = s\,.\,(2s)^2 = 4s^3$

$\Rightarrow \quad 4 \times 10^{-12} = 4s^3$

$\Rightarrow \quad s^3 = 1 \times 10^{-12}$

$\Rightarrow \quad s = 1 \times 10^{-4}$ M

$\Rightarrow \quad [M^{2+}] = 1 \times 10^{-4}$ M

**44.** **(4)**

Conjugate base of $OH^-$

$$OH^- \rightleftharpoons O^{2-} + H^+$$

**45.** **(1)**

For acidic buffer, $pH = pK_a + \log\frac{[A^-]}{[HA]}$

when the acid is 50% ionised, $[A^-] = [HA]$

or $\quad pH = pK_a + \log 1$ or $pH = pK_a$

given $pK_a = 4.5$

$\therefore \quad pH = 4.5$

$\therefore \quad pOH = 14 - 4.5 = 9.5$

**46.** **(2)**

$$pH = 7 + \frac{1}{2}pK_a - \frac{1}{2}pK_b = 7 + \frac{4.8}{2} - \frac{4.78}{2} = 7.01$$

**47.** **(1)**

$$Na_2CO_3 \longrightarrow 2Na^+ + CO_3^{2-}$$

$1\times10^{-4}$M $\quad 2\times10^{-4}$M $\quad 1\times10^{-4}$ M

$K_{sp}[BaCO_3] = [Ba^{+2}]\,[CO_3^{2-}]$

$5.1 \times 10^{-9} = [Ba^{+2}] \times 1 \times 10^{-4}$

$[Ba^{+2}] = 5.1 \times 10^{-5}$M

**48.** **(1)**

In (ii) equation $H_2PO_4^-$ gives one $H^+$ ion to $H_2O$ therefore in the (ii) equation it act as an acid.

**49.** **(3)**

$H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$  $K_1 = 4.2 \times 10^{-7}$

$HCO_3^- \rightleftharpoons H^+ + CO_3^{2-}$  $K_2 = 4.8 \times 10^{-11}$

$K_1 >> K_2$

$\therefore \quad [H^+] = \left[HCO_3^-\right]$

$$K_2 = \frac{[H^+][CO_3^{2-}]}{[HCO_3^-]}$$

But, $[H^+] = [HCO_3^-]$

$[CO_3^{2-}] = K_2 = 4.8 \times 10^{-11} M$

**50.** **(2)**

For precipitation to start, $K_{sp} = Q_{sp}$

$K_{sp} = [Ag^+]\,[Br^-]$

But, $[Ag^+] = 0.05$ M

$\therefore \quad [0.05]\,[Br^-] = 5.0 \times 10^{-13}$

$$[Br^-] = \frac{5.0\times10^{-13}}{0.05} = 1 \times 10^{-11} \text{ M}$$

moles of KBr required = M × V = $1 \times 10^{-11} \times 1 = 1 \times 10^{-11}$ mol

weight of KBr required = $1 \times 10^{-11} \times 120 = 1.2 \times 10^{-9}$ g

**51.** **(1)**

Salt of weak acid and weak base

$$pH = \frac{1}{2}(pk_w + pK_a - pk_b) = \frac{1}{2}(14+3.2-3.4) = 6.9$$

**52.** **(3)**

$NH_3 + HCl \longrightarrow NH_4Cl$

| | $NH_3$ | $HCl$ | $NH_4Cl$ |
|---|---|---|---|
| Millimoles, | 10 | 5 | 0 |
| Finally, | 5 | 0 | 5 |

Resulting solution will be buffer

$\therefore$

$$pOH = pK_b + \log_{10}\frac{[NH_4Cl]}{[NH_3]} = 4.75 + \log_{10}\frac{5}{5} = 4.75$$

$\therefore \quad pH = 14 - 4.75 = 9.25$

**53.** **(1)**

$B + H^+ \longrightarrow BH^+$

At the half equivalent point, $[B] = [BH^+]$

$\Rightarrow \quad pOH = pK_b$ (from buffer formula)

**54.** **(4)**

$[CH_3COOH] = 0.1$ M

$$\therefore pH = \frac{1}{2}(pK_a - \log C) = \frac{1}{2}(4.76 + 1) = 2.88.$$

**55.** **(3)**

$[Ag^+]\,[Cl^-] = K_{sp}$ = constant

$\Rightarrow \quad xy$ = constant

So, shape of graph should be a rectangular hyperbola.

**56.** **(3)**

Due to complex formation, solubility of sparingly soluble salt increases because of solubility equilibrium shifting in forward direction.

**57.** **(4)**

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$$[H^+] = 3.4\times10^{-4} = C\alpha$$

$$K_a = C\alpha^2 = (C\alpha)(\alpha)$$

$$\alpha = \frac{1.7\times10^{-5}}{3.4\times10^{-4}} = 5\times10^{-2}$$

$$\therefore \quad C = \frac{3.4\times10^{-4}}{5\times10^{-2}} = 6.8\times10^{-3}\,M$$

**58.** **(2)**

HCl is a strong acid & $CH_3COOH$ is a weak acid. At infinite dilution, complete dissociation of weak acid takes place.

**59.** **(1)**

(I) $pH = pK_a + \log_{10}\left[\frac{\text{Salt}}{\text{Acid}}\right] = 5 + \log_{10}\left[\frac{0.1}{0.01}\right] = 4$

(II) $pOH = pK_b + \log_{10}\left[\frac{0.1}{0.1}\right] = 6$

$pH = 14 - 6 = 8$

(III) $pH = \frac{1}{2}[pK_w + pK_a - pK_b]$

$= \frac{1}{2}[14 + 5 - 7] = 6$

(IV) Neutral solution pH = 7

**60.** **(2)**
Theoretical

*Integer Type Questions (61 to 75)*

**61.** **(900)**
Initially degree of dissociation

$$\alpha = \sqrt{\frac{K_a}{C}}$$

Now, degree of dissociation,

$$\alpha_1 = 2\alpha = \sqrt{\frac{4K_a}{C}} = \sqrt{\frac{K_a}{C_1}}$$

So, $C_1 = \frac{C}{4}$

$\Rightarrow$ Hence, we have,

$300 \times 0.2 = V_f \times \frac{0.2}{4}$ so $V_f = 1200$ mL

Hence, water added = 1200 – 300 = 900 mL

**62.** **(9)**
$N_1V_1 = N_2V_2$

$10^{-3} \times 10 = N_2 \times 1000$

$\Rightarrow$ $N_2 = 10^{-5}$ N

$\therefore$ pH = 5

And pOH = 14 – 5 = 9

**63.** **(7)**
As $V \to \infty$, solution will be neutral. So, pH = 7 at 25ºC.

**64.** **(3)**

$$[H^+] = c \times \alpha = 0.1 \times \frac{30}{100} = 0.03 \text{ M}$$

**65.** **(20)**

$$\underset{}{AgCrO_4} \rightleftharpoons \underset{2s}{2Ag^+} + \underset{s}{CrO_4^{2-}}$$

$K_{sp} = (2s)^2s = 4s^3$

$$s = \left(\frac{K_{sp}}{4}\right)^{\frac{1}{3}} = \left(\frac{32 \times 10^{-12}}{4}\right)^{\frac{1}{3}} = 2 \times 10^{-4}\text{M.}$$

**66.** **(50)**
$H_2A \rightleftharpoons H^+ + HA^-$ ;

$$K_1 = \frac{[H^+]\ [HA^-]}{[H_2A]} = 1 \times 10^{-5}$$

$HA^- \rightleftharpoons H^+ + A^{2-}$ ;

$$K_2 = 5 \times 10^{-10} = \frac{[H^+]\ [A^{2-}]}{[HA^-]}$$

$$K = \frac{[H^+]^2\ [A^{2-}]}{[H_2A]} = K_1 \times K_2 = 5 \times 10^{-15}$$

**67.** **(10)**
$K_{SP} = 1.0 \times 10^{-11} = [Mg^{+2}]\,[OH^-]^2$

$1.0 \times 10^{-11} = (0.001)\,[OH^-]^2$

$[OH^-] = 10^{-4}$ M

pOH = 4

pH = 14 – 4 = 10

**68.** **(5)**

$$HQ \rightleftharpoons H^+ + Q^-$$

| | | |
|---|---|---|
| 0.1 | | |
| 0.1 – x | x | x |

pH = 3, $[H^+] = 10^{-3}$, $x = 10^{-3}$

$$K_a = \frac{(x)\times(x)}{(0.1-x)} = \frac{(10^{-3})^2}{0.1-10^{-3}} \simeq \frac{10^{-6}}{0.1} = 10^{-5}$$

$pK_a = -\log K_a = 5$

**69.** **(9)**
pH = 1 $\Rightarrow [H^+] = 10^{-1} = 0.1$ M

pH = 2 $\Rightarrow [H^+] = 10^{-2} = 0.01$ M

For dilution of HCl $M_1V_1 = M_2V_2$

$0.1 \times 1 = 0.01 \times V_2$

$V_2 = 10$ L

Volume of water added = 10 – 1 = 9 litre

**70.** **(316)**
Let volume of 1st solution = V mL

$\therefore$ Volume of 2nd solution = (800–V) mL

Amount of acid in 1st solution + Amount of acid in 2nd solution = Amount of acid in final solution.

$$\therefore \frac{45V}{100} + \frac{20(800-V)}{100} = \frac{29.875(800)}{100}$$

$\therefore$ V= 316 mL

**71.** **(4)**

$$\frac{\alpha_1}{\alpha_2} = \sqrt{\frac{K_{a_1}}{K_{a_2}}} = \sqrt{\frac{3.14\times10^{-4}}{1.96\times10^{-5}}} = 4:1$$

**72.** **(9)**

$$pOH = pK_b + \log\frac{\left[NH_4^+\right]}{[Base]}$$

$$pOH = 4.74 + \log\frac{1}{0.5}$$

$pOH = 4.74 + 0.3$

$pOH = 5.04$

$pH = 14 - 5.04 \approx 9$

**73.** **(2)**

**$S_1$:** pH ↑, T ↓ .

**$S_3$:** In the presence of strong base, the degree of dissociation of a weak base decreases than in water.

**74.** **(10)**

For acidic buffer

$$pH = pK_a + \log\frac{[Salt]}{[Acid]}$$

$$6 = 5 + \log\frac{[Salt]}{[Acid]} \text{ or } \frac{[Salt]}{[Acid]} = \frac{10}{1}$$

**75.** **(2)**

**$S_1$:** Final solution will contain NaCl (salt of SA and SB) and $CH_3COONH_4$ (salt of WA and WB with $K_a = K_b$). So, final solution will be neutral (pH = 7 at 25ºC).

**$S_2$:** Equivalence point pH will be greater than 7, but Methyl orange indicator has pH range = 3.1 – 4.4. So, Methyl orange cannot be used as indicator in given titration.

**$S_3$:** $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

(proton donor)

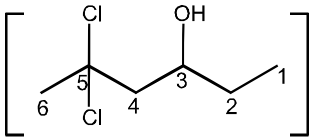
acid

# ORGANIC CHEMISTRY- SOME BASIC PRINCIPLES & TECHNIQUES

## *Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** 2, 2-Dichlorohexane-4-ol is incorrect name & correct name of compound




is

5,5-Dichlorohexan-3-ol.

**2.** **(3)**

**Sol:** Both have same molecular formula but different degree of amine so called functional isomers.

**3.** **(2)**

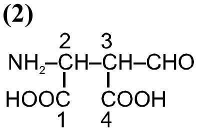
**Sol:** Trans–2–methylhex-3-ene does not has chiral carbon.

**4.** **(2)**

**Sol:** Both the isomers are not mirror image of each other so called configurational diastereomers.

**5.** **(2)**

**Sol:**

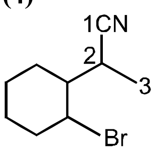



**6.** **(3)**

**Sol:** Meso compound is optically inactive due to internal compensation of optical rotation.

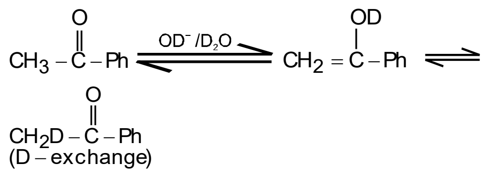
**7.** **(4)**

**Sol:**




**8.** **(1)**

**Sol:**



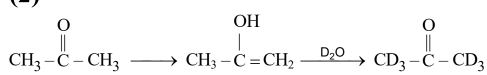

**9.** **(1)**

**Sol:** Optically active molecules have non-superimposable mirror image.

(1) is optically active while (2), (3), (4) are optically inactive.

**10.** **(2)**

**Sol:**




(Keto form) acetone Enol form

On treatment with $D_2O$ all tautomerizable H-atoms are replaced by deuterium.

**11.** **(2)**

**Sol:** $-\overset{O}{\overset{\|}{C}}-NH_2$, when attached to a ring, is a named as carboxamide.

(2) $-\overset{O}{\overset{\|}{C}}-NH_2$ has higher priority than –C≡N

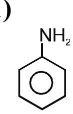
(3) –C≡N has prefix cyano

**12.** **(2)**

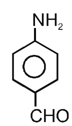
**Sol:** Because glycerine decomposes at its boiling point.

**13.** **(1)**

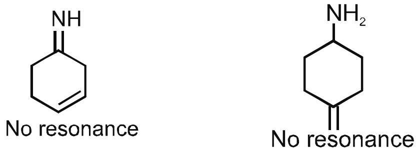
**Sol:**



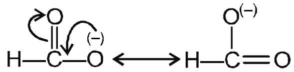

3 R S
with double
bond character




4 R S
with double
bond character




**14.** **(4)**

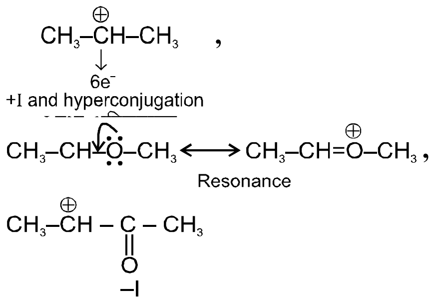
**Sol:** 

In $HCOO^-$ , the two carbon oxygen bonds are of equal length because the anion $HCOO^-$ has two equally stable resonating structures.

**15.** **(3)**

**Sol:** Acidic strength ∝ stability of its conjugate base.

**16.** **(4)**

**Sol:** 


**17.** **(2)**

**Sol:** Enol content depends on the stability of enol formed by the compound.

**18.** **(3)**

**Sol:** ERG groups decreases the stability of carbanion

**19.** **(2)**

**Sol:** Electron releasing group increases the stability of carbocation and electron withdrawing group decreases the stability of carbocation

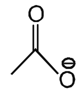
**20.** **(4)**

**Sol:** The most basic is $(CH_3)_3CO^-$ because of three electron donating $-CH_3$ groups (+ I effect) attached which tends to increase the electrons density at O atom.

**21.** **(4)**

**Sol:** $CCl_3$ is meta-directing due to reverse hyperconjugation (–H)

**22.** **(3)**

**Sol:**  is resonance stabilised.

**23.** **(2)**

**Sol:** Volume of nitrogen collected at 300 K and 715 mm pressure is 50 mL

Actual pressure = 715 – 15 = 700 mm

Volume of nitrogen at STP = $\dfrac{273\times700\times50}{300\times760}$

= 41.9 mL

22,400 mL of $N_2$ at STP weighs = 28 g

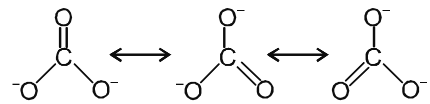
41.9 mL of nitrogen weighs = $\dfrac{28\times41.9}{22400}$ g

Percentage of nitrogen = $\dfrac{28\times41.9\times100}{22400\times0.3}$

= 17.46%

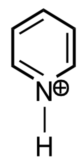
**24.** **(3)**

**Sol:**



Equivalent resonating structures thus all bonds have equal bond lengths

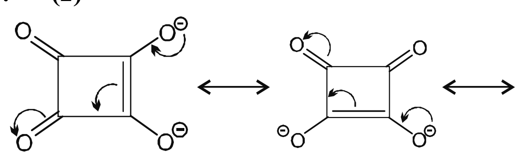
**25.** **(1)**

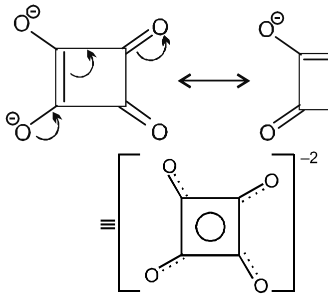
**Sol:**  Pyridinium ion is aromatic in nature because in pyridine the lone pair is not involved in conjugation.

**26.** **(3)**

**Sol:** More stable resonating structure contribute more towords resonance hybrid.

**27.** **(2)**





**28.** **(2)**

**Sol:** There are unpaired electrons, others have no unpaired electrons.

**29.** **(3)**

**Sol:** Resonance energy α stability.

**30.** **(3)**

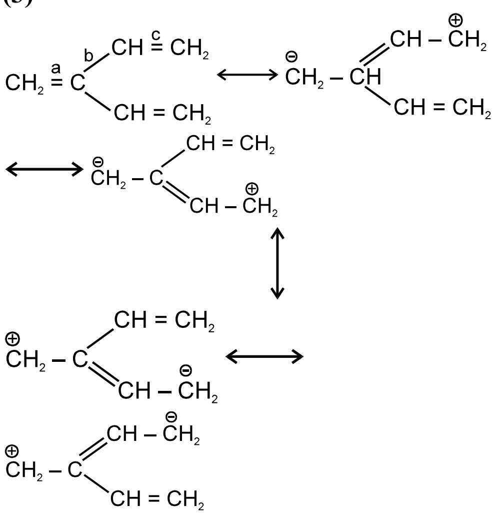
**Sol:** Carbocations, carbonions, free radicals and radical cations are $sp^2$, $sp^3$, $sp^2$ and sp hybrid respectively.

**31.** **(4)**

**Sol:** Charge is never delocalized on the meta position at the benzene nucleus with respect to group.

**32.** **(3)**

**Sol:**



**33.** **(3)**

**Sol:** There is conjugation in A, B, D but not in C.

**34.** **(1)**

**Sol:** As per the definition

**35.** **(2)**

**Sol:**

| | |
|---|---|
| $H_2C=\overset{+}{N}=\overset{-}{N}$ (I) | $H_2\overset{+}{C}-N=\overset{-}{N}$ (II) |
| $H_2\overset{-}{C}-\overset{+}{N}\equiv N$ (III) | $H_2\overset{-}{C}-N=\overset{+}{N}$ (IV) |

octet complete — octet incomplete

octet complete — octet incomplete

–ve charge on nitrogen — –ve charge on nitrogen–

ve charge on carbon — –ve charge on carbon

**36.** **(4)**

**Sol:** + I group stabilises the carbocation and – I group stablises carbanion.

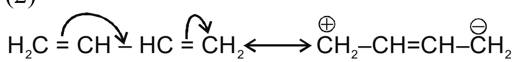
**37.** **(2)**

**Sol:** Due to presence of conjugated system.

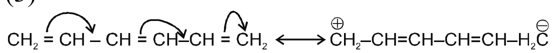
**38.** **(1)**

**Sol:** (1) $CH_3 - CH = CH - CH_3$ only hyper conjugation

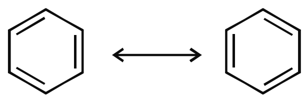
(2)



(3)



(4)



**39.** **(1)**

**Sol:** a is least stable since charge separation is done and +ve charge is towards –m group. d is most stable due to no charge separation and more linearly conjugation.

**40.** **(2)**

**Sol:** Stability ∝ extent of resonance.

**41.** **(1)**

**Sol:** $-\overset{\ominus}{O} > -NH_2 > -OH > -NHCOCH_3$

**42.** **(2)**

**Sol:** Activating group ⇒ $-NH_2 > -CH_3$

Deactivating group ⇒ $-Cl > -NO_2$

**43.** **(1)**

**Sol:** Hyperconjugation

$CH_3- > CH_3CH_2- > (CH_3)_2CH- > (CH_3)_3C-$

**44.** **(4)**

**Sol:** In propene

$$H^{\oplus}\ \ H_2C^{\ominus}-CH=CH_2 \rightleftharpoons CH_2=CH-CH_2^{\ominus}$$

In ethane: no hyperconjugation

**45.** **(2)**

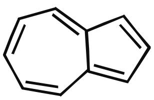
**Sol:** Heat of hydrogenation $\propto \dfrac{1}{\text{stability of alkene}}$.

(III & IV have both resonance and hyperconjugation where as I and II have only hyperconjugation.)

**46.** **(4)**

**Sol:** Due to resonance

**47.** **(2)**

**Sol:**  contain 10 π electrons. Azulene is a dipolar ion and has both rings aromatic in its ionic form.

**48.** **(3)**

**Sol:** All are aromatic and obeys Huckel's rule.

**49.** **(1)**

**Sol:** As per the definitions

**50.** **(3)**

**Sol:** $NO_2$, CN, $SO_3H$ having only –M (mesomeric) effect.

**51.** **(2)**

**Sol:** Heat of Hydrogenation $\propto \dfrac{1}{\text{stability of alkene}}$

**52.** **(3)**

**Sol:** C–C bond length $\propto$ No. of hyperconjugative structure.

**53.** **(2)**

**Sol:** $C_1$–$C_2$ is shorter because it is double bond in two of three resonance structure; $C_2$–$C_3$ is a single bond in two of three resonance structures.

**54.** **(4)**

**Sol:** In (III) positive charge does not participate in resonance as nitrogen is $sp^3$ hybridised

**55.** **(1)**

**Sol:** Compound with complete octet are more stable.

**56.** **(2)**

**Sol:** Fact.

**57.** **(1)**

**Sol:** More resonance structure, more stability.

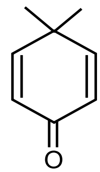
**58.** **(1)**

**Sol:** More stable resonance structure contributes more in resonance hybrid.

**59.** **(1)**

**Sol:** $CH_3$ group has + I effect, as number of – $CH_3$ group increases the inductive effect increases.

**60.** **(3)**

**Sol:** All are aromatic compounds except  .

It is non aromatic so least resonance stabilised.

## *Integer Type Questions (61 to 75)*

**61.** **(50)**

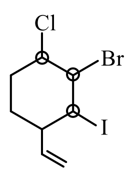
**Sol:** 0.17g $NH_3$ will contain $\left(\dfrac{14}{17}\times 0.17\right)$g of nitrogen, i.e. 0.14g of nitrogen

$$\%\ \text{Nitrogen} = \frac{\text{Mass of nitrogen}}{\text{Mass of compound}} \times 100$$

$$= \frac{0.14}{0.28} \times 100 = 50\%$$

**62.** **(16)**

**Sol:**

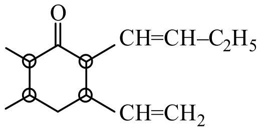



No. of stereo centre (n) = 4

Total no. of stereo isomer = $2^4$ = 16

**63. (32)**

**Sol:**

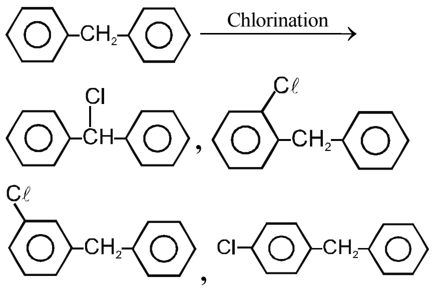



No. of stereo centre (n) = 5

Total no. of stereo isomer = $2^5 = 32$

**64. (4)**

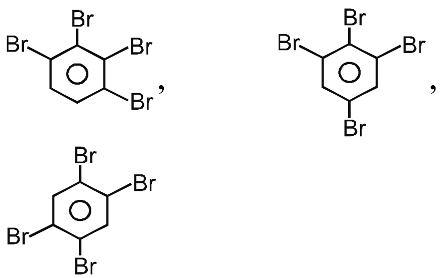
**Sol:**




Total 4-isomers

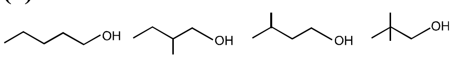
**65. (3)**

**Sol:**




**66. (4)**

**Sol:**




**67. (1)**

**Sol:** In all other cases positive charge is not in conjugation.

**68. (22)**

**Sol:** 3 + 5 + 9 + 5 = 22

**69. (7)**

**Sol:** Refer (+I) and (–I) groups.

**70. (8)**

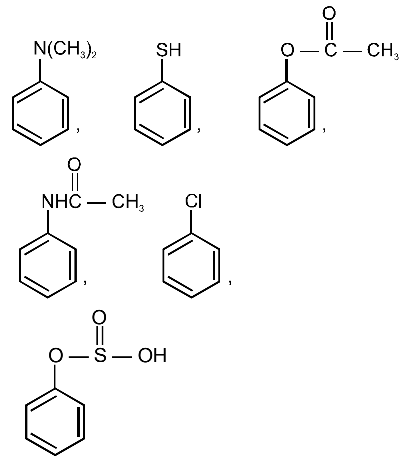
**Sol:** 3π-bond and 1 lone pair electron.

**71. (7)**

**Sol:** 7 including the given structure in which every C will recieve a positive charge.

**72. (6)**

**Sol:**



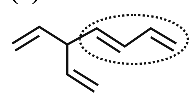

have + M group.

**73. (9)**

**Sol:** no. of α-hydrogen = 9

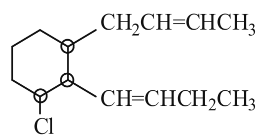
**74. (2)**

**Sol:**



**75. (32)**

**Sol:**




No. of stereo centre (n) = 5

Total no. of stereo isomer = $2^5 = 32$

# HYDROCARBONS

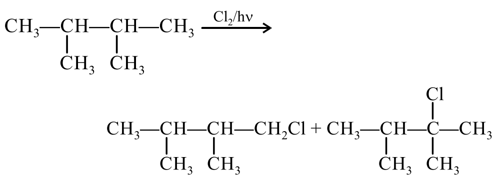
## *Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** 2-Methylbut-2-ene & 3-Methylbut-1-ene both gives 2-Methylbutane after hydrogenation.

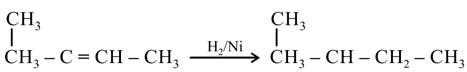
**2.** **(4)**

**Sol:**

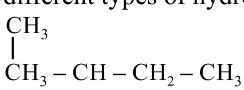



**3.** **(2)**

**Sol:**

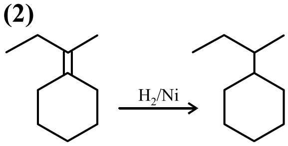



 has four chemically different types of hydrogen atoms.



**4.** **(2)**

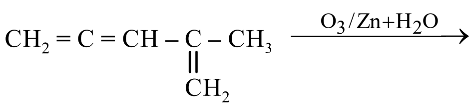
**Sol:**




(x)

**5.** **(2)**

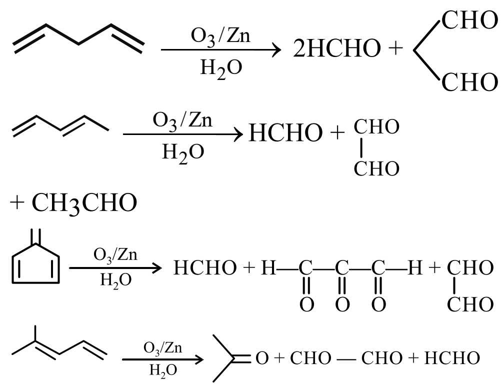
**Sol:**




$2HCHO + CO_2 + CH_3—CO—CHO$

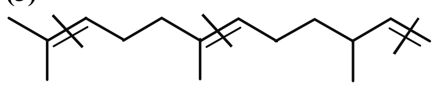
**6.** **(1)**

**Sol:**




**7.** **(3)**

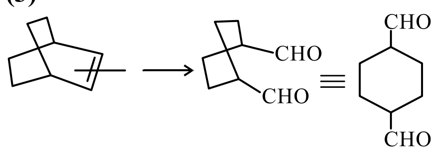
**Sol:**



$\xrightarrow{O_3/Zn}$ 2-methylpentanedial+4-oxopentanal+formaldehyde+acetone.

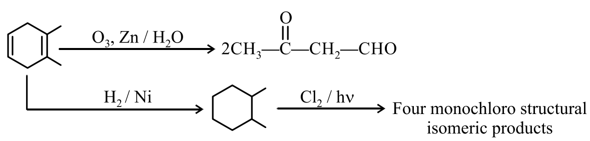
**8.** **(3)**

**Sol:**



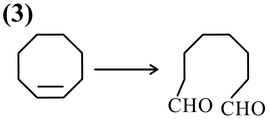

**9.** **(4)**

**Sol:**



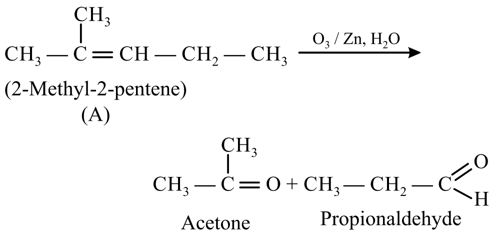

**10.** **(3)**

**Sol:**



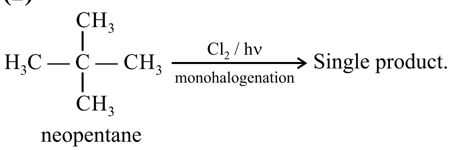
**11.** **(3)**

**Sol:**



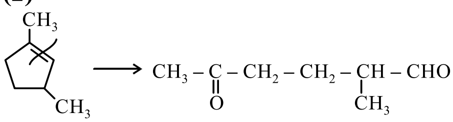

**12.** **(2)**

**Sol:**




**13.** **(2)**

**Sol:**



(5-keto-2-methyl hexanal)

**14.** **(4)**

**Sol:** (1), (2) and (3) give same product on hydrogenation.

**15.** **(4)**

**Sol:** Clemmensen reduction is not suitable for acid-sensitive substrates.

**16.** **(2)**

**Sol:** Wolff- Kishner reduction

**17.** **(3)**

**Sol:** Wolff- Kishner reagent (contain base) does not affect acid- sensitive substrates but affect base-sensitive substrates.

**18.** **(3)**

**Sol:** Soda- lime decarboxylation.

**19.** **(2)**

**Sol:** $R-COOH \xrightarrow[\Delta]{NaOH+CaO} R-H$

**20.** **(3)**

**Sol:** $2R-x+2Na \xrightarrow[either]{dry} R-R+2NaX$ (Wurtz reaction)

**21.** **(2)**

**Sol:** Reactivity of $x_2$ for photochemical halogenation:

$F_2 > Cl_2 > Br_2 > I_2$.

**22.** **(3)**

**Sol:** Reactivity of H during photochemical halogenation: 3°H > 2°H > 1°H.

**23.** **(1)**

**Sol:** Straight chain alkanes converted into branched alkanes in presence of anhydrous $AlCl_3$ and HCl gas.

**24.** **(4)**

**Sol:** Isomerisation of alkanes.

**25.** **(2)**

**Sol:** Birch Reduction $\longrightarrow$ Convert alkyne to trans. alkene.

**26.** **(3)**

**Sol:** Dehydrohalogenation of alkyl halides

$\longrightarrow$ form stable alkene.

**27.** **(2)**

**Sol:** Dehalogenation of vicinal dihalide.

**28.** **(3)**

**Sol:** Addition of HX on alkene by Markovnikov's rule.

**29.** **(2)**

**Sol:** Oxymercuration- demercuration process gives alcohol corresponding to Markovnikov addition.

**30.** **(2)**

**Sol:** Hydroboration- oxidation process gives alcohol corresponding to anti- Markovnikov addition.

**31.** **(4)**

**Sol:** Peroxide effect/ Khrasch effect.

**32.** **(3)**

**Sol:** Presence or absence of Peroxide has no effect on the orientation of addition of HCl.

**33.** **(2)**

**Sol:** Dehydrohalogenation of vicinal dihalide form alkyne.

**34.** **(2)**

**Sol:** Dehydrohalogenation of vicinal dihalide

**35.** **(3)**

**Sol:** 1, 1, 1-trihaloalkane with silver powder form alkynes.

**36.** **(4)**

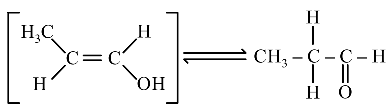
**Sol:** Halogens like bromine or chlorine add up to alkyne to give tetrahaloalkane.

**37.** **(4)**

**Sol:** Addition of HX to unsymmetrical alkyne take place by Markovnikov's rule and form geminal dihalide.

**38.** **(2)**

**Sol:** $H_3C-C\equiv CH \xrightarrow[H_2O_2/OH^-]{B_2H_6}$



**39.** **(1)**

**Sol:** Alkyne react with water to form carbonyl compound by Markovnikov's rule using $Hg^{2+}$ catalyst.

**40.** **(4)**

**Sol:** Product is (o, m, p) - xylene.

**41.** **(2)**

**Sol:** Zn dust convert phenol to benzene.

**42.** **(1)**

**Sol:** Benzoic acid convert into Benzene by reaction with soda lime (NaOH + CaO).

**43.** **(1)**

**Sol:** (Conc. $HNO_3$ + Conc. $H_2SO_4$) generate $NO_2^{\oplus}$ electrophile.

**44.** **(3)**

**Sol:** Sulphonation of Benzene (electrophile: $SO_3$).

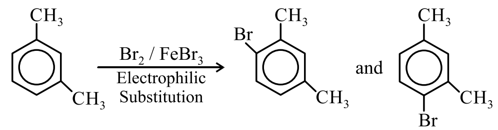
**45.** **(3)**

**Sol:** Lewisite is obtained when acetylene reacts with arsenic chloride.

$$CH\equiv CH \xrightarrow{AsCl_3} \underset{\text{(Lewisite)}}{CHCl=CHAsCl_2}$$

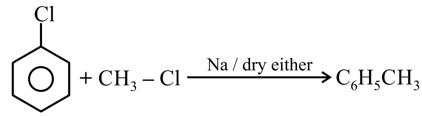
**46.** **(3)**

**Sol:**



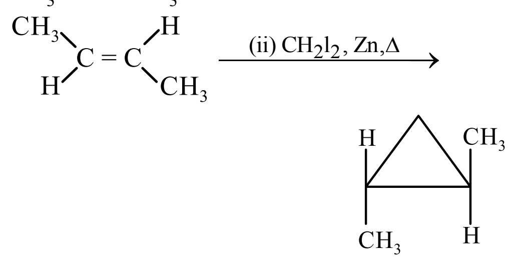

**47.** **(3)**

**Sol:** When an alkyl halide and an aryl halide react with sodium in the presence of dry ether to give aryl alkane (or alkyl benzene) the reaction is known as wurtz-fittig reaction




**48.** **(4)**

**Sol:** $CH_3-C\equiv C-CH_3 \xrightarrow{\text{(i) Na, } NH_3\text{(l)}}$




**49.** **(3)**

**Sol:** Quaternary ammonium salt undergoes hofmann elimination.

**50.** **(4)**

**Sol:** $CH_3-CH_2-CH_2-OH \xrightarrow[(160–180°C)]{conc.\,H_2SO_4}$

**(X)**

$$CH_3-CH=CH_2 \xrightarrow{Br_2} CH_3-\underset{Br}{CH}-\underset{Br}{CH_2}$$

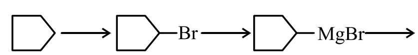
(Y)

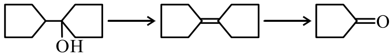
$$\xrightarrow[\substack{NaNH_2 \\ -2HBr}]{alc.KOH} CH_3-C\equiv C-H$$

(Z)

**51.** **(1)**

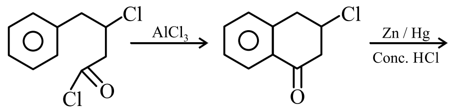
**Sol:**



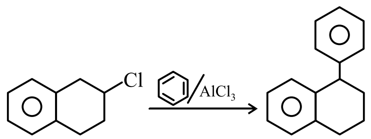


**52.** **(2)**

**Sol:**



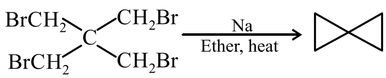
[A]



[B] [C]

**53.** **(4)**

**Sol:**



**54.** **(4)**

**Sol:** Alkenes generally undergo electrophilic addition reactions.

**55.** **(3)**

**Sol:** Other alkyl halide should not be 3° alkyl halide in corey-house synthesis, as it is a $S_N2$ process.

**56.** **(1)**

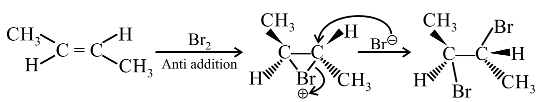
**Sol:** After completion of reaction solution will be alkaline due to formation of NaOH.

**57.** **(4)**

**Sol:** Due to radical Intermediate.

**58.** **(1)**

**Sol:**

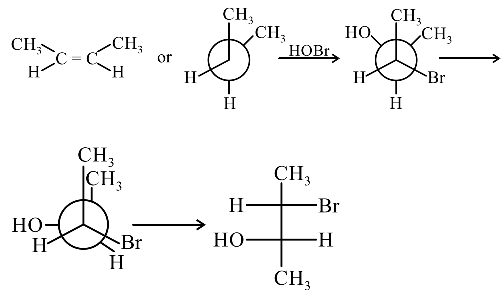


**59.** **(3)**

**Sol:** Conceptual

**60.** **(2)**

**Sol:**



## *Integer Type Questions (61 to 75)*

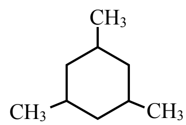
**61.** **(5)**

**Sol:** Number of mole of hydrogen needed is = number of double bonds = 5

**62.** **(1)**

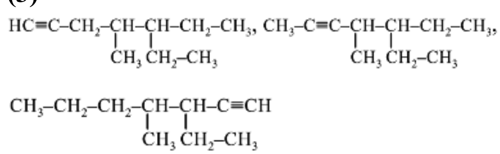
**Sol:** 2, 2, 3, 3-Tetramethylbutane have only one type of chemically different hydrogen atom.

**63.** **(3)**

**Sol:**  has three chemically different types of hydrogen atom.

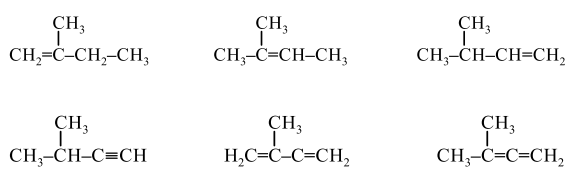
**64.** **(3)**

**Sol:**



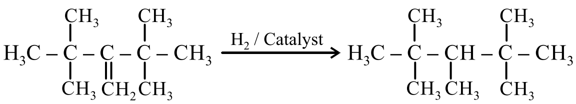
**65.** **(6)**

**Sol:**



**66.** **(4)**

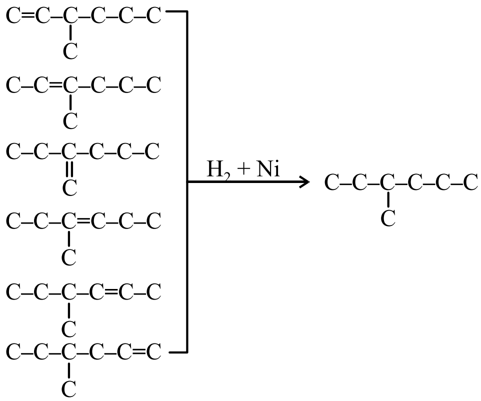
**Sol:** Only one alkene



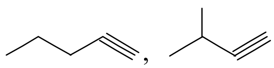
Three monochloro isomers are possible as it has three different types of 'H' atoms.

**67. (6)**

**Sol:**



**68. (2)**

**Sol:** $C_5H_8$  (Molecular Mass = 68)

**69. (44)**

**Sol:** $CH_3CH=CHCH_3 \xrightarrow[H_2O]{O_3/Zn} 2CH_3CHO.$

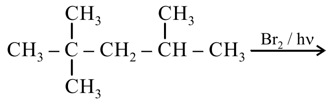
**70. (44)**

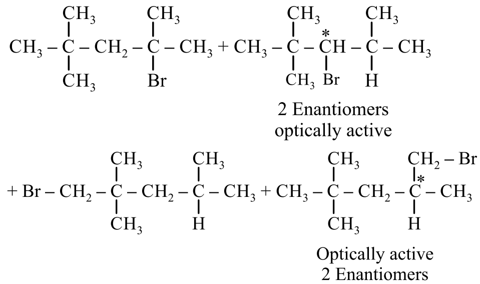
**Sol:** Correy- House synthesis ; Z = Propane ($C_3H_8$)

**71. (2)**

**Sol:** Polymerization of alkyne.

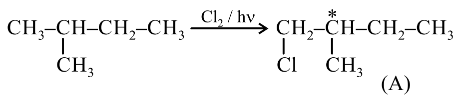
**72. (4)**

**Sol:** 




**73. (30)**

**Sol:**



Product ratio $\Rightarrow$ 6 : 5 : 6 : 3

Total yield $\Rightarrow$ 6 + 5 + 6 + 3 = 20

$\% \text{ yield} = \frac{6}{20} \times 100$

**74. (3)**

**Sol:** (i), (ii) & (iv) are correct.

**75. (2)**

**Sol:** $H_2$ will be liberated at cathode.

# SOLUTIONS AND COLLIGATIVE PROPERTIES

*Single Option Correct Type Questions (01 to 60)*

**1.** **(3)**

**Sol:** $P = P_A^o X_A + P_B^o (1 - X_A)$ and

$P_A^o X_A = Y_A P = Y_A [P_A^o X_A + P_B^o (1 - X_A)]$

so, $\frac{1}{Y_A} = 1 + \frac{P_B^o}{P_A^o}\left(\frac{1}{X_A} - 1\right)$

so, $x = 1 + \frac{P_B^o}{P_A^o}(y - 1)$

Hence $\Rightarrow (x - 1)\frac{P_A^o}{P_B^o} + 1 = y$

so, y = mx + C gives the result

**2.** **(1)**

**Sol:** Elevation in boiling point $\propto$ concentration of a solution. Thus, the order of concentration of solution is I < II < III.

**3.** **(2)**

**Sol:** Atmospheric pressure is low.

**4.** **(2)**

**Sol:** Vapour pr. depends on temperature not volume.

**5.** **(2)**

**Sol:** Solubility of gas in liquid increases with increase in pressure and decrease in temperature.

**6.** **(1)**

**Sol:** A: Benzene B: Toluene

$P = P_A + P_B$

$P = P_A^0 X_A + P_B^0 X_B$

$= 75 \times \frac{1}{2} + 22 \times \frac{1}{2} = 37.5 + 11 = 48.5$

Mole fraction of benzene in vapour, $Y_A = \frac{P_A}{P}$

$= \frac{37.5}{48.5} = 0.78$

Similarly, mole fraction of toluene in vapour, $Y_B = 0.22$

$\therefore$ The vapour will contain higher percentage of benzene

**7.** **(1)**

**Sol:** (2) $CHCl_3 + CH_3COCH_3$

**8.** **(2)**

**Sol:** $X_A = \frac{1}{3}$, $X_B = \frac{2}{3}$

$P = P_A^0 X_A + P_B^0 X_B$

$= 150 \times \frac{1}{3} + 240 \times \frac{2}{3}$

$= 50 + 160 = 210$ mm

$P_{exp.} < P_{calculated}$

$\therefore$ There is negative deviation from Raoult 's law

**9.** **(4)**

**Sol:**

$$A_xB_y \rightleftharpoons xA^{m+} + yB^{n+}$$

| | | | |
|---|---|---|---|
| Initial moles | n | 0 | 0 |
| At eq b. | $n(1-\alpha)$ | $nx\alpha$ | $ny\alpha$ |

$i = \frac{\text{Total mol at equilirium}}{\text{Initial mol}} =$

$\frac{n[(1-\alpha) + x\alpha + y\alpha]}{n}$

$i = (1 - \alpha) + x\alpha + y\alpha$

It can also seen that all other expressions imply the same thing.

**10.** **(2)**

**Sol:** For dissociation (i > 1)

**11.** **(4)**

**Sol:** $AlPO_4 \rightleftharpoons Al^{3+} + PO_4^{3-}$

$i = 1 + x = 2$

$\Delta T_b = \text{molality} \times k_b \times i$

$\therefore \dfrac{\Delta T_b}{K_b} = 0.02.$

**12.** **(2)**

**Sol:** $\Delta T_b = m\,k_b = \dfrac{w}{M} \times \dfrac{1000}{W} \times k_b$

$\Delta T_b = 47.98 - 46.3 = 1.68$

$1.68 = \dfrac{28}{M} \times \dfrac{1000}{315} \times 2.38$

$M = \dfrac{28 \times 1000 \times 2.38}{315 \times 1.68} = 125.92$

$\text{Atomicity} = \dfrac{\text{Mol. wt.}}{\text{At. wt.}} = \dfrac{125.92}{31} = 4.02$

So. Molecule is = $P_4$.

**13.** **(2)**

**Sol:** Given, w = 0.2 g, W = 20 g,

$\Delta T = 0.45^\circ C$

$\Delta T = \dfrac{1000 \times K \times w}{m \times W}$

or $0.45 = \dfrac{1000 \times 5.12 \times 0.2}{20 \times m}$

$\therefore$ m(observed) = 113.78

Now for $2CH_3COOH \rightleftharpoons (CH_3COOH)_2$

| | | |
|---|---|---|
| Before association | 1 | 0 |
| After association | $1 - \alpha$ | $\alpha/2$ |

Where $\alpha$ is degree of association

$\therefore \dfrac{m_{normal}}{m_{observed}} = 1 - \alpha + \alpha/2$

or $\dfrac{60}{113.78} = 1 - \alpha + \alpha/2$

or $\alpha = 0.945$

or 94.5 %

**14.** **(4)**

**Sol:** Semipermeable membrane allows the solvent particles only to pass through it.

**15.** **(3)**

**Sol:** $\pi_f V_f = \pi_1 V_1 + \pi_2 V_2$

$\pi_f = \dfrac{1.2V + 2.5V}{2V} = \dfrac{3.7V}{2V}$

$\pi_f = 1.85$ atm.

**16.** **(4)**

**Sol:** For isotonic solution $\pi_1 = \pi_2$ ; $C_1 = C_2$ ; $n_1 = n_2$

$\dfrac{W_1}{M_1} = \dfrac{W_2}{M_2} \Rightarrow \dfrac{10.5}{M} = \dfrac{30}{180}$

$\Rightarrow M = \dfrac{10.5 \times 180}{30} = 63$

**17.** **(4)**

**Sol:** All solution have same No. of particle and also have same value of $\pi$. $n_1 = n_2$; $\pi_1 = \pi_2$ (Isotonic).

**18.** **(2)**

**Sol:** $HA \longrightarrow H^+ + A^-$ , pH = 2

| | | |
|---|---|---|
| $0.1 - x$ | x | x |
| pH = 2 | so | $[H^+] = 0.01$ |

Total Concentration = 0.1 + 0.01 = 0.11 M

$\pi = CRT = 0.11\,RT$

**19.** **(3)**

**Sol:** B.P. of water is elevated.

**20.** **(4)**

**Sol:** For an ideal solution $\Delta S_{mix} \neq 0$

**21.** **(2)**

**Sol:** For negative deviation; $\Delta H_{mix} < 0$, $\Delta V_{mix} < 0$.

**22.** **(3)**

**Sol:** $P_{Total} = 0.4 \times 80 + 0.6 \times 120 = 104 > 100$ mm of Hg.

**23.** **(4)**

**Sol:** Both solution will have same value of $K_f$ and $\Delta T_f$.

**24.** **(1)**

$\pi = CRT \quad 7.40 = n \times 0.0821 \times 300$

$\pi = \dfrac{n}{v}RT \quad n = \dfrac{7.4}{0.0821 \times 300} = 0.3.$

**25. (1)**

**Sol:** When dried fruits and vegetables are place in water, they slowly get swelled due to osmosis i.e. water molecules pass through SPM present in cell-walls. If temperature is increased osmosis will be faster.

**26. (3)**

**Sol:** Osmosis is a process in which solvent (water in this case) flows from low $conc^n$ $sol^n$ to high $conc^n$ $sol^n$ by SPM.

**27. (2)**

**Sol:** Moles of urea = $\frac{6.02\times10^{20}}{6.02\times10^{23}} = 10^{-3}$ moles

Concentration (molarity) of solution = $\frac{10^{-3}}{100} \times 1000 = 0.01$ M.

**28. (1)**

**Sol:** Elevation in boiling point is a colligative property which depends upon the number of solute particles. Greater the number of solute particles in a solution, higher the extent of elevation in boiling point.

$Na_2SO_4 \rightarrow 2Na^+ + SO_4^{2-}$

**29. (3)**

**Sol:** $Na_2SO_4 \rightleftharpoons 2Na^+ + SO_4^{2-}$

| | | |
|---|---|---|
| 1 | 0 | 0 |
| $1-\alpha$ | $2\alpha$ | $\alpha$ |

Vant Hoff factor (i) = $\frac{1-\alpha+2\alpha+\alpha}{1} = 1+2\alpha.$

**30. (3)**

**Sol:** Equimolar solutions of all the substances in the same solvent will show equal elevation in boiling points as well as equal depression in freezing point.

**31. (3)**

Total millimoles of solute = 480 × 1.5 + 520 × 1.2 = 720 + 624 = 1344.

Total volume = 480 + 520 = 1000.

Molarity of the final mixture = $\frac{1344}{1000}$ = 1.344 M.

**32. (2)**

**Sol:** Molality, m = $\frac{M}{1000d - MM_2} \times 1000$

where M = molarity, d = density, $M_2$ = molecular mass

$m = \frac{2.05\times1000}{1000\times1.02 - 2.05\times60} = 2.28 \text{ mol kg}^{-1}$

**33. (1)**

**Sol:** The solution is non-ideal, showing +ve deviation from Raoult's Law.

**34. (2)**

**Sol:** $P_{total} = P^o_A X_A + P^o_B X_B = P^o_A \times \frac{1}{4} + P^o_B \times \frac{3}{4} =$

$550 \Rightarrow P^o_A + 3P^o_B = 550 \times 4$ .....(i)

similarly

$560 = P^o_A \times \frac{1}{5} + P^o_B \times \frac{4}{5}$

$\Rightarrow P^o_A + 4P^o_B = 560 \times 5$ .....(ii)

eq. (ii) – eq.(i)

$P^o_B = 560 \times 5 - 550 \times 4 = 600$

so $P^o_A = 400$.

**35. (2)**

**Sol:** $Na_2SO_4(s) \xrightarrow{H_2O} 2Na^+ (aq.) + SO_4^{2-}(aq.)$

$\Delta T_f = i\, K_f m$

$= 3 \times 1.86 \times 0.01 = 0.0558$ K.

**36. (1)**

**Sol:**

| | |
|---|---|
| 0.5 M $C_2H_5OH$ (aq) | 0.1 M $Mg_3(PO_4)_2$ (aq) |
| i = 1 | i = 5 |

effective molarity = 0.5

effective molarity = 0.5 m

| | |
|---|---|
| 0.25 M KBr (aq) | 0.125 M $Na_3PO_4$ (aq) |
| i = 2 | i = 4 |

effective molarity = 0.5 M

effective molarity = 0.5 M

Hence all colligative properties are same.

**37. (2)**

**Sol:** $\frac{P_0 - P_S}{P_S} = \frac{n}{N}$

$\frac{185-183}{183} = \frac{1.2/M}{100/58}$

$M \approx 64$ g/mol

**38.** **(2)**

**Sol:** Moles of glucose $= \frac{18}{180} = 0.1$

Moles of water $= \frac{178.2}{18} = 9.9$

$\Rightarrow \quad n_{Total} = 10$

$\Rightarrow \quad \frac{\Delta P}{P^\circ} = \frac{0.1}{10}$

$\Delta P = 0.01\ P^o = 0.01 \times 760 = 7.6$ torr

$P_S = 760 - 7.6 = 752.4$ torr

**39.** **(2)**

**Sol:** According to Henry's law

$\frac{P_1}{P_2} = \frac{S_1}{S_2}$

$\therefore \quad S_1$ & $S_2$ are solubility of gas (g/L)

$\frac{500}{750} = \frac{0.01}{S_2}$

$\therefore \quad S_2 = \frac{750 \times 0.01}{500} = 0.015\,g/L$

**40.** **(4)**

**Sol:** For $MX_2$ type salt

Vant factor (i) $= 1 + 2\alpha = 2$

$\Rightarrow \quad \alpha = 0.5$

**41.** **(1)**

**Sol:** $P_{N_2} = K_H \times x_{N_2}$

$x_{N_2} = \frac{1}{10^5} \times 0.8 \times 5 = 4 \times 10^{-5}$ per mole

In 10 mole solubility is $4 \times 10^{-4}$ .

**42.** **(1)**

**Sol:** As T increase, V.P. increases. So, C & D options get rejected.

$\Delta T_f = K_f \times m$

$273 - T'_f = 2 \times \frac{34.5/46}{0.5}$

$\therefore \quad T'_f = 270$ K

**43.** **(3)**

**Sol:** When non-volatile solute added to solvent. Due to elevation in boiling point, boiling point$\uparrow$ and due to depression in freezing point, freezing temperature$\downarrow$.

**44.** **(3)**

**Sol:** As $\Delta T_b = i\ K_b m$

so $iK_b$ m can be expressed in degree (Unit of temperature)

and $K_b$ m can be expressed in degree (Unit of temperature)

and $\frac{\Delta T_b}{i}$ can be expressed in degree (Unit of temperature)

But `unit of $K_b$ is $mol^{-1}$ kg K

**45.** **(1)**

**Sol:** From given graph, we can say $T_1$ is that temp at which solid state and liquid (solution) are in equilibrium.

**46.** **(4)**

**Sol:** $P = P_A^\circ X_A + P_B^\circ X_B$

$\frac{100}{4} + \frac{60 \times 3}{4} = 70$ mm < 75 mm (experimental)

Thus, there is positive deviation (1) is true, mixture is more volatile due to decrease in b.p. Thus, (2) is true also force of attraction is decreased thus (3) is true.

**47.** **(4)**

**Sol:** In HF hydrogen bonding is present so there is association of molecules due to this van't hoff factor is less , so depression in f.p decreases therefore f.p. value is larger than HCl. Similarly value of i = 2 for NaCl and i = 1 for Glucose.

**48.** **(2)**

**Sol:** Boiling point get lowered when vapour pr. increases and it happens when there is a positive deviation from Raoult's law.

**49.** **(1)**

**Sol:** Mixtures of $CHCl_3$ and $CH_3COCH_3$ shows negative deviation from Raoult's law , so vapour pressure decreases and boiling point increases.

**50.** **(4)**

**Sol:** All are facts.

We should remember that, Entropy of solution is more than entropy of pure solvent. So the difference in entropy change will be less in case of solution.

**51.** **(1)**

**Sol:** $M_{observed} = \frac{58.5}{i}$ ; i > 1.

**52.** **(2)**

**Sol:** There is very weak attraction between benzene and methanol as compare to attraction between molecules of methanol.

**53.** **(1)**

**Sol:** KOH solution is 30% by weight.

$\therefore$ wt. of KOH = 30 g

and Wt. of solution = 100 g

$\therefore$ Volume of solution $= \frac{100}{d}$

$\therefore$ Molarity $= 6.90 = \left(\frac{30}{56 \times \frac{100}{1000 \times d}}\right)$

$= 1.288 \text{ g mL}^{-1}$

**54.** **(2)**

**Sol:** Ostomic pressure of such substances are measurable.

**55.** **(2)**

**Sol:** As $m \rightarrow 0$ (infinite dilution) both electrolytes will be completely dissociated so

$NaCl \rightleftharpoons Na^+ + Cl^-$

$NaHSO_4 \rightleftharpoons Na^+ + H^+ + SO_4^{2-}$.

**56.** **(1)**

**Sol:** $\Delta T_b = ik_b\, m$ so $i = \frac{2.08}{0.52 \times 1} = 4$

so the compex is $K_3\,[Fe(CN_6)]$

$K_3\,[Fe(CN)_6] \rightleftharpoons 3\,K^+ + [Fe(CN)_6]^{3-}$

**57.** **(2)**

**Sol:** $0.0558 = i \text{ x } 1.86 \text{ x } \frac{0.01}{1} \Rightarrow i = 3$

$\Rightarrow$ fully ionized

$0.0744 = i \times 1.86 \times \frac{21.68}{271 \times 2} \Rightarrow i = 1$

$\Rightarrow$ fully unionized

**58.** **(3)**

**Sol:** Theoretical

**59.** **(1)**

**Sol:** $\pi = i.\ CRT$

(I) i for NaCl;

(S) $\pi = 2 \times 0.10\ RT = 0.20\ RT$

(II) i for $Na_2SO_4$;

(R) $\pi = 0.2 \times 3\ RT = 0.6\ RT$

(III) i for $Ca(NO_3)_2$;

(Q) $\pi = 0.1 \times 4\ RT = 0.4\ RT$

(IV) i for $Al(NO_3)_3$;

(P) $\pi = 0.1 \times 3\ RT = 0.3\ RT$

**60.** **(1)**

**Sol:** (I) $i = 1 + (4 - 1) \times 0.8 = 3.4$

(II) $i = 1 + (3 - 1) \times 0.9 = 2.8$

(III) $i = 1 + (4 - 1) \times 0.9 = 1 + 2.7 = 3.7$

(IV) $i = 1 + (5 - 1) \times 0.7 = 1 + 4 \times 0.7 = 3.8$

## *Integer Type Questions (61 to 75)*

**61.** **(30)**

Total mass of solution = (15 + 35) gram = 50 gram

mass percentage of methyl alcohol

$= \frac{\text{Mass of methyl alcohol}}{\text{Mass of solution}} \times 100$

$= \frac{15}{50} \times 100 = 30\%$

**62.** **(260)**

As $X_A \longrightarrow 1$. Then we will have pure methanol so $P_T = 120\ X_A + 140 = 120 + 140 =$ 260 mm of Hg.

**63.** **(3)**

**Sol:** If the solution is infinitely dilute, $NaHSO_4$ would dissociate completely.

$\therefore$ $NaHSO_4 \longrightarrow Na^+ + HSO_4^-$

$HSO_4^-$ would further dissociate as :

$HSO_4^- \longrightarrow H^+ + SO_4^{2-}$

i = 3

**64.** **(150)**

$\frac{1}{5} = \frac{(W/60)}{(W/60) + (180/18)}$

**65.** **(1)**

**Sol:** Lowering of V.P. is colligative property

thus, $i\,(K_2SO_4) = 1 + (y - 1)\,x = 1 + 2x = 3$

$\therefore$ If $\frac{\Delta p}{p^\circ} = \frac{n_1 i}{n_1 i + n_2}$

$\frac{10}{50} = \frac{3n_1}{3n_1 + 12} = \frac{n_1}{n_1 + 4}$

$n_1 = 1$

**66.** **(50)**

$P_B = P^o_B\, XB$ $\quad P^o_B = 75$ torr

$X_B = \frac{78/78}{(78/78)+(46/92)} = \frac{1}{1+0.5} = \frac{1}{1.5}$ $\quad P_B =$

$75 \times \frac{1}{1.5} = 50$ torr.

**67.** **(350)**

According to Raoult's law

$P = P_A + P_B = P^o_A x + P^o_B x_B$

or $290 = P^o_A \times (0.6) + 200 \times (1 - 0.6)$

or $290 = 0.6 \times P^o_A + 0.4 \times 200$

or $P^o_A = 350$ mm.

**68.** **(93)**

$\Delta T_f = i \times k_f \times m$

$2.8 = 1 \times 1.86 \times \frac{x}{62\times 1}$

$x = \frac{2.8\times 62}{1.86} = 93$ gm

**69.** **(45)**

$\Delta T_f = imk_f$

$3.82 = [1+(3-1).815]m \times 1.86$

$m = \frac{3.82}{2.63\times 1.86} = \frac{5}{142}\times\frac{1000}{x}$

$x = 45$ g

**70.** **(2)**

**Sol:** Volume of solution $= \frac{\text{Mass}}{\text{Density}} = \frac{1120}{1.15}$ mL

Molarity of solution can be calculated as

$M = \frac{w_B \times 1000}{m_B \times V} = \frac{120\times 1000}{60\times(1120)/1.15} = 2.05$ M

**71.** **(100)**

$RLVP = \frac{i\ n_{NaCl}}{i\ n_{NaCl} + n_{H_2O}}$ $\quad ; 0.4 = \frac{i}{i+3}$

so $i = 2$

$\because$ $i = 1 + \alpha$ so $\alpha = 1$ or 100%

**72.** **(210)**

Isotonic solutions have same osmotic pressure.

$\pi_1 = C_1 RT$ , $\pi_2 = C_2 RT$

For isotonic solution, $\pi_1 = \pi_2$

$\therefore$ $C_1 = C_2$.

or $\frac{1.5/60}{V} = \frac{5.25/M}{V}$ [where M = molecular weight of the substance]

or $\frac{1.5}{60} = \frac{5.25}{M}$ or M = 210.

**73.** **(72)**

$P_T = X_{Heptane}\, P^o_{Heptane} + X_{Octane}\, P^o_{Octane}$

$= \frac{0.25}{0.557} \times 105 + \frac{0.307}{0.557} \times 45$

$47.127 + 24.80 = 71.92 \approx 72$ kPa

**74.** **(293)**

$\pi = CRT$

$\pi = \frac{c}{M} RT$ C = moles/liter,

$c = kg/m^3$

$\frac{\pi}{c} = \frac{RT}{M}$

$M = \frac{RT}{\pi/c}$ $\quad [\pi/c = 8.314 \times 10^{-3}]$

$M = \frac{8.314\times 293}{8.314\times 10^{-3}} = 293 \times 10^3$ [T = 293 k]

**75.** **(325)**

Apply raoult's law:

$P_{Total} = X_A P^\circ_A + X_B P^\circ_B$

$= \left(\frac{0.1}{0.1+0.1}\right)\times 415 + \left(\frac{0.1}{0.1+0.1}\right)\times 200$

$= 307.5$ mmHg

Mole fraction of $CHCl_3$ in vapour form ($Y_B$)

$= \frac{X_B P^\circ_B}{P_{Total}} = \frac{0.5\times 200}{307.5} = 0.325$

# ELECTROCHEMISTRY

## Single Option Correct Type Questions (01 to 60)

**1.** **(1)**

**Sol:** In electrochemical cell, $H_2$ is anode and Cu is cathode because of their standard reduction potential values.

**2.** **(4)**

**Sol:** Hydrogen electrode contains Pt-conductor coated with platinum black which adsorb Hydrogen on its surface.

**3.** **(2)**

**Sol:** Electron will travel from anode to cathode.

**4.** **(1)**

**Sol:** The value of standard electrode potential of $Pb^{2+}$ is more than that of $Fe^{2+}$ So Fe will get oxidized and $Pb^{2+}$ will get reduced.

**5.** **(2)**

**Sol:** $Zn + 2Ag^{+} \longrightarrow 2Ag + Zn^{2+}$

$E^{\circ}_{cell} = 0.76 - (-0.80) = 1.5\ eV$

**6.** **(3)**

**Sol:** M is more reactive than carbon and B is more relative than A. Also both B and A are less reactive than C.

**7.** **(1)**

**Sol:** $E = -2.36 - \frac{0.0591}{1}\log\frac{1}{0.1} = -2.41V$

**8.** **(4)**

**Sol.** $E = E^{\circ} - \frac{0.06}{2}\log\left(\frac{Ti^{+}}{Cu^{+2}}\right)^{2}$

**9.** **(2)**

**Sol:** $E = E^{\circ} - \frac{0.06}{2}\log\left(\frac{Zn^{+2}}{Ag^{+}}\right)^{2} \Rightarrow \log\frac{\left[Zn^{+2}\right]}{[Ag^{+}]}$

$= 2(E^{\circ} - E)$

**10.** **(1)**

**Sol:** $\frac{W}{2\times 2} = \frac{W'}{4\times 1}$

**11.** **(4)**

**Sol:** Faraday's second law- the amounts of elements deposited on the electrodes are in the ratio of their equivalent masses

**12.** **(1)**

**Sol:** $PbSO_4$ is formed

**13.** **(3)**

**Sol:** Electrolyte $CuSO_4$ dissociates as $Cu^{2+}$ and $SO_4^{-2}$ along with $H^{+}$ and $OH^{-}$ ions in the aqueous solution.

$Cu^{2+}$ has higher reduction potential than $H^{+}$, it gets preferentially reduced and $OH^{-}$ has higher oxidation potential than $SO_4^{-2}$, it gets preferentially oxidised.

Hence, Cu at cathode and $O_2$ at anode are produced.

**14.** **(4)**

**Sol:** The characteristics of fuel cell.

**15.** **(4)**

**Sol:** The conductance of strong electrolyte like NaCl will increase with concentration.

Specific conductance = Conductance × cell constant.

Higher the conductance, higher is the specific conductance.

**16.** **(1)**

**Sol:** $\lambda_{Ag^+} = 62.3$ Scm$^2$ mol$^{-1}$, $\lambda_{cl^-} = 67.7$ Scm$^2$ mole$^{-1}$

$K_{Agcl} = 3.4 \times 10^{-6}$ Scm$^{-1}$

$$\wedge^{\infty}_{AgCl} = (62.3 + 67.5) = \frac{1000 \times 3.4 \times 10^{-6}}{S}$$

$$S = \frac{3.4 \times 10^{-3}}{(62.3 + 67.5)} = 2.6 \times 10^{-5} \text{ M}$$

**17.** **(1)**

**Sol:** $$\Lambda_{eq} = \frac{k \times 1000}{N} = \frac{0.0014 \times 1000}{0.01}$$

$= 140$ cm$^2\Omega^{-1}$eq$^{-1}$

**18.** **(3)**

**Sol:** $H^+$ ions are replaced by $NH_4^+$ ions, conductance decreases, after equivalent point it becomes almost constant as dissociation of $NH_4OH$ will be suppressed due to common ion ($NH_4^+$).

**19.** **(1)**

**Sol:** $Fe \rightarrow Fe^{2+} + 2e^-$ (At anode)

$O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (At cathode)

The overall reaction is:

$2Fe + O_2 + 2H_2O \rightarrow 2Fe(OH)_2$

$Fe(OH)_2$ can be dehydrated to iron oxide FeO, or further oxidised to $Fe(OH)_3$ and then dehydrated to iron rust, $Fe_2O_3$

**20.** **(1)**

**Sol:** As $E^o_{Cu^{2+}} \longrightarrow Cu = 0.337$ V > $E^0_{H^+/H_2}$

$\therefore$ $Cu^{2+}$ can be reduced by $H_2$.

**21.** **(4)**

**Sol:** $H^+ + e^- \longrightarrow \frac{1}{2} H_2$. $\qquad E = 0 - \frac{.0591}{1}$

$\log_{10} \frac{1}{[H^+]} = + 0.591 \log_{10}[H^+]$.

$E_1 = 0$ {pH = 0}.

$E_2 = + 0.0591 \log_{10}[10^{-7}]$

$= - .0591 \times 7$ {at pH = 7} $= - 0.41$ V.

**22.** **(3)**

**Sol:** Number of moles of $Cu^{2+}$ discharged from anode = number of moles of $Cu^{2+}$ deposited at cathode.

**23.** **(3)**

**Sol:** Higher the standard reduction potential, greater the tendency to get deposit at cathode.

**24.** **(1)**

**Sol:** At cathode-

$$2H_2O(\ell) + O_2(g) + 4e^- \longrightarrow 4OH^-(aq)$$

**25.** **(4)**

**Sol:** $2Fe + \frac{3}{2} O_2 \longrightarrow Fe_2O_3$

Brown

$Cu + CO_2 + H_2O \longrightarrow CuCO_3 . Cu(OH)_2$

Green

$Ag + H_2S \longrightarrow Ag_2S$

Black

**26.** **(4)**

**Sol:** Follow theory of corrosion.

**27.** **(1)**

**Sol:** $E_1 = \frac{-0.059}{1} \log [H^+]$

or $pH_1 = E_1 / 0.059 = pK_a + \log \frac{x}{y}$

$pH_2 = E_2 / 0.059 = pK_a + \log \frac{y}{x}$

or $\frac{E_1 + E_2}{0.059} = 2\ pK_a$

or $pK_a = \frac{E_1 + E_2}{0.118}$

**28.** **(1)**

**Sol:** $E^o_{Fe^{2+}/Fe} = - 0.441$ V

$E^o_{Fe^{3+}/Fe} = - 0.771$ V

$E^o_{cell} = E^o_{OP_{Fe/Fe^{2+}}} + E^o_{RP_{Fe^{3+}/Fe^{2+}}}$

(see redox change)

$= + 0.441 + 0.771 = 1.212$ V

**29. (3)**

**Sol:** Salt bridge is used to remove or eliminate liquid junction potential arised due to different relative speed of ions of electrolytes at the junction of two electrolytes in an electrochemical cell. Thus, A salt used for this purpose should have almost same speeds of its cation and anion.

**30. (2)**

**Sol:** $E_{cell} = E^0_{cell} - \frac{0.0591}{2} \log_{10} \frac{1}{[Cu^{2+}]}$.

**31. (2)**

**Sol:** Concentration of $H_2SO_4$ increases ; $O_2$, $H_2$

**32. (1)**

**Sol:** Electrolyte $Na_2SO_4$ dissociates as $Na^+$ and $SO_4^{-2}$ along with $H^+$ and $OH^-$ ions in the aqueous solution.

$H^+$ has higher reduction potential than $Na^+$, it gets preferentially reduced and $OH^-$ has higher oxidation potential than $SO_4^{-2}$, it gets preferentially oxidised.

Hence, $H_2$ at cathode and $O_2$ at anode are produced.

**33. (2)**

**Sol:** $\frac{1000 \times 2}{(55+32)} = \frac{27 \times 24 \times 3600 \times \eta}{96500}$

or $\eta = 0.951 = 95.1\%$

**34. (1)**

**Sol:** The cells whose $E°_{cell}$ is zero are called concentration cells.

Nernst equation:

$$E = E° - 2.303 \frac{RT}{nf} \log Q$$

$$E_{cell} = \frac{RT}{nF} \ln \frac{[Cl^-]_{LHS}}{[Cl^-]_{RHS}}$$

**35. (4)**

**Sol:** The number of ions per unit volume carrying the current decreases on dilution, so conductivity always decreases with decrease in concentration, whereas molar conductivity increases with dilution. Hence the number of ions per unit volume that carry charge in a solution decreases.

**36. (3)**

**Sol:** The SRP of water is –1.23 V, if any substance has SRP value between –1.23 to zero, then reduction of the substance will be possible in basic medium.

**37. (2)**

**Sol:** The $E^o$ of cell will be zero.

**38. (3)**

**Sol:** At LHS (oxidation) $2 \times (Ag \longrightarrow Ag^+ + e^-)$

$E^o_{ox} = -x$

At RHS (reduction) $Cu^{2+} + 2e^- \longrightarrow Cu$

$E^o_{red} = +y$

$2Ag + Cu^{2+} \longrightarrow Cu + 2Ag^+$,

$E^o_{red} = (y - x)$

**39. (4)**

**Sol:** $0 = 0.295 - \frac{0.059}{2} \log K$;

$\log K = 10$; $K = 10^{10}$.

**40. (3)**

**Sol:** $E^o_{cell} = 0.77 + 0.14 = 0.91$ volt.

**41. (3)**

**Sol:** $Zn + 2H^+_{(aq)} \longrightarrow Zn^{2+}(aq) + H_2(g)$

$$E = E^o - \frac{0.0591}{2} \log \frac{[Zn^{2+}]pH_2}{[H^+]^2}$$

Adding $H_2SO_4$ means increasing H+ and therefore Ecell will increase and reaction will shift to forward direction.

**42. (1)**

**Sol:** $Cr^{2+} | Cr^{3+} = +0.41V$

$Mn^{2+} | Mn^{3+} = -1.57V$

$Fe^{2+} | Fe^{3+} = -0.77V$

$Co^{2+} | Co^{3+} = -1.97V$

As Cr will have maximum oxidation potential value, therefore its oxidation will be easiest.

**43.** **(4)**

**Sol:** $CH_3COONa + HCl \rightarrow CH_3COOH + NaCl$

From the reaction,

$\Lambda^0_{CH_3COONa} + \Lambda^o_{HCl} = \Lambda^0_{CH_3COOH} + \Lambda^o_{NaCl}$

or $\Lambda^0_{CH_3COOH} = \Lambda^0_{CH_3COONa} + \Lambda^o_{HCl} - \Lambda^o_{NaCl}$

Thus to calculate the value of $\Lambda^0_{CH_3COOH}$ one should know the value of $\Lambda^o_{NaCl}$ along with $\Lambda^0_{CH_3COONa}$ and $\Lambda^o_{HCl}$.

**44.** **(4)**

**Sol:** $0.152 = -0.8 - \frac{0.059}{1}\log K_{SP};$

$\log K_{SP} = -16.11.$

**45.** **(3)**

**Sol:** $E = E^\circ - \frac{0.0591}{n}\frac{[Zn^{2+}]}{[H^+]^2}$, If $[H^+]$ increases then $E_{cell}$ also increases.

**46.** **(1)**

**Sol:** $0 = +1.1 - \frac{0.0591}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]};$

$\log\frac{[Zn^{2+}]}{[Cu^{2+}]} = 37.3.\ ;\ \frac{[Zn^{2+}]}{[Cu^{2+}]} = 10^{37.3}$

**47.** **(4)**

**Sol:** $E_{cell} = E^0_{cell} - \frac{0.059}{6}\log\frac{[Cr^{+3}]^2}{[Fe^{+2}]^3}$

$= 0.3 - \frac{0.056}{6}\log\frac{(0.1)^2}{(0.01)^3} = 0.3 - 0.04$

$= 0.26$ V

**48.** **(3)**

**Sol:** $\frac{2}{3}Al_2O_3 \longrightarrow \frac{4}{3}Al + O_2$

$\Delta_rG = +966\ kJ\ mol^{-1} = 966 \times 10^3\ J\ mol^{-1}$

$\Delta G = -nFE_{cell}$

$966 \times 10^3 = -4 \times 96500 \times E_{cell}$

$E_{cell} = 2.5$ V

**49.** **(3)**

**Sol:** $2H^+(aq) + 2e^- \longrightarrow H_2(g)$

$E_{red} = E^o_{red} - \frac{0.0591}{n}\log\frac{P_{H_2}}{(H^+)^2};\qquad E_{red} = 0$

$-\frac{0.0591}{2}\log\frac{2}{(1)^2};\ E_{red} = -\frac{0.0591}{2}\log 2$

∴ $E_{red}$ is forund to be negative for (3) option.

**50.** **(1)**

**Sol:** x = 1.4 S/m.

R = 50 Ω

M = 0.2

$K = \frac{1}{R} \times \frac{\ell}{A}$

$\Rightarrow \frac{\ell}{A} = 1.4 \times 50\ m^{-1}.$

Now, new solution has M = 0.5, R = 280 Ω

$\Rightarrow K = \frac{1}{R} \times \frac{\ell}{A} = \frac{1}{280} \times 1.4 \times 50 = \frac{1}{4}$

$\Rightarrow \Lambda_M$

$= \frac{K}{100 \times M} = \frac{\frac{1}{4}}{1000 \times 0.5} = \frac{1}{2000} = 5 \times 10^{-4}$

**51.** **(3)**

**Sol:** $\lambda_C = \lambda_\infty - B\sqrt{C}$ (Debye Huckel onsager equation)

**52.** **(1)**

**Sol:** $Mn^{3+} \xrightarrow{E^0_1 = 1.51V} Mn^{2+} \xrightarrow{E^0_2 = -1.18V} Mn$

∴ for $Mn^{2+}$ disproportionation, $E^0 = -1.51$ V $-1.18$ V

$= -2.69\ V < 0$

Reaction is non-spontaneous.

**53.** **(3)**

**Sol:** $Cu^{2+}(aq.) + 2e^- \rightarrow Cu(s)$

∵ 2 moles of electrons deposit 1 mol or 63.5 g of Cu.

∴ 6.35 g, we require $\frac{N_A}{5}$ electrons.

**54.** **(2)**

**Sol:** $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$

$$E = 1.51 - \frac{0.059}{5}\log\frac{[Mn^{2+}]}{[MnO_4^-][H^+]^8}$$

Taking $Mn^{2+}$ and $MnO_4^-$ in standard state i.e. 1 M,

$$E = 1.51 - \frac{0.059}{5} \times 8 \log\frac{1}{[H^+]} = 1.51 -$$

$$\frac{0.059}{5} \times 8 \times 3 = 1.2268\ V$$

Hence at this pH, $MnO_4^-$ will oxidize only $Br^-$ and $I^-$ as SRP of $Cl_2/Cl^-$ is 1.36 V which is greater than that for $MnO_4^-/Mn^{2+}$.

**55.** **(4)**

**Sol:** $E^o_{T\ell/T\ell^+} = +0.34V$

$= E^o_{A\ell/A\ell^+} = +0.55V$

Therefore $T\ell^+$ more stable

**56.** **(1)**

**Sol:** Cell reaction:

$M_{(s)} + 3Ag^+ (aq) \longrightarrow M^{3+} (aq) + 3Ag_{(s)}$

Applying Nernst equation:

$$E_{cell} = 1\,E^o_{cell} - \frac{0.059}{n}\log_{10} Q$$

$$\therefore\ 0.421 = (0.8 - E^o_{M^{3+}/M}) - \frac{0.059}{3}\log_{10}\frac{0.001}{(0.01)^3}$$

$$\therefore\ E^o_{M^{3+}/M} = 0.32V$$

**57.** **(4)**

**Sol:** $2Cu^{+1} \longrightarrow Cu + Cu^{+2}$

$2Cu^{+1} + 2e \longrightarrow 2Cu$

$Cu - 2e \longrightarrow Cu^{+2}$

---

$2Cu^{+1} \longrightarrow Cu^{+2} + Cu$

---

$$\therefore\ E^\circ\ \frac{2\times0.521+2(-0.337)}{2}$$

$= 0.184$

**58.** **(2)**

**Sol:** $ClO_3^- + 2H_2O + 4e \longrightarrow ClO^- + 4OH^-$ ; $\Delta G_1^\circ$

$ClO^- + H_2O + e \longrightarrow \frac{1}{2}Cl_2 + 2OH^-$ ; $\Delta G_2^\circ$

$\frac{1}{2}Cl_2 + e \longrightarrow Cl^-$ ; $\Delta G_3^\circ$

---

$ClO_3^- + 3H_2O + 3e \longrightarrow Cl^- + 6OH^-$ ; $\Delta G^\circ$

---

$\therefore\ \Delta G^\circ = \Delta G_1^\circ + \Delta G_2^\circ + \Delta G_3^\circ$

$-6FE^\circ = -4F \times 0.54 - 1F \times 0.45 - 1F \times 1.07$

$$\therefore\ E^\circ = +\frac{3.68}{6} = +0.61\ V$$

**59.** **(2)**

**Sol:** $Zn + Ni^{+2} \longrightarrow Zn^{+2} + Ni$

$E^\circ = E^\circ_{Ni^{+2}/Ni} - E^\circ_{Zn^{+2}/Zn}$

$= -0.23 - (-0.76) = +0.53\ V$

Positive value shows that the process is spontaneous.

Rest of all (I) (II) (III) combination have negative E° value.

(I) E° = –0.44 – (–0.23) = –0.21 V

(II) E° = –0.76 – (–0.23) = –0.53 V

(III) E° = –0.76 – (–0.44) = –0.32 V

**60.** **(4)**

**Sol:** $H^+ + e^- \longrightarrow \frac{1}{2}H_2.$

$E = 0 - \frac{.0591}{1} \log_{10}\frac{1}{[H^+]} = +0.0591$

$\log_{10}[H^+]$.

$E_1 = 0$ {pH = 0}.

$E_2 = +0.0591\log_{10}[10^{-14}]$

$= -.0591 \times 14$ {at pH = 14}

$= -0.82$ V.

## Integer Type Questions (61 to 75)

**61.** **(120)**

**Sol:** $E_{cell} = E^0_{cell} - \frac{0.06}{1}\log_{10}[H^+][Cl^-]$

and $E'_{cell} = E^0_{cell} - \frac{0.06}{1}\log_{10} 100[H^+][Cl^-]$.

$E'_{cell} - E_{cell} = -2 \times 0.06$

$-\frac{x}{1000} = -0.120.$ x = 120

**62.** **(3)**

**Sol:** **At anode**

$4OH^- \longrightarrow O_2 + 2H_2O + 4e^-$

$2SO_4^{-2} \longrightarrow S_2O_8^{-2} + 2e^-$

1 mol of $O_2$ requires 4 mole or 4f of electricity

1 mol of $S_2O_8^{-2}$ requires 2f of electricity

Total charge used at Anode = 2f + 4f = 6f

4x + 2x = 6 × f

**At cathode**

$2H^+ + 2e^- \longrightarrow H_2$

2 mole $e^-$ (2f) liberate 1 mole $H_2$

∴ 6f 3 mole

y = 3

**63.** **(65)**

**Sol:**

Anode $H_2 \longrightarrow 2H^+ + 2e^-$

Cathode $HgCl_2 + 2e^- \longrightarrow 2Hg + 2Cl^-$

$H_2 + HgCl_2 \longrightarrow 2H^+ + 2Hg + 2Cl^-$

$E_{cell} = E^o_{cell} - \frac{0.06}{2}\log[H^+]^2[Cl^-]^2$

$0.67 = E^o_c - E^o_a - 0.06\log[H^+][1]$

$0.67 = 0-(-0.28) - 0.06\log[H^+]$

$\frac{0.67-0.28}{0.06} = -\log[H^+]$

$\frac{0.39}{0.06} = pH$

$pH = 6.5 = \frac{x}{10}$

x = 65

**64.** **(11)**

**Sol:** $0.34 = \frac{0.06}{2}\log K_{eq}$

$\log K_{eq} = 11.3$ or $K_{eq} = 2 \times 10^{11} = 2 \times 10^x$

$\Rightarrow$ x = 11

**65.** **(94)**

**Sol:** $E = 0.80 - (-0.14) = 0.94\text{ V} = \frac{x}{100} \Rightarrow x = 94$

**66.** **(26)**

**Sol:** $0.52 = \frac{y}{50} \Rightarrow y = 26$

**67.** **(193)**

**Sol:** $\frac{0.55}{M} \times 3 = \frac{0.55 \times 100 \times 60}{96500}$

$\Rightarrow M = 48.25\text{ g/mol} = \frac{z}{4} \Rightarrow z = 193$

**68.** **(31)**

**Sol:** $5 = \frac{52 \times 15 \times t}{3 \times 96500} \Rightarrow t = 31$

**69.** **(180)**

**Sol:** $Q = it = 100 \times 10^{-3} \times 30 \times 60 = 180$

**70. (16)**

**Sol:** $$\frac{(W)_{H_2}}{(W)_{Cu}} = \frac{(Ew)_{H_2}}{(Ew)_{Cu}}$$

$$\frac{0.504}{(W)_{Cu}} = \frac{\frac{2}{2}}{\frac{63.5}{2}}$$

$\Rightarrow$ $W_{Cu} = 16$ gm

**71. (392)**

**Sol:** $Ka = 25\times10^{-6}$ $\wedge_{eq} = 19.6$ Scm$^2$ eq$^{-1}$, C = 0.01

$Ka = 0.01 \times \alpha^2$

$$\Rightarrow \alpha = \sqrt{\frac{25\times10^{-6}}{10^{-2}}} = 5 \times 10^{-2}$$

$$\alpha = 5 \times 10^{-2} = \frac{19.6}{\overset{\circ}{\wedge}_{eq}}$$

$$\Rightarrow \overset{\circ}{\wedge}_{eq} = \frac{19.6}{5\times10^{-2}} = 392 \text{ Scm}^2 \text{ eq}^{-1}.$$

**72. (39)**

**Sol:** Conductance (G) = $\frac{1}{R} \Rightarrow \frac{1}{300}$

$$\therefore \quad \kappa = G\left(\frac{\ell}{A}\right)$$

Cell constant $\left(\frac{\ell}{A}\right) = \frac{0.013}{1} \times 300 = 3.9$ cm$^{-1}$

$= \frac{x}{10} \Rightarrow x = 39$

**73. (20)**

**Sol:** $$x = \frac{\Lambda_{eq}^{c}}{\Lambda_{eq}^{\infty}} = \frac{80}{400}\times100$$

**74. (54)**

**Sol:** Moles of hydrogen = $\frac{5600}{22400} = 0.25$,

$$2H^+ + 2e^- \longrightarrow H_2$$

$\because$ 1 mole of hydrogen required 2 moles of electrons

$\therefore$ 0.25 mole of hydrogen required $2\times0.25$ moles of electrons

$$Ag^+ + e^- \longrightarrow Ag$$

1 mole of silver requires 1 mole of electrons.

Moles of silver deposited = 0.50 moles

Mass of silver = 0.5 × 108 = 54 gm

**75. (105)**

**Sol:** $\frac{W}{7} = \frac{1930\times0.75}{96500}$ ; W = 0.105 g

x = 0.105 × 1000 = 105

# CHEMICAL KINETICS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** $\frac{1}{C_t} = \frac{1}{C_0} + Kt.$

$\frac{1}{0.04} = \frac{1}{0.02} + 0.002 \times t.$

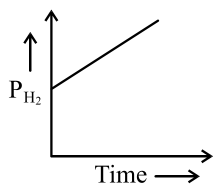
$\Rightarrow \quad 25 = 5 + 0.002 \times t$

$\Rightarrow \quad t = \frac{20}{2\times10^{-3}} = 10{,}000$ sec.

**2.** **(2)**

**Sol:** $2HI(g) \longrightarrow H_2(g) + I_2(g)$ (zero order)

t = 0 a b 0 $b \propto P_{H_2}$, initial




t = t a – 2x b + x $P_{H_2} \propto (b + x)$

$\Rightarrow P_{H_2} = P_{H_2}$, initial + kt (zero order reaction)

**3.** **(2)**

**Sol:** $t_{1/2} \propto \frac{1}{(\text{initial conc.})^{\text{order}-1}}$

**4.** **(2)**

**Sol:** $t_{1/2} \propto \frac{1}{a^{n-1}}$

$\frac{15}{10} = \left(\frac{200}{300}\right)^{n-1}$

$\frac{3}{2} = \left(\frac{2}{3}\right)^{n-1}$

$n - 1 = -1$

$n = 0$

**5.** **(4)**

**Sol:** $X \propto t$ order = 0

$\frac{-d(A)}{dt} = \text{constant}$

**6.** **(3)**

**Sol:** $\log\frac{K_2}{K_1} = \frac{\Delta E_a}{2.303RT}$

$= \frac{4.606\times1000}{2.303\times2\times500} = 2$

$\frac{K_2}{K_1} = 10^2$ $K_2 = 100\ K_1$

**7.** **(3)**

**Sol:** $k = \frac{0.693}{t_{1/2}} = \frac{0.693}{150.5}$ $min^{-1}$ ; $t = \frac{2.303}{k}\log$

$\frac{100}{100-40} = \frac{2.303\times150.5}{0693} \log\frac{100}{60} = 111$ minutes

**8.** **(4)**

**Sol:** Mol $L^{-1}$ of $N_2O_5$ reacted = 2 × 0.1 = 0.2 ; $[N_2O_5]$ left = 1.0 – 0.2 = 0.8 mol $L^{-1}$

Rate of reaction = k × $[N_2O_5]$ = 3.0 × $10^{-4}$ × 0.8 = 2.4 × $10^{-4}$ mol $L^{-1}$ $s^{-1}$ ;

Rate of formation of $NO_2$ = 4 × 2.4 × $10^{-4}$ = 9.6 × $10^{-4}$ mol $L^{-1}s^{-1}$.

**9.** **(4)**

**Sol:** rate of reaction depends up on conc., pressure of $O_2$ and surface area of iron.

**10.** **(2)**

**Sol:** $4A + B \longrightarrow 2C + 2D$

$$-\frac{1}{4}\frac{d[A]}{dt} = -\frac{d[B]}{dt} = +\frac{1}{2}\frac{d[C]}{dt} = \frac{1}{2}\frac{d[D]}{dt}$$

**11.** **(3)**

**Sol:** $k = \frac{2.303}{t}\log\left(\frac{P_i}{P_t}\right)$ ;

| | $(CH_3)_2N_2 \longrightarrow$ | $C_2H_6$ | $+ N_2$ |
|---|---|---|---|
| t = 0 | 200 | 0 | 0 |
| | 200 – x | x | x |

as per given 200 + x = 350 x = 150

$$\therefore \quad k = \frac{2.303}{t}\log\left(\frac{200}{200-150}\right)$$

$k = 3.45 \times 10^{-4}\ sec^{-1}$

**12.** **(4)**

**Sol:** $E_a = 41570 \times R = 41570 \times 8.31 = 345446.70$ J

**13.** **(1)**

**Sol:** (I) For zero order reaction $C = C_o - kt$

(II) For first order reaction

$$\log C = \log C_o - \frac{k}{2.303} \times t$$

(III) For zero order reaction $\frac{-dc}{dt}$ vs C equal to zero

(IV) For first order reaction $\frac{-dc}{dt} = k_{[c]}$, $\log\left(\frac{dc}{dt}\right) = \log k + \log c$

Hence plot of $\log\left(\frac{-dc}{dt}\right)$ against log c (abscissa) will have slope equal to unity

**14.** **(1)**

**Sol:** (I) $2.303 \log_{10}\frac{K_2}{K_1}$

$$= \frac{E_a}{R}\left[\frac{T_2 - T_1}{T_2T_1}\right] = \frac{65000}{8.314}\left[\frac{25}{273\times 290}\right] = 2.4$$

$$\Rightarrow \frac{K_2}{K_1} = 11$$

$T_2 = 298$ K ; $T_1 = 273$ K ,

$E_a = 65000$ J , R = 8.314 J/(mol K)

(II) $\frac{2.5}{20} = \frac{1}{8} = \left(\frac{1}{2}\right)^n$

$$\Rightarrow n = 3 \Rightarrow t = 3 \times \frac{0.693}{0.0693} = 30$$

(III) Zero order: $t_{1/2} = \frac{a}{2K}$ I order : $t_{1/2} = \frac{0.693}{K}$

$$\frac{1}{2K_1} = \frac{0.693}{K_2}$$

$$\Rightarrow \frac{K_2}{K_1} = 2 \times 0.693$$

(IV) $t_{1/2} \propto (a)^{1-n}$

or $(1-n) = \frac{\log t'_{1/2} - \log t''_{1/2}}{\log a' - \log a''}$

$$t_{1/2} \propto \frac{1}{a^{n-1}}$$

$$\Rightarrow \frac{480}{240} = \left(\frac{0.0677}{0.136}\right)^{n-1}$$

n = 0

**15.** **(1)**

**Sol:** For Ist order reaction,

$[A]_t = [A]_0\, e^{-Kt}$

$$-\frac{d[A]}{dt} = K[A]_t = [A]_0\, K\, e^{-Kt}$$

$Kt = 2.303 \log [A]_0 - 2.303 \log [A]_t$

$$\Rightarrow \log [A]_t = \log [A]_0 - \frac{Kt}{2.303}\ .$$

**16.** **(2)**

**Sol:** $2NO + 2H_2 \longrightarrow N_2 + 2H_2O$

$$\frac{-1}{2}\frac{d[NO]}{dt} = -\frac{1}{2}\frac{d[H_2]}{dt} = \frac{d[N_2]}{dt}$$

$$= \frac{1}{2}\frac{d[H_2O]}{dt} = \text{Rate}$$

$$k_1 = \frac{k}{2} = \frac{k_1'}{2} = \frac{k_1''}{2}.$$

**17.** **(2)**

**Sol:** $t = \frac{2.303}{K} \log \frac{C_O}{C_t}$

$$\Rightarrow \quad t = \frac{2.303}{K}[\log C_O - \log C_t]$$

$$\frac{Kt}{2.303} = \log C_O - \log C_t$$

$$\Rightarrow \quad \log C_t = \left(\frac{-K}{2.303}\right)t + \log C_O$$

So, slope (<+ky) $= \left(\frac{-K}{2.303}\right)$

**18.** **(4)**

**Sol:** According to graph given it would be first order reaction

**19.** **(3)**

**Sol:** $C_t = Co\ kt \Rightarrow kt = C_t / Co$

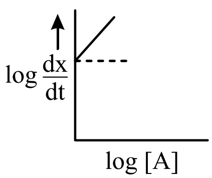
$\underline{kt\ \ 75\% = 0.75co}$ . f $\underline{kt\ \ 50\% = 0.5co}$

$$\frac{t75\%}{t50\%} = \frac{75}{50} = 1.5.$$

**20.** **(3)**

**Sol:** $\frac{dx}{dt} = K[A]^2$

$$\log\frac{dx}{dt} = 2\log[A] + \log k$$




compare with y = m × + c graph obtained

**21.** **(1)**

**Sol:** $k = \frac{1}{t}\ln\left(\frac{P_0}{P_t}\right)$

| | A → | B + | C |
|---|---|---|---|
| t = 0, | Po | 0 | 0 |
| t = t, | $P_0 - x$ | x | x |

**22.** **(1)**

**Sol:** Rate increases as temperature increases.

**23.** **(4)**

**Sol:** The effective collisions must posses

i) Energy should be ≥ threshold energy

ii) Molecule should have proper orientation.

**24.** **(2)**

**Sol:** Slower step is rate determining step.

**25.** **(1)**

**Sol:** by graph we can say $\log t_{1/2} = \log a$

$t_{1/2} = a$ .....(1)

$t_{1/2} \propto a$ for zero order Rxn

$k \times t_{1/2} = \frac{a}{2}$ .....(2)

then $k = \frac{1}{2}$

**26.** **(4)**

**Sol:** $K_1 = A_1e^{-E_1/RT}$ and $K_2 = A_2e^{-E_2/RT}$

$\frac{K_1}{K_2} = \frac{A_1}{A_2} = e^{(E_2-E_1)/RT}$ ; $A_1$ and $A_2$ are not given.

**27.** **(2)**

**Sol:** For reaction, $A \longrightarrow B$.

$E_a = 10$ kJ/mole, $\Delta H = 5$ kJ/mole

Rxn endothermic because ΔH (+)

$\Delta H = E_a - E_b \Rightarrow 5 = 10 - E_b$

$E_{ab} = 10 - 5 = 5$ kJ/mole. Then [B].

**28.** **(1)**

**Sol:** $\log k = -\frac{E_a}{2.303\ R}\frac{1}{T} + \text{constant}$

$= -\frac{E_a}{2.303\ R} \times 10^{-3} \times \frac{10^3}{T} + \text{constant}$

thus, slope of graph will be

$= -\frac{E_a \times 10^{-3}}{2.303\ R} = -\frac{4}{0.4}$

$\Rightarrow \quad E_a = 2.303 \times 1.98 \times 10^4 = 45600$ cal

**29.** **(3)**

**Sol:** Rate = K $[X][Y_2]$

$K_{eq} = \frac{[X]^2}{[X_2]}$

$[X] = \sqrt{K_{eq}} \times [X_2]^{1/2}$

Rate = $K \times \sqrt{K_{eq}}\ [X_2]^{1/2}\ [Y_2]$

So the order of overall reaction is 1.5

**30.** **(3)**

**Sol:** $C_3 = \frac{C_0}{2^3} = \frac{C_0}{8}$

$\frac{C_3}{C_0} = \frac{1}{8}$

**31.** **(1)**

**Sol:** Rate = K $[\text{reactant}]^n$, K increases with temperature for any reaction

**32.** **(1)**

**Sol:** The catalyst-reactant interaction forms activated adsorbed complex and adsorption is exothermic and thus a catalyst always lowers the energy of activation.

**33.** **(1)**

**Sol:** An elementary reaction is a single step reaction and has order and molecularity same.

**34.** **(1)**

**Sol:** $K = (\text{mol L}^{-1})^{1-n}\ \text{sec}^{-1}$, n = 0, 1.

**35.** **(4)**

**Sol:** $H_2 + I_2 \rightarrow 2HI$

When 1 mole of $H_2$ and 1mole of $I_2$ reacts, 2 moles of HI are formed in the same time interval.

Thus, the rate may be expressed as

$\frac{-\Delta[H_2]}{\Delta t} = \frac{-\Delta[I_2]}{\Delta t} = \frac{1}{2}\frac{\Delta[HI]}{\Delta t}$

The negative sign signifies a decrease in concentration of the reactant with increase of time.

$H_2 + I_2 \rightarrow 2HI$

**36.** **(4)**

**Sol:** Rate 1 = k $[A]^n\ [B]^m$

On doubling the concentration of A and halving the concentration of B

Rate 2 = k $[2A]^n\ [B/2]^m$

Ratio between new and earlier rate.

$\frac{k\ [2A]^n\ [B/2]^m}{k\ [A]^n\ [B]^m} = 2^n \times \left(\frac{1}{2}\right)^m = 2^{n-m}$

**37.** **(3)**

**Sol:** $\text{Rate}_1 = k\ [NO]^2\ [O_2]$

When volume is reduced to 1/2, concentration become two times,

$\text{Rate}_2 = k\ [2NO]^2\ [2O_2]$

$\frac{\text{Rate}_1}{\text{Rate}_2} = \frac{k\ [NO]^2\ [O_2]}{k\ [2NO]^2\ [2O_2]}$ or $\frac{\text{Rate}_1}{\text{Rate}_2} = \frac{1}{8}$

$\therefore \quad \text{Rate}_2 = 8\ \text{Rate}_1$.

**38.** **(3)**

**Sol:** In Arrhenius equation, $k = Ae^{-Ea/RT}$

k = rate constant, A = frequency factor

T = temperature, R = gas constant, $E_a$ = energy of activation.

This equation can be used for calculation of energy of activation.

**39.** **(4)**

**Sol:** $2A + B \longrightarrow C$

rate = k [A] [B]

The value of k (velocity constant) is always independent of the concentration of reactant and it is a function of temperature only.

**40. (3)**

**Sol:** $t_{1/2} = 4$ hours $n = \frac{T}{t_{1/2}} = \frac{24}{4} = 6;\ N = N_0\left(\frac{1}{2}\right)^N$

or, $N = 200 \times \left(\frac{1}{2}\right)^6$

$= 200\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2}\times\frac{1}{2} = 3.125g.$

**41. (1)**

**Sol:** For endothermic reaction, $\Delta H = +ve\ \Delta H = E_f - E_b$, it means $E_b < E_f$.

**42. (1)**

**Sol:** Generally, molecularity of simple reactions is equal to the sum of the number of molecules of reactants involved in the balanced stoichiometric equation. Thus, a reaction involving two different reactants can never be unimolecular.

**43. (3)**

**Sol:** Given rate = k $[CO]^2$
Thus, according to the rate law expression doubling the concentration of CO increases the rate by a factor of 4.

**44. (2)**

**Sol:** In first order reaction for X% complation

$k = \frac{2.303}{t}\log\left(\frac{100}{100 - x\%}\right)$

$\frac{0.693}{t_{1/2}} = \frac{2.303}{t}\log\left(\frac{100}{100-99}\right)$

$\frac{0.693}{6.93} = \frac{2.303\times 2}{t}$

So, t = 46.06 min.

**45. (3)**

**Sol:** $K_1 = A_1 e^{-Ea_1/RT}$

$K_2 = A_2 e^{-Ea_2/RT}$

$\frac{K_1}{K_2} = \frac{A_1}{A_2}e^{(E_{a_2} - E_{a_1})/RT}$

$K_1 = K_2 A \times e^{E_{a_1}/RT}$

**46. (1)**

**Sol:** $\log\frac{K_2}{K_1} = \frac{-E_a}{2.030R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$\frac{K_2}{K_1} = 2$ ; $T_2 = 310$ K $\quad T_1 = 300$ K

$\Rightarrow \log 2 = \frac{-E_a}{2.303\times 8.134}\left(\frac{1}{310} - \frac{1}{300}\right)$

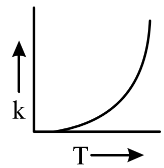
$\Rightarrow E_a = 53598.6$ J / mol = 53.6 KJ/mol

**47. (4)**

**Sol:** $1.2 \times 10^{-3} = K(0.1)^x(0.1)^y$
$1.2 \times 10^{-3} = K(0.1)^x(0.2)^y$
$2.4 \times 10^{-3} = K(0.2)^x(0.1)^y$
$R = K[A]^1[B]^0$

**48. (1)**

**Sol:** $k = Ae^{-Ea/RT}$
So, variation will b




**49. (3)**

**Sol:**

| | A(g) + | 2B(g) → | C(g) |
|---|---|---|---|
| t = 0 | 0.4 atm | 1 atm | 0 atm |
| t = t | (0.4 –0.3) atm | (1 – 0.6) atm | 0.3 atm |

Since reaction is elementary.
So, Rate of reaction w.r.t. A & B will be of order equal to stoichiometric coefficient
Rate = $K[A][B]^2$
$Rate_{(Initial)} = K[0.4][1]^2$
$Rate_{(after\ t = t)} = K[0.1][0.4]^2$

$\frac{R_{(t=t)}}{R_{(t=o)}} = \frac{K[0.1]\ [0.4]^2}{K[0.4]\ [1]} = \frac{1}{25}$

**50. (4)**

**Sol:** $(mol/L)^{1-n}sec^{-1}$

**51. (1)**

**Sol:** Order of reaction is an experimental quantity.

**52. (3)**

**Sol:** $r_1 = k[A]^2 [B]$ ; $r_2 = k[2A]^2 [2B] = 8 r_1$

**53. (2)**

**Sol:** $0.2\text{ M} \xrightarrow[t_{1/2}=5\text{ hr}]{} 0.1\text{ M} \xrightarrow[t_{1/2}=5\text{ hr}]{} 0.05\text{ M}$

From $0.2\text{ M} \xrightarrow[t=10\text{ hr}]{} 0.05\text{ M}$

So $t_{1/2}$ is constant which is characteristic of first order reaction.

Hence, $t_{1/2} \propto (a)^0$.

**54. (3)**

**Sol:** First step is slow (require large activation energy) second step is fast (less activation energy) and overall reaction exothermic, so product energy level should be less as compare to reactants.

**55. (4)**

**Sol:** Temperature coefficient = $k_{308}/k_{298}$

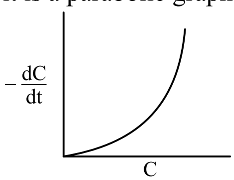
**56. (2)**

**Sol:** $t_{1/2} = \frac{t}{4}$ ; $t_{1/2} = T \ln 2$

so $\frac{t}{4} = T \ln 2$ ; $t = 4T \ln 2$

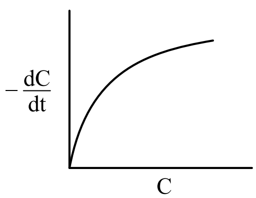
**57. (2)**

**Sol:** it is a parabolic graph of $y = x^2$




So, This is the graph of second order

$y^2 = x$ $\qquad$ $y = (x)^{\frac{1}{2}}$




$\frac{-dc}{dt} = K[C]^{\frac{1}{2}}$ So, reaction is $\left(\frac{1}{2}\right)$ order.

**58. (4)**

**Sol:** For nth order, $t_{1/2} \propto (a)^{1-n}$.

$\Rightarrow \frac{t_{1/2}}{(a)^{1-n}}$ or $t_{1/2} \times (a)^{n-1}$ = Constant

$\therefore$ Given $t_{1/2} \times (a)^{n-1}$ = Constant

$\Rightarrow (a)^{n-1} = (a)^2 \Rightarrow n - 1 = 2 \Rightarrow n = 3$

Hence, third order reaction.

**59. (1)**

**Sol:** For zero order reaction, $t_{1/2} \propto (a)^1$

**60. (4)**

**Sol:** Rate law for

| Ist order | IInd order | IIIrd order |
|---|---|---|
| Rate = $K[A]^1$ | $R_2 = K[A]^2$ | $R_3 = K[A]^3$ |

Than we can say [A] = 1

$r_1 = r_2 = r_3$ [A] < 1 then

$r_1 > r_2 > r_3$

y [A] > 1 then $r_3 > r_2 > r_1$

## Integer Type Questions (61 to 75)

**61. (11)**

**Sol:** $\log\left(\frac{K_2}{K_1}\right) = \frac{E_a}{2.303R}\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$

$= \frac{65\times10^3 \times (298-273)}{2.303\times8.3\times298\times273}$

Calculation we find

$\frac{K_2}{K_1} = 11$

**62. (15)**

**Sol:** $\underline{A}$ : $a \xrightarrow{5\text{min}} 2a \xrightarrow{5\text{min}} a \xrightarrow{5\text{min}} a/2$

$\underline{B}$ : $a \xrightarrow{5\text{min}} a/2$ , So time is 15 minutes.

**63. (2)**

**Sol.** For zero order $t_{1/2} = \frac{a_0}{2k}$, so $\underline{t_{1/2} \times a_0} = \frac{a^2}{2k}$ is not a constant.

For 1[st] order $t_{1/2}$ is constant so $\underline{t_{1/2} \times a_0}$ is not constant.

For 2[nd] order $t_{1/2} = \frac{1}{a_0 k}$ so $\underline{t_{1/2} \times c_0 = k}$ is constant.

**64.** **(80)**

**Sol:** R = K [A]

$R = 4 \times 10^{-3} \times 0.02 = 8 \times 10^{-5}$ mole/L $sec^{-1} = x \times 10^{-6} \Rightarrow x = 80$

**65.** **(2)**

**Sol:** We know,

$$\log K = \log A - \frac{E_a}{2.303RT}$$

compare this by y = mx + c

$m = -\frac{E_a}{2.303R}$ slope of this

Given,

$$-\frac{E_a}{2.303R} = -\frac{1}{2.303}$$

$E_a = R = 2$ cal = y

**66.** **(80)**

**Sol:** $\Delta H = Ea_t$ - Eab

– 20 = 60 – Eab so Eab = so.

**67.** **(2)**

**Sol:** $\Delta H = E_f - E_b \quad -40 = 80 - E_b$

$E_b = 120$ kJ/mole,

Catalyst lower the $E_f$ To 20 kJ/ mole for forward Rxn then $E_f' = 20$ kJ/mol

we know catalyst decreases the Activation energy equal amount in both direction

$E_b' = (120 - 60) = 60$ kj/mol

$$\frac{E_b}{E'_b} = \frac{120}{60} = 2.0$$

**68.** **(3)**

**Sol:** Order is the sum of the power of the concentrations terms in rate law expression. $R = [A] . [B]^2$

Thus, order of reaction = 1 + 2 = 3.

**69.** **(30)**

**Sol:** The concentration of the reactant decreases from 0.8 M to 0.4 M in 15 minutes, i.e., $t_{1/2}$ = 15 minute. Therefore, the concentration of reactant will fall from 0.1 M to 0.025 in two half-live. i.e., $2t_{1/2} = 2 \times 15 = 30$ minutes.

**70.** **(2)**

**Sol:** $NO(g) + Br_2(g) \rightleftharpoons NOBr_2(g)$

$NOBr_2(g) + NO(g) \longrightarrow 2NOBr(g)$ [rate determining step]

Rate of the reaction (r) = k $[NOBr_2]$ [NO]

where

$[NOBr_2] = K_c [NO] [Br_2]$

$r = k. K_C. [NO] [Br_2] [NO]$

$r = k' [NO]^2 [Br_2]$.

The order of the reaction with respect to NO(g) = 2.

**71.** **(20)**

**Sol:** $\Delta H_R = E_f - E_b = 180 - 200 = -20$ $kJmol^{-1} = x$

$\Rightarrow x = 20$

**72.** **(100)**

**Sol:** Let A be the activity for safe working.

Given, $A_o = 10$ A  Ao × No and A × N

$$t = \frac{2.303}{\lambda}\log\frac{N_o}{N} = \frac{2.303}{\lambda}\log\frac{A_o}{A}$$

$$= \frac{\frac{2.303}{0.693}}{30}\log\frac{10A}{A} = \frac{2.303\times30}{0.693}\log 10 = \frac{2.303\times30}{0.693} = 99.69 \text{ days}$$

**73.** **(32)**

**Sol:** $$\frac{\text{Rate at } 50^\circ C}{\text{Rate at } T_1\ ^\circ C} = (2)^{\frac{\Delta T}{T_1}} = (2)^{\frac{50}{10}}$$

$= 2^5 = 32$ times

**74.** **(1)**

**Sol:** For P, if $t_{50\%} = x$

then $t_{75\%} = 2x$

This happens only in first order reaction. So, order with respect to P is 1.

For Q, the graph shows that concentration of Q decreases linearly with time. So, rate, with respect to Q, remains constant. Hence, it is zero order wrt Q. So, overall order is 0 + 1 = 1

**75.** **(0)**

**Sol:** $R = k [A]^m$ if $M = 0 \Rightarrow R = K$

# THE p-BLOCK ELEMENTS
# (GROUP 13 To 18)

## *Single Option Correct Type Questions (01 to 60)*

**1.** **(1)**

**Sol:** Poor shielding by f-and d- electrons enhances the effective nuclear charge in Bi. This causes contraction in size.

**2.** **(2)**

**Sol:** $PH_3$ is less basic than $NH_3$ due to lesser availability of lone pair of electrons. The lone pair of electron is present in spherical s-orbital as compared to directional $Pp_3$ hybrid orbital in $NH_3$.

**3.** **(3)**

**Sol:** Reducing agents can reduce $Cr_2O_7^{2-}$ to $Cr^{3+}$ (green solution).

**4.** **(4)**

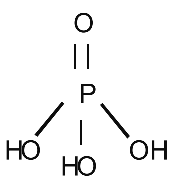
**Sol:** Both statement are correct

**5.** **(3)**

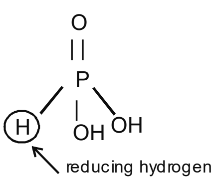
**Sol:** Refer Inert-pair effect.

**6.** **(4)**

**Sol:**




$(H_3PO_4)$




$(H_3PO_3)$

Strength of phosphorus oxy acid depends upon the number of OH groups per P = O group, more the OH group less will be the electronic withdrawing effect of P = O group. It is the P = O group which induces polarisation and helps in the release of proton from-OH group. $H_3PO_3 > H_3PO_4$

**7.** **(4)**

**Sol:** Metallic oxides are generally basic in nature.

**8.** **(4)**

**Sol:** Melting point $\propto$heat of atomization $\propto$ strength of metallic bond

Strength of metallic bond depends on number of mobile electrons per atom and size of atom.

**9.** **(2)**

**Sol:** Has one lone pair of electrons on central atom which they can donate to lewis acid and the order of basicity is :

$NH_3 > PH_3 > AsH_3 > SbH_3$

**10.** **(2)**

**Sol:** (2) Statement is correct.

**11.** **(1)**

**Sol:** The basic strength of the hydrides of group 15 elements down the group decreases with decrease in the electronegativity of the central atom according to Drago's rule.

**12. (4)**

**Sol:** N ≡ N bond dissociation energy is very high, and thus it is state and inert under ordinary conditions.

**13. (1)**

**Sol:** The difference of electronegativities between nitrogen (V) and oxygen is least as compared to that of in the other oxides. On moving down the group acidic strength decreases.

**14. (3)**

**Sol:** $Sb_4O_6$ reacts with NaOH forming arsenite as well as HCl forming $SbCl_3$.

**15. (1)**

**Sol:** Nitrogen can't expand its octet due to unavailability of d-orbital.

**16. (2)**

**Sol:** S and O-non-metals ; Po-metal ; Te and Se semi-metals.

**17. (3)**

**Sol:** Sulphur has greater tendency for catenation than oxygen.

**18. (4)**

**Sol:** Due to decrease in bond dissociation enthalpy from $H_2O$ to $H_2Te$, reading nature increases.

**19. (4)**

**Sol:** All statement are correct.

**20. (2)**

**Sol:** Bond dissociation enthalpy decreases down the group with increasing H–E bond length with increasing size of atoms from O to Te.

**21. (1)**

**Sol:** Acidic strength: $H_2O < H_2S < H_2Se < H_2Te$.

**22. (2)**

**Sol:** As water has H-bonding due to the presence of highly electronegative oxygen but $H_2S$ does not (electronegativity of sulphur is low).

**23. (3)**

**Sol:** Factual

**24. (1)**

**Sol:** Vanderwaal's forces increase as we move down the group and hydrogen bonding is present in $NH_3$.

**25. (1)**

**Sol:** High temperature is required to break N ≡ N.

**26. (1)**

**Sol:** As non-metallic character of element attached to oxygen atom increases, the difference between the electronegativity values of element and oxygen decreases and the acid character of oxides increases and vice-versa.

**27. (1)**

**Sol:** Intermolecular forces between $H_2S$, $H_2Se$ and $H_2Te$ molecules are purely Van der Waal's force of attraction while in water there is stronger H-bonding between the water molecules. H-bond is stronger than Van der Waal's force of attraction and thus more energy is required for converting $H_2O(\ell)$ to $(H_2O)(g)$.

**28. (4)**

**Sol:** N and O have ability to form pπ-pπ multiple bonds with it self on account of smaller size of atoms. N - N and 0-0 bond energies are less on account of repulsion between non-bonded pairs of electrons due to smaller size of atoms. S - S bond energy (265 kJ $mol^{-1}$) is next to C - C.

**29. (4)**

**Sol:** (1) –Bond dissociation energy of $F_2$ is less than that of $Cl_2$

(2) –Cl has higher E.A. than fluorine.

(3) –HF is weaker acid than HCI, due to higher bond energy.

**30. (1)**

**Sol:**

(a) (F); As the size of halogen atom increases crowding on Si atom will increase, hence, tendency of attack of Lewis base decreases.

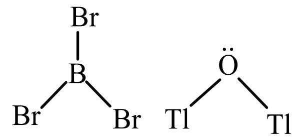
(b) (T); M.P. of $NH_3$ is highest due to intermolecular H-bonding in it.
Next lower M.P. will be of $SbH_3$ followed by $AsH_3$ due to high mol. wt. of $SbH_3$.

(c) (F); M.P. and B.P. of increase from $PH_3$ to $SbH_3$ via $AsH_3$ due to increase in mol. wt. $NH_3$ does not follow this trend due to inter molecular H-bonding.

(d) (T); Value of bond moment decreases.

**31. (2)**

**Sol:**




Trigonal planar Basic nature

B $(OH)_3$ Monobasic acid

$AlCl_3$ Dimer form

**32. (4)**

**Sol:** a. $(SiH_3)_3$ N (Pπ-dπ bond)

b. $BF_3$ (pπ-pπ bond)

c. $SiO_2$ ($sp^3$-hybridization)

d. $B_2H_6$ (3 centre 2-electron bond)

**33. (4)**

**Sol:** s-block & p-block elements collectively comprise the representative elements. The valence shell electronic configuration of halogen is $ns^2$ $np^5$ and the last electron enters in p-subshell. Thus, halogens belongs to p-block elements.

**34. (2)**

**Sol:** Fact.

**35. (3)**

**Sol:** Fluorine has less negative electron gain enthalpy than chlorine.

**36. (4)**

**Sol:** Bond length ∝ size of atom

**37. (1)**

**Sol:** Fact

**38. (4)**

**Sol:** According to their SRP.

**39. (1)**

**Sol:** HF has highest boiling point on account of intermolecular hydrogen bonding. But from HCl to HI the boiling point show a regular increase due to a corresponding increase in the magnitude of van der Waal's force of attraction as the size of the halogen increases.

**40. (4)**

**Sol:** As the size of anion increases the distance between the nucleus and valence shell electrons increases resulting into weak force of attraction between them. This leads to increase in the ease of the donation of electrons in the order $F^- < Cl^- < Br^- < I^-$ Hence $I^-$ acts as a strongest reducing agent.

**41. (2)**

**Sol:** All halogen exhibit –1 oxidation state. However, chlorine, Bromine and Iodine exhibit +1, +3, +5 and +7 oxidation state also.

**42. (1)**

**Sol:** Fluorine atom has no d-orbitals in its value shell and therefore can't expand its octet.

**43. (3)**

**Sol:** $F_2 + 2e^- \rightarrow 2F^-$ $\quad E° = +2.87$ V

**44. (3)**

**Sol:** Bond length $\propto$ 1/(bond dissociation energy) and bond dissociation energy $\propto$ bond strength.

**45. (3)**

**Sol:** In March 1962, Neil Bartlett, then at the University of British Columbia, observed the reaction of a noble gas. First , he prepared a red compound which is formulated as $O_2^+ PtF_6^-$. He , then realised that the first ionisation enthalpy of molecular oxygen (1175 kJ mol $^{-1}$) was almost identical with that xenon (1170 kJ mol $^{-1}$). He made efforts to prepare same type of compound with $Xe^+ PtF_6^-$ by mixing Pt $F_6$ and Xenon. After this discovery, a number of xenon compounds mainly with most electronegative elements like fluorine and oxygen, have been synthesised.

**46. (2)**

**Sol:** I.E: He > Ne > Ar > Kr > Xe.

**47. (4)**

**Sol:** Due to large size of xe.

**48. (4)**

**Sol:**

$F_2 + 2e^- \longrightarrow 2F^-$ $\quad \varepsilon° = +2.87$ V ;

$Cl_2 + 2e^- \longrightarrow 2Cl^-$ $\quad \varepsilon° = +1.36$ V

$Br_2 + 2e^- \longrightarrow 2Br^-$ $\quad \varepsilon° = +1.09$ V ;

$I_2 + 2e^- \longrightarrow 2I^-$ $\quad \varepsilon° = +0.54$ V

More the value of the SRP, more powerful is the oxidising agent. Hence the order of oxidising power is $F_2 > Cl_2 > Br_2 > I_2$.

**49.** **(3)**

**Sol:** (1) 64 < 99 < 114 < 133 – covalent radius/pm down the group size increases due to addition of new shells.

(2) 515 > 391 > 347 > 305 – $\Delta_{hyd}H(X^-)$ KJ $mol^{-1}$

Degree of hydration $\propto \frac{1}{\text{size of anion}}$

(3) 158.8 < 242.6 > 192.8 > 1.51 |-Bond dissociation enthalpy | ($kJ\ mol^{-1}$) F–F < Cl–Cl on account of large repulsion between non-bonded pairs of electron due to small F-F bond length.

(4) 143 < 199 < 228 < 266 – X – X distance/pm as size of element increases the X-X distance increases.

**50.** **(4)**

**Sol:** (1) As O.N. increases, acidic strength increases.

(2) As non-metallic character increases, acid strength increases

(3)

| Oxyacid | No. of $p\pi - p\pi$ bond |
|---|---|
| $HClO_4$ | 3 |
| $HClO_3$ | 2 |
| $HClO_2$ | 1 |
| $HClO$ | 0 |

(4) All are $sp^3$ hybridised, therefore same percentage s-character.

**51.** **(1)**

**Sol:** As charge dispersion increases, the stability of conjugated base increases and thus acidity increases.

**52.** **(3)**

**Sol:** Fact.

**53.** **(2)**

**Sol:** $Sn^{4+} > In^{+} > Sn > In$

**54.** **(1)**

**Sol:** In general, left to right in a period electronegative increases and top to bottom it decreases.

**55.** **(1)**

**Sol:** $TlI_3$ exists as Tl+ and $I_3^-$ while $PbF_4$ exists because of $F^-$ being very weak reducing agent.

**56.** **(4)**

**Sol:**

| **Element :** | B | S | P | F |
|---|---|---|---|---|
| **I.E.($kJ\ mol^{-1}$) :** | 80 | 100 | 101 | 168 |

In general as we move from left to right in a period, the ionization enthalpy increases with increasing atomic number. The ionization enthalpy decreases as we move down a group. P ($1s^2, 2s^2, 3s^2\ 3p^3$) has a stable half filled electronic configuration than S ($1s^2$, $2s^2$, $2p^6$, $3s^2$, $3p^4$). For this reason, ionization enthalpy of P is greater than S.

**57.** **(1)**

**Sol:** Due to the inert pair effect (the reluctance of $ns^2$ electrons of outermost shell to participate in bonding) the stability of $M^{2+}$ ions (of group 14 elements) increases as we go down the group.

**58.** **(3)**

**Sol:** Group is elements has stable half-filled configuration

**59.** **(3)**

**Sol:** Additional electrons are repelled more effectively by 2p electrons in F atom than by 3p electrons in Cl atom.

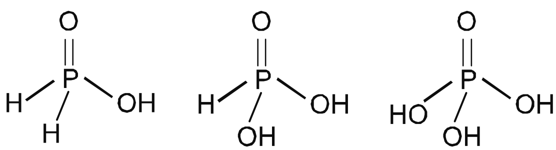
**60.** **(3)**

**Sol:** In p-block elements (i.e. $14^{th}$ group here), the lower oxidation state becomes more stable on going down the group due to inert pair effect. Thus, $Pb^{4+}$ is less stable than Sn4+. This makes the $Pb^{4+}$ a stronger oxidising agent. Therefore, the statement-2 is incorrect.

*Integer Type Questions (61 to 75)*

**61.** **(3)**

**Sol:**



$H_3PO_2$ = monobasic

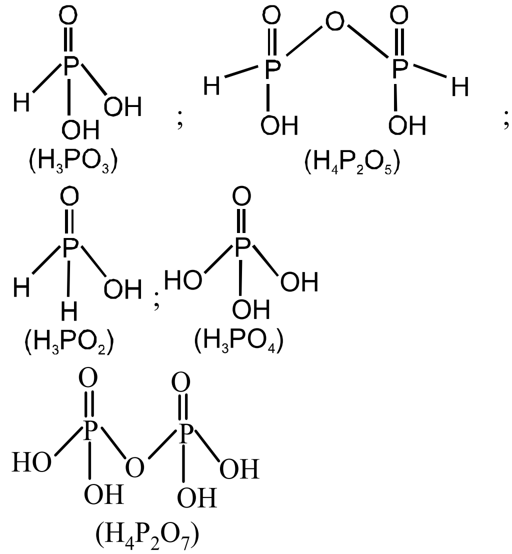
; $H_3PO_3$ = dibasic

; $H_3PO_4$ = tribasic.

one ionisable $H^+$ two ionisable $H^+$ three ionisable $H^+$

**62.** **(2)**

**Sol:**




**63.** **(3)**

**Sol:** (i) (ii) (iii)

$H_2SO_4$ oxidises HI to $I_2$., and Al to $Al^{+3}$

**64.** **(3)**

**Sol:** (i), (ii), (iii) are correct.

The Ionisation energy of group 15 elements is much large than that of group 14 elements in the corresponding period.

**65.** **(2)**

**Sol:** Density $IE_1$; O > S > Se > Te. Increases from O to Te with increasing atomic number.

**66.** **(2)**

**Sol:** The stability of hydrides decreases from $NH_3$ to $BiH_3$ which can be observed from their bond dissociation enthalpy. The correct order is

$NH_3 < PH_3 < AsH_3 < SbH_3 < BiH_3$.

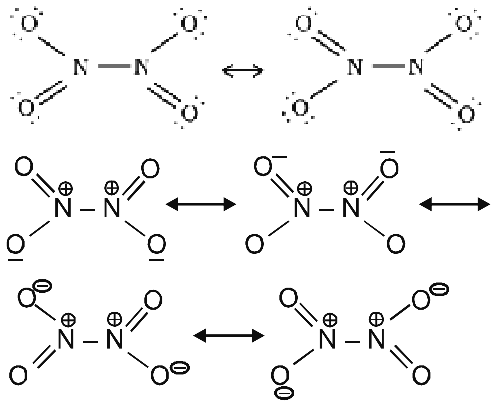
Property

$NH_3$ $PH_3$ $AsH_3$ $SbH_3$ $BiH_3$

$\Delta_{diss}H^{\ominus}(E–H)$ / kJ $mol^{-1}$ 389 322 297 255

**Alternate Solution**

$N_2O_4$ may has four resonating structure but in NCERT only two resonating structure . Resonating structures of $N_2O_4$ are



**67. (5)**

**Sol:** Due to small size of He. It escapes from interstitial spaces/voids of molecular lattice of quinols.

**68. (5)**

**Sol:** Incorrect order of bond dissociation energy $F_2 > Cl_2 > Br_2 > I_2$ due to following order of size I > Br > Cl > F.

**69. (3)**

**Sol:** (I) They do not form compounds readily as they are chemically inert on account of stable electron configuration.

(II), (III) & (IV) are correct statement.

**70. (4)**

**Sol:** (ii), (iii), (v), (vii) are correct.

$BiI_5$ does not exists because of $I^-$ being very strong reducing agent. So it reduces $Bi^{5+}$ to $Bi^{3+}$ and forms $BiI_3$.

**71. (2)**

**Sol:** $N_2O$ and NO are neutral oxides.

**72. (2)**

**Sol:** When cooled to a few degrees above absolute zero, helium state to behave like a super fluid (a liquid with no viscosity).

**73. (6)**

**Sol:** (Except (c))

**74. (21)**

**Sol:** (x = 4, y = 4, z = 3)

**75. (26)**

**Sol:** (a = 12, b = 20, c = 30)

# THE d- AND f- BLOCK ELEMENTS & QUALITATIVE ANALYSIS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** $VO^{2+}$; $3d^1$ electron configuration, $\mu_{BM} = \sqrt{3}$

$Fe^{2+}$; $3d^6$ electron configuration, $\mu_{BM} = \sqrt{24}$

$E_u^{+3}$ is more stable than $E_u^{+2} \Rightarrow E_u^{+2}$ is a strong reducing agent.

**2.** **(4)**

**Sol:** The order of basic character of the transition metal monoxide is TiO > VO > CrO > FeO because basic character of oxides decreases with increase in atomic number. Hence, oxides of transitional metals in low oxidation state ie, + 2 and +3 are generally basic except $Cr_2O_3$.

**3.** **(1)**

**Sol:** This phenomenon is associated with the intervention of the 4f orbitals which must be filled before the 5d series of elements begin. The filling of 4f before 5d orbital results in a regular decrease in atomic radii called

Lanthanoid contraction. This is because of poor shielding of one of the 4 f-electrons by another in the sub-shell.

**4.** **(1)**

**Sol:** $CuCl_2.2H_2O$ $\quad Cu^{+2} \longrightarrow 3d^9$ $\quad$ Green and paramagnetic

$Cu_2Cl_2$ $\quad Cu^{+1} \longrightarrow 3d^{10}$ $\quad$ Colourless and diamagnetic

CuO $\quad$ Black and basic

$ZnCO_3$ $\quad$ Calamine

**5.** **(1)**

**Sol:** a. $NH_4Br + AgNO_3 \rightarrow AgBr + NH_4NO_3$ (Preparation of sensitive film)

b. $C_6H_4(OH)_2 + 2AgBr \rightarrow 2Ag + C_6H_4O_2 + 2HBr$ (Developing of the film)

c. $2Na_2S_2O_3 + AgBr \rightarrow Na_3[Ag(S_2O_3)_2] + 2NaBr$ (Fixing of the film)

d. $AuCl_3 + 3Ag \rightarrow 3AgCl + Au$ (Toning Process)

**6.** **(1)**

**Sol:** There is irregular trend in the first ionisation enthalpy of the 3d metals.

Se Ti V Cr Mn Fe Co Ni Cu Zn

In kJ/mol:

631 656 650 653 717 762 758 736 745 906

**7.** **(3)**

**Sol:** The lesser number of oxidation states in the begining of series can be due to the presence of smaller number of electrons to lose or share (Sc, Ti). On the other hand, at the extreme right hand side end (Cu, Zn), lesser number of oxidation state is due to large number of d electrons so that only a fewer orbitals are available in which the electron can share with other for higher valence.

**8.** **(1)**

**Sol:** (1) $Cr^{2+}$ is reducing as it involves change from $d^4$ to $d^3$, the latter is more stable configuration ($t^3{}_{2g}$) Mn(III) to Mn(II) is from $3d^4$ to $3d^5$ again $3d^5$ is an extra stable configuration.

(2) Due to higher CFSE of $d^6$ configuration in presence of ligands which more than compensates the 3rd IE.

(3) The hydration or lattice energy more than compensates the ionisation enthalpy involved in removing electron from $d^1$.

**9.** **(3)**

**Sol:** $\sqrt{15} = \sqrt{n(n+2)}$ ; n = 3, and three unpaired electrons are found when Mn is in $Mn^{4+}$ i.e., $3d^3$ $4s^0$ configuration as its metal electron configuration is $[Ar]^{18}\ 3d^5\ 4s^2$.

**10.** **(1)**

**Sol:** $SO_3^{2-}$ reduces $KMnO_4$ to $Mn^{2+}$ (colourless)

$5SO_3^{2-} + 2MnO_4^- + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$

**11.** **(4)**

**Sol:** (1) This activity is ascribed to their ability to adopt multiple oxidation state and to form complexes.

(2) Because of having larger number of unpaired electrons in their atoms, they have stronger inter atomic interaction and hence stronger bonding between the atoms.

(3) Transition metals like Fe, Co, Ni, Cu etc. form interstitial compounds with elements such as hydrogen, boron, carbon and nitrogen. The small atoms of these non-metallic elements (H, B, C, N, etc.) get trapped in vacant spaces of the lattices of the transition metal atoms.

**12.** **(3)**

**Sol:** $2CrO_4^{2-}$ (yellow) + $2H^+$ $\longrightarrow Cr_2O_7^{2-}$ (organge) + $H_2O$.

**13.** **(2)**

**Sol:** $Mn_2O_7$ is an acid anhydride of $HMnO_4$ and thus $MnO_4^-$ is oxo-salt of $Mn_2O_7$.

$Mn_2O_7 + H_2O \longrightarrow 2HMnO_4$;

$2HMnO_4 + KOH \longrightarrow 2KMnO_4 + H_2O$.

**14.** **(3)**

**Sol:** $K_2Cr_2O_7 + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 4H_2O + 3O$

$[SO_2 + [O] + H_2O \longrightarrow H_2SO_4 \times 3.$

$K_2Cr_2O_7 + H_2SO_4 + 3SO_2 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3$ (Green coloured) + $3H_2O$

Acidified $K_2Cr_2O_7$ is oxidising agent and undergoes reduction to form green coloured solution of $Cr_2(SO_4)_3$.

**15.** **(2)**

**Sol:** Pm is a artificial or synthesis element.

**16.** **(2)**

**Sol:** Across lanthanoide series basicity of lanthanoide hydroxide decreases.

**17.** **(1)**

**Sol:** Electronic configuration lanthanoid $4f^{1-14}\ 5d^1\ 6s^2$ and electronic configuration of actinoide $5f^{1-14}\ 6d^1, 7s^2$.

**18.** **(2)**

**Sol:** $_{28}Ni(I) = 3d^8 4s^1$; $_{30}Zn(I) = 3d^{10} 4s^1$ ; $_{29}Cu(I) = 3d^{10}$

1752 1734 1950 kJ $mol^{-1}$

**19.** **(1)**

**Sol:** $Cr^{3+} + e^- \longrightarrow Cr^{2+}$, $E^\Theta = -0.41$ volts and

$Mn^{3+} + e^- \longrightarrow Mn^{2+}$ , $E^\Theta = +1.51$ volts

This shows that $Cr^{2+}$ is unstable and has a tendency to acquire more stable $Cr^{3+}$ state by acting as a reducing agent. On the other hand $Mn^{3+}$ is unstable and is reduced to more stable $Mn^{2+}$ state.

**20.** **(1)**

**Sol:** $_{25}Mn^{2+} - 3d^5$ configuration, n = 5,

so $\mu = \sqrt{5(5+2)} = 5.93$

$_{26}Fe^{3+} - 3d^5$ configuration, n = 5,

so $\mu = \sqrt{5(5+2)} = 5.93$

**21.** **(3)**

**Sol:** (1) In $Cr_2O_7^{2-}$, the valence shell electron configuration of Cr(VI) is $3d^0$. Thus Cr(VI) is diamagnetic but coloured due to the charge transfer spectrum.

(2) In $(NH_4)_2$ $[TiCl_6]$, the valence shell electron configuration of Ti(IV) is $3d^0$. Thus Ti(IV) is diamagnetic and colourless.

(3) In $VOSO_4$, the valence shell electron configuration of V(IV) is $3d^1$. Thus V(IV) is paramagnetic and blue coloured due to d-d transition.

(4) In $K_3[Cu(CN)_4]$, the valence shell electron configuration of Cu(I) is $3d^{10}$. Thus Cu(I) is diamagnetic and colourless.

**22.** **(2)**

**Sol:** (1) Associated with d-d transition of electron.

(2) The transition metals form the reaction intermediates due to the presence of vacant orbitals or their tendency to form variable oxidation states.

(3) Associated with the number of unpaired electrons participating in metallic bonding.

(4) As $\mu = \sqrt{n(n+2)}$, so it is associated with number of unpaired electron.

**23.** **(3)**

**Sol:** $Cr_2O_7^{2-} + 2H^+ + 4H_2O_2 \longrightarrow 2CrO_5 + 5H_2O$

**24.** **(1)**

$_{21}La(OH)_3$ is more basic than $Lu(OH)_3$.

**25.** **(3)**

**Sol:** **Assertion:** Electron configuration of Cr(g) is $[Ar]^{18}\ 3d^5\ 4s^1$ and, therefore, it has six unpaired electrons.

**Reason:** Fully filled orbital is more stable than half filled orbital on account of more number of exchange of electrons resulting into the greater release of exchange energy.

**26.** **(1)**

**Sol:** $_{23}V^{2+}$ (aq) – $[Ar]^{18}\ 3d^3 \longrightarrow$ Violet colour.

$_{24}Cr^{3+}$ (aq) – $[Ar]^{18}\ 3d^3 \longrightarrow$ Violet colour.

**27.** **(1)**

**Sol:** Assertion is incorrect statements but Reason is correct statements.

$2Cu^+ \longrightarrow Cu^{2+} + Cu^+$

so, copper (I) compound are unstable in aqueous solution and undergo disproportional.

**28.** **(1)**

**Sol:** Assertion: Correct statement and Reason is correct explanation of Assertion.

Green $\rightarrow \overset{+6}{Mn}O_4^{2-}$ – $[Ar]^{18}\ 3d^1\ 4S^o$ ; there is one unpaired electron, so paramagnetic.

Purple $\rightarrow \overset{+6}{Mn}O_4^{2-}$ – $[Ar]^{18}\ 3d^o\ 4s^o$ ; here all electrons are paired, so diamagnetic.

**29.** **(1)**

**Sol:** (1) Valence shell electron configuration of $Mn^{2+}$ is $3d^5$, therefore, has the maximum number of unpaired electrons equal to 5 and, therefore, has maximum magnetic moment.

(2) Valence shell electron configuration of $Fe^{2+}$ is $3d^6$, therefore, has the maximum number of unpaired electrons equal to 4.

(3) Valence shell electron configuration of $Ti^{2+}$ is $3d^2$, therefore, has the maximum number of unpaired electrons equal to 2.

(4) Valence shell electron configuration of $Cr^{2+}$ is $3d^4$, therefore, has the maximum number of unpaired electrons equal to 4.

**30.** **(1)**

**Sol:** Cerium $Ce_{58}[Xe]4f^1 5d^1 6s^2$

Its most stable oxidation state is +3 but +4 is also existing.

**31.** **(1)**

**Sol:** $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$.

**32.** **(1)**

**Sol:** $Cr^+$ has stable half-filled electronic configuration, $[Ar]^{18}\ 3d^5\ 4s^0$. the removal of one more electron from this stable half-filled configuration will require higher energy.

**33. (1)**

**Sol:** Cu, Ag, Au group of elements are called coinage metals as these are used in minting coins.

**34. (2)**

**Sol:** $NO_3^-$ gives $NO_2$ with concentrated $H_2SO_4$ which on passing through water form colourless $HNO_3(\ell)$ and $HNO_2(\ell)$. $Br^- + MnO_2$ on heating with concentrated $H_2SO_4$ gives $Br_2$ gas which on passing through water imparts it a reddish brown colour.

**35. (4)**

**Sol:** Due to lanthanide contraction there occurs net decrease in size. Only one 0.85Å is smaller one. So, radius of $Lu_{71}^{3+}$ will be closest to 0.85Å.

**36. (3)**

**Sol:** Cerium can also show the oxidation state of +4 in solution as it leads to a noble gas configuration, from $[Xe]^{54} 4f^1 5d^1 6s^2$ to $[Xe]^{54}$, after losing four electrons. It is only $Ce^{4+}$ which exist in solution among the lanthanides.

**37. (3)**

**Sol:** The atomic radii of the second and third transition series are almost the same. This phenomenon is associated with the intervention of the 4f orbitals which must be filled before the 5d series of elements begin. The filling of 4f before 5d orbital results in a regular decrease in atomic radii called Lanthanoid contraction which essentially compensates for the expected increase in atomic size with increasing atomic number. The net result of the lanthanoid contraction is that the second and the third d series exhibit similar radii (e.g., Zr 160 pm, Hf 159 pm).

**38. (1)**

**Sol:** Valence shell electron configuration of $_{28}Ni^{2+}$ is $3d^8 4s^0$. Or

| 3d | | | | | 4s | 4p | | |
|---|---|---|---|---|---|---|---|---|
| ↑↓ | ↑↓ | ↑↓ | ↑ | ↑ | | | | |

So, number of unpaired electrons (n) = 2

$$\therefore \quad \mu = \sqrt{n(n+2)} = \sqrt{2(2+2)} = \sqrt{8} \approx 2.84$$

**39. (2)**

**Sol:** The decrease in the force of attraction exerted by the nucleus on the valency electrons due to presence of electrons in the inner shells is called shielding effect. An $4f$ orbital is nearer to the nucleus than $5f$ orbitals. In addition, the 20 electrons of 3d and 4d orbitals contribute the shielding to 4f electron while 44 electrons of 3d, 4d, 5d and 4f contribute the shielding to 5f. Hence shielding of $5f$ is more than 4f.

**40. (2)**

**Sol:** The distance between the nucleus and $5f$ orbitals (actinides) is more than the distance between the nucleus and 4f orbitals (lanthanides). Hence the hold of nucleus on valence electron decreases in actinides. For this Statement-2 the actinoids exhibit more number of oxidation states in general.

**41. (1)**

**Sol:** There is very small energy difference between 5f and 6d orbitals in actinoids than those of between 4f and 5d orbitals. Hence, electrons present in 5f and 6d orbitals can take part in bonding.

**42. (4)**

**Sol:** Availability of 4f electrons donot results in the formation of compounds in +4 state for all the members of the series.

**43. (4)**

**Sol:** Lutetium ($_{71}Lu$) = $[Xe]^{54} 4f^{14} 5d^1 6s^2$

**44. (3)**

**Sol:** Colour of $KMnO_4$ is due to charge transfer from $O^{2-}$ (ligand) to Mn (VII) (Central metal ion).

**45. (1)**

**Sol:** Pyrolusite on fusion with KOH in air gives green coloured manganate.

$2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_2$ (green) + $2H_2O$

**46. (1)**

**Sol:** $2MnO_4^- + I^- + H_2O \rightarrow 2MnO_2 + IO_3^- + 2OH^-$

**47. (3)**

**Sol:** $CuF_2$ contains $Cu^{+2}$, having $d^9$ configuration, therefore, there is one unpaired electron which undergoes d–d transition in visible region. $CuF_2$ in crystalline form is blue in colour.

**48. (2)**

**Sol:** Transition metal oxide with highest oxidation states is most acidic in character because of the very less difference in the values of electronegativity between $Mn^{7+}$ and $O^{2-}$, and the decreasing order of acidic character is

$$\overset{+7}{Mn_2O_7} > \overset{+4}{MnO_2} > \overset{+3}{Mn_2O_3} >> \overset{+2}{MnO}.$$

**49. (2)**

**Sol:** (1) Oxidation state of iron is +3 but it can exceed to a maximum of +6. Oxidation state of cobalt is +3 but it can exceed to a maximum of +4.

(2) Highest oxidation state of Cr in $CrO_2Cl_2$ is + 6 and highest oxidation state of Mn in $MnO_4^-$ is + 7.

(3) Oxidation state of titanium is +2 but it can exceed to a maximum of +4. Oxidation state of Mn is +4 but it can exceed to a maximum of +7.

(4) Oxidation state of cobalt is +3 but it can exceed to a maximum of +4. Oxidation state of Mn is +7 which is its highest oxidation state.

**50. (2)**

**Sol:** $S_1$: Increased nuclear charge is poorly screened by d-orbital electrons so attraction between nucleus and electron increases. Hence size decreases and density increases.

$S_2$: ${}_{24}Cr^{2+}$ $[Ar]^{18}$ $3d^4$ ;

$$\mu_{BM} = \sqrt{n(n+2)} = \sqrt{4(4+2)} = 4.90 \text{ BM}.$$

$S_3$: Interstitial compounds they have high melting points which are higher than those of pure metals because of strong interatomic bonding.

$S_4$: In alkaline medium it also acts as oxidising agent according to the following reaction;

$e^- + MnO_4^- \longrightarrow MnO_4^{2-}$.

**51. (1)**

**Sol:** X : $[K_3 Fe(CN)_6)$ Y : Fe $[Fe(CN)_6]$

**52. (1)**

**Sol:** $2KMnO_4 + 3H_2SO_4$

$\rightarrow 2KHSO_4 + (MnO_3)_2SO_4 + 2H_2O$

$(MnO_3)_2SO_4 + H_2O \rightarrow Mn_2O_7 + H_2SO_4$

$$Mn_2O_7 \xrightarrow{\Delta} 2MnO_2 + \frac{3}{2}O_2$$

**53. (2)**

**Sol:** (1) $Cr_2O_7^{2-} + 14H^+ + 6I^- \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$.

(2) In acidic solution, actually chromate is converted to dichromate.

$2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$.

(3) $(NH_4)_2Cr_2O_7 \xrightarrow{\Delta} N_2 + 4H_2O + Cr_2O_3$.

(4) $6Fe^{2+} + Cr_2O_7^{2-} + 14H^+$

$\longrightarrow 6Fe^{3+} + 2Cr^{3+} + 7H_2O$.

**54. (2)**

**Sol:** High melting point of Cr is attributed to the involvement of greater number of electrons from (n – 1) d i.e. 5 in addition to the ns i.e. 1 electrons in the interatomic metallic bonding.

**55. (1)**

**Sol:** $NO_2^- + 2I^- + 4CH_3COOH$

$\rightarrow I_2 + 2NO\uparrow + 4\,CH_3COO^- + 2H_2O$

**56. (2)**

**Sol:** Mn exhibits all the oxidation states from +2 to +7.

**57.** **(3)**

**Sol:** (1) Cu = 8.95 (2) Ni = 8.91

(3) Sc = 3.0 (4) Zn = 7.14.

Acorss the period atomic volumes decreases upto copper due poor shielding of d-orbital electrons and addition of extra electrons in inner orbitals and then increases in zinc due to interelectronic repulsions in completely filled d- and s-orbitals. Consequently densities increase from Sc to Cu and then decreases in Zn.

**58.** **(1)**

**Sol:** $V_2O_5$ and $Cr_2O_3$ are amphoteric in nature.

$Mn_2O_7$ and $CrO_3$ are acidic in nature.

$V_2O_3$, CrO and FeO are basic in nature.

**59.** **(4)**

**Sol:** ${}_{29}Cu = |Ar|_{18}\ 3d^{10}4s^1$

${}_{29}Cu^+\ |Ar|_{18}\ 3d^{10}\ 4s^0$

in $Cu^{+1}$ ion, electronic configuration is $3d^{10}$ (Complete d orbital) so removal of electron recquired higher energy.

**60.** **(3)**

**Sol:** Ion E.C. Number of unpaired electron $\mu = \sqrt{n(n+2)}$ B.M.

(A) ${}_{24}Cr^{+3}\ |Ar|_{18}\ 3d^3\ 45^0$ 3 $\sqrt{15}$

(B) ${}_{26}Fe^{+2}\ |Ar|_{18}\ 3d^6\ 45^0$ 4 $\sqrt{24}$

(C) ${}_{28}Ni^{+2}\ |Ar|_{18}\ 3d^8\ 45^0$ 2 $\sqrt{8}$

(D) ${}_{25}Mn^{+2}\ |Ar|_{18}\ 3d^5\ 45^0$ 5 $\sqrt{35}$

## *Integer Type Questions (61 to 75)*

**61.** **(3)**

**Sol:** Most of the trivalent lanthanoid compounds except that of $La^{3+}$ and $Lu^{3+}$ are coloured both in the solid state and in the aqueous solution. The colour of these ions can be attributed due to the presence of unpaired f-electrons.

**62.** **(3)**

**Sol:** (i) $V^{2+}$ = 3 unpaired electrons
($V^{2+}$ = 3)
$Cr^{2+}$ = 4 unpaired electrons
($Cr^{2+}$ = 4)
$Mn^{2+}$ = 5 unpaired electrons
($Mn^{2+}$ = 5)
$Fe^{2+}$ = 4 unpaired electrons
($Fe^{2+}$ = 4)
Hence the order of paramagnetic behaviour should be
$V^{2+} < Cr^{2+} = Fe^{2+} < Mn^{2+}$

(ii) ionic size decrease from left to right in same period

(iii) $Co^{3+}/Co^{2+}$= 1.97 ; $Fe^{3+}/Fe^{2+}$ =0.77 ; $Cr^{3+}/Cr^{2+}$= - 0.41
$Sc^{3+}$ is highly stable. It does not show +2)

(iv) The oxidation states increases as we go from group 3 to group 7 in same period.

**63.** **(3)**

**Sol:** In $Co^{+3}$ ion, electronic configuration $|Ar|_{18}\ 3d^6 4s^0$. For octahedral complex 4 unpaired electron get paired and in configuration become $t_{2g}^6\ eg^0$ and hybridization $d^2sp^3$.

Os has maximum VIII oxidation state.

**64.** **(79)**

**Sol:** Gold

**65.** **(22)**

**Sol:** ${}_{22}Ti = 3d^2\ 4s^2$

**66.** **(22)**

**Sol:** ${}_{24}Cr^{6+}$ – $[Ar]^{18}\ 3d^o$ ; ${}_{22}Ti^{4+}$ – $\{Ar\}^{18}\ 3d^0$ ;
${}_{25}Mn^{7+}$ – $[Ar]^{18}3d^0$

**67.** **(4)**

**Sol:** $2MnO_4^- + 5SO_3^{-2} + 6H^+ \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3\ H_2O$.

$\therefore\ \frac{2}{5}$ mole of $MnO_4^-$ for one mole $SO_3^{2-}$.

4 mole $MnO_4^-$ fes 10 mole $SO_3^{-2}$

**68.** **(6)**

**Sol:** $Fe_{26}$–$[Ar]3d^6 4s^2$

$Fe^{2+}{}_{(24\ electrons)}$ – $[Ar]\ 3d^6 4s^0$

**69.** **(3)**

**Sol:** $3.87 = \sqrt{n\ (n+2)}$ ; n = number of unpaired electrons.

So, $n = 3$.

**70.** **(3)**

**Sol:** $_{22}Ti = |Ar|_{18}\ 3d^2\ 4s^2$ magnetic moment of $Ti^{+n}$ ion is 1.73 BM it means this ion contents one unpaired electron so after removing 3 electron $Ti^{+3}$ ion formed. $Ti^{+3} = |Ar|_{18}\ 3d^1\ 4s^0$.

**71.** **(9)**

**Sol:** $6KMnO_4 + 10FeC_2O_4 + 24H_2SO_4 \longrightarrow$ $3K_2SO_4 + 6MnSO_4 + 5Fe_2(SO_4)_3 + 20CO_2 + 24H_2O$.

$\therefore\ \frac{3}{5}$ mole of $KMnO_4$ for one mole ferrous oxalate.

10 mole $FeC_2O_4$ requires 60 mole $KMnO_4$

15 mole $FeC_2O_4$ requires $\frac{6}{10} \times 15 = 9$ mole

**72.** **(2)**

**Sol:** $SO_2$ and $SO_3$

$2FeSO_4 \xrightarrow{\Delta} Fe_2O_3 + SO_2\uparrow + SO_3\uparrow$

The acidic gases produced are $SO_2$ and $SO_3$

**73.** **(50)**

**Sol:** 24 Carat gold is having % of 100%

**74.** **(3)**

**Sol:** Cu, Ag and Au are transition metals.

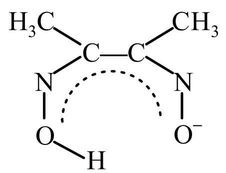
**75.** **(46)**

**Sol:** Pd (Z = 46) has no s-electrons in outer most shell

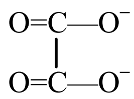
# COORDINATION COMPOUNDS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(1)**




**Sol:** (1)




(2)

(3) $NH_2CH_2CH_2NH_2$

**2.** **(1)**

**Sol:** $NO_2^-$ ion can coordinate through either the nitrogen or the oxygen atoms to a central metal ion.

**3.** **(3)**

**Sol:** $NO_2^- \rightarrow$ N-nitro, $–ONO^- \rightarrow$ O-nitro.

**4.** **(3)**

**Sol:** Factual

**5.** **(1)**

**Sol:** O.N of Nitrogen $NH_3$ is –3.

**6.** **(2)**

**Sol:** Refer IUPAC Nomenculature.

**7.** **(2)**

**Sol:** According to IUPAC nomenclature.

**8.** **(3)**

**Sol:** According to IUPAC nomenclature.

**9.** **(2)**

**Sol:** $[Rh\ (III)(en)_2\ (ONO)\ (SCN)]^+\ (NO_3^-)$

**10.** **(3)**

**Sol:** (1) 24 + 12 = 36 and 26 + 10 = 36

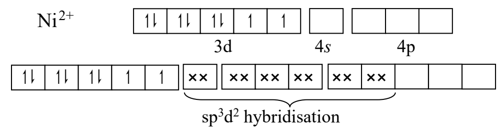
(2) 29 – 1 + 8 = 36 and 28 + 8 = 36

(3) 27 – 2 + 12 = 37 and 28 – 2 + 12 = 38

(4) 23 + 1+ 12 = 36 and 27 – 3 + 12 = 36

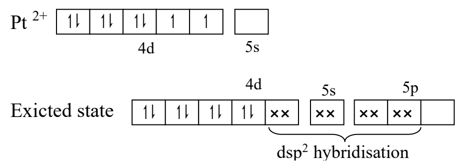
**11.** **(2)**

**Sol:** $sp^3d^2$




**12.** **(1)**

**Sol:** Since hybridization is $dsp^2$ so it is square planar,




**13.** **(1)**

**Sol:** $[Co(NH_3)_5(NO_3)]Br_2 \xrightleftharpoons{aq.} [Co(NH_3)_5(NO_3)]^{2+} + 2Br^-$

It has two ionisable bromide ion. They will react with $AgNO_3$ solution to give two mol of yellow precipitate

**14.** **(1)**

**Sol:** $[NiCl_4]^{2-}$ ($3d^8$) is tetrahedral with two unpaired electrons, $\mu_{BM} = 2.83$.

$[PdCl_4]^{2-}$ ($4d^8$) is square planar and diamagnetic, $\mu_{BM} = 0$.

**15.** **(4)**

**Sol:** Order of strength of ligands is $CN^- > NH_3 > H_2O > Cl^-$

**16.** **(1)**

**Sol:** On the basis of number of unpaired electrons the correct order is P > Q > R > S.

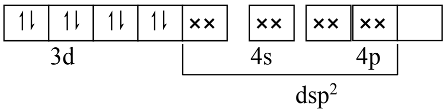
**17.** **(3)**

**Sol:** In $[Fe(CN)_6]^{4-}$; Fe(II) is $t_{2g}^6$, $eg^0$ due to strong ligands.

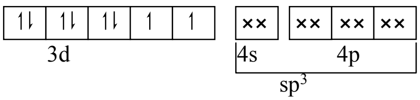
**18.** **(3)**

**Sol:** The electronic configuration of Ni in $[Ni(CN)_4]^{2-}$, $[NiCl_4]^{2-}$ and $Ni(CO)_4$ are as following

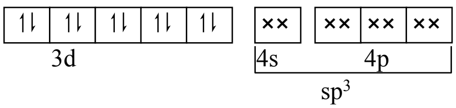
$Ni^{2+}$ in $[Ni(CN)_4]^{2-}$




$Ni^{2+}$ in $[Ni(Cl_4)]^{2-}$ –




Ni in $[Ni(CO)_4]$ –




CO and $CN^-$ are strong ligands so they induces pairing of electrons so their complexes are diamagnetic while $Cl^-$ is a weak ligand so it does not induce the pairing of electrons so its complex is paramagnetic.

**19.** **(4)**

Stability of complex $\propto$ Formation of chelate rings.

**20.** **(4)**

**Sol:** cis and trans forms both have an element of symmetry. So does not show optical activity.

**21.** **(4)**

**Sol:**
(1) No anionic ligand is present in coordination sphere for the exchange with $Cl^-$ ions present in ionisation sphere.
(2) No anionic ligand is present in coordination sphere for the exchange with $Cl^-$ ions present in ionisation sphere.
(3) No anionic ligand is present in coordination sphere for the exchange with $Cl^-$ ions present in ionisation sphere.
(4) $Br^-$ and $SO_4^-$ can exchange their positions between coordination sphere and ionisation sphere. Hence it shows ionization isomerism.

**22.** **(3)**

**Sol:** $NO_2^-$ is an ambidentate ligand and can link to central metal ion either through N or O. Hence it show linkage isomerism.

There is exchange of $NO_2^-$ and $SO_4^{2-}$ occurs between coordination sphere and ionization sphere. Hence it show ionisation isomerism.

$Ma_5b$ has only one form, therefore, it does not show geometrical isomerism.

$Ma_5b$ has mirror plane, therefore, it does not show optical isomerism.

**23.** **(3)**

**Sol:** $Ma_5b$ will not show geometrical isomerism.

**24.** **(1)**

Refer IUPAC Nomenculature.

**25.** **(2)**

**Sol:** According to Werner's theory statements (II) and (III) are correct.
(I) Ligands are connected to the metal ion by coordinate covalent bond (dative bond).
(II) Secondary valencies i.e. coordination number give rise to stereochemistry of the complexes because of their directional properties.
(III) Secondary valencies correspond to coordination number i.e. number of σ-bonds between metal ion and ligands.

**26.** **(2)**

**Sol:** 1 mole of complex X giving 2 mole of particles will be $[Cr(H_2O)_4Br_2]Cl.H_2O$ i.e $[Cr(H_2O)_4Br_2]^+ + Cl^-$

1 mole of complex Y giving 3 mole of particles will be $[Cr(H_2O)_5Cl]Br_2$ i.e $[Cr(H_2O)_5Cl]^{2+} + 2Br^-$

**27.** **(3)**

**Sol:** I, II are optically inactive.

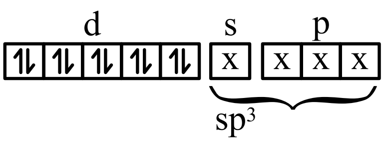
**28.** **(4)**

**Sol:** Tris-(ethylenediamine) cobalt (III) bromide $[Co(en)_3]Br_3$ exhibits optical isomerism:

**29.** **(2)**

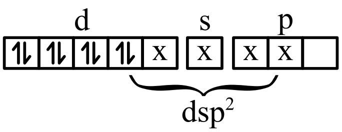
**Sol:** In $Ni(CO)_4$, nickel is $sp^3$-hybridised because in it oxidation state of Ni is zero. So, configuration of

$_{28}Ni = 1s^2, 2s^22p^6, 3s^23p^63d^8, 4s^2$



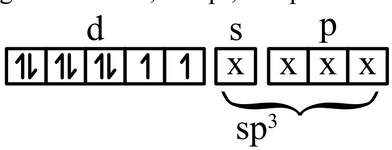

(CO is a strong field ligand, hence does pairing of electrons)

In $[Ni(CN)_4]^{2-}$, nickel is present as $Ni^{2+}$, so its configuration = $1s^2, 2s^22p^6, 3s^23p^63d^8$




$CN^-$ is strong field ligand, hence it makes $Ni^{2+}$ electrons to be paired up.

In $[NiCl_4]^{2-}$, nickel is present as $Ni^{2+}$, so its configuration = $1s^2, 2s^22p^6, 3s^23p^63d^8$

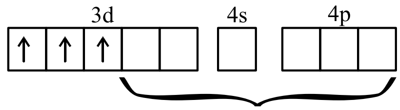



$Cl^-$ is a weak field ligand, hence in $Ni^{2+}$ electrons are not paired.

**30.** **(1)**

**Sol:** Magnetic moment = $\sqrt{n\ (n+2)}$ B.M = 3.83 B.M. (Given).

Hence, n= 3, i.e. there are three unpaired electrons. Thus, we have

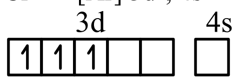



In $d^2sp^3$ hybridisation, the orbitals taking part are $d_{x^2-y^2}$ and $d_{z^2}$. Hence, unpaired electrons are present in $3d_{xy}$, $3d_{yz}$, $3d_{xz}$.

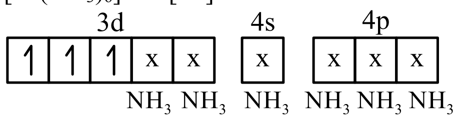
**31.** **(3)**

**Sol:** In $[Cr(NH_3)_6]^{3+}$, Cr is present as $Cr^{3+}$.

$Cr^{3+}$ = [Ar] $3d^3, 4s^0$




$[Cr(NH_3)_6]^{3+}$ = [Ar]




Since, this complex has three unpaired electrons, excitation of electrons is possible and thus, it is expected that this complex will absorb visible light.

**32.** **(2)**

**Sol:** $[Fe(H_2O)_6]^{3+}$

$Fe^{+2} = 3d^5\ (t_{2g}^{1,1,1}\ e_g^{1,1})$

so C.F.S.E. is = $[-0.4 \times 3 + 0.6 \times 2]\ \Delta_0 = 0$

**33.** **(4)**

**Sol:** $CoCl_3 \cdot 3NH_3$ is $[Co(NH_3)_3Cl_3]$ so it will not ionize and does not give $Cl^-$ ion test.

**34.** **(1)**

**Sol:** Potassium amminedicyanodioxoperoxochromate(VI)

(1) Is correct answer

(2) Is wrong because name of anionic complex ends in ate.

(3) Is wrong because name of co-ordination sphere is one word.

(4) Is wrong because oxidation state of Cr and its name both are wrong.

**35.** **(4)**

**Sol:** According to spectro chemical series.

**36.** **(1)**

**Sol:** On charge balancing, $[Co(III)(NH_3)_5(CO_3)]^+ + Cl^-$ .

**37.** **(2)**

**Sol:** **Assertion:** $I^-$ ion is a stronger reducing agent than $Cl^-$ ion. It reduces $Cu^{2+}$ to $Cu^+$ ion.

**Reason:** $[NiCl_2(PPh_3)_2]$ has tetrahedral geometry (triphenyl phosphine is a bulkier group).

**38.** **(3)**

**Sol:** The stability of complexes increases with increase in the strength of the ligand field. The strength of ligand field according to spectrochemical series increase as given below $I^- < Br^- < SCN^- < Cl^- < S^{2-} < F^- < OH^- < C_2O_4^{2-} < H_2O < NCS^- < edta^{4-} < NH_3 < en < CN^- < CO$

**39.** **(3)**

**Sol:** Only primary valencies out side the coordination sphere are ionised and these react with $AgNO_3$ to give white precipitate of AgCl.

$$[Co(NH_3)_5Cl]Cl_2 \longrightarrow [Co(NH_3)_5Cl] + 2Cl^-$$

$$\xrightarrow{2AgNO_3} 2AgCl + 2NO_3^-$$

**40.** **(4)**

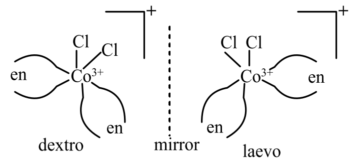
Pi- bond, if any between the ligating atom and the central atom / ion are not considered for determination of coordination number.

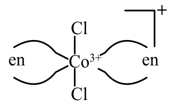
**41.** **(4)**

**Sol:** Chlorophyll a green pigment in plants contains Mg.

**42.** **(1)**

**Sol:** (1) $[Co(en)_2Cl_2]^+$ shows geometrical as well as optical isomerism. (Only cis-form but not trans form as it has one of the symmetry elements).



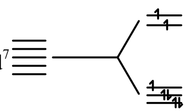



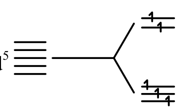

(2) It exists only in one.

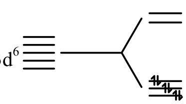
(3) Exist in cis and trans forms only (no optical isomerism because of the presence of the plane of symmetry).

(4) Exist in cis and trans forms only (no optical isomerism because of the presence of the plane of symmetry).

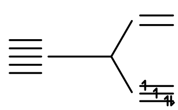
**43.** **(4)**

**Sol:** (i) $Co^{2+}$, $3d^7$  $Cl^-$ is weak field ligand.

(ii) $Mn^{2+}$, $3d^5$  $Cl^-$ is weak field ligand.

(iii) $Fe^{2+}$, $3d^6$  $CN^-$ is strong field ligand so compels for pairing of electrons.

**44.** **(1)**

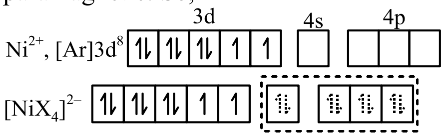
**Sol:** $3d^4$ 

$CN^-$ is strong field ligand; so it compels for pairing of electrons to have two d-orbital empty.

$$\mu = \sqrt{n(n+2)} = \sqrt{2(2+2)} = 2.84 \text{ B.M}$$

**45. (2)**

**Sol:** If $X^-$ is weak filed then (say $Cl^-$) $[Ni(Cl)_4]^{2-}$ is tetrahedral ($sp^3$) with two unpaired electrons. If $X^-$ is strong field ligand then (say $CN^-$), $[Ni(CN)_4]^{2-}$ is square planar ($dsp^2$) with no unpaired electrons. Also given $[NiX_4]^{2-}$ is paramagnetic. So,




$sp^3$ hybrid orbitals

**46. (4)**

**Sol:** CFSE depends on the relative magnitude of crystal field splitting, $\Delta_o$ and pairing energy and in turns $\Delta_o$ depends upon the field produced by ligand and charge on the metal ion. The order of increasing crystal field strength is $C_2O_4^{3-} < H_2O < NH_3 < CN^-$.

**47. (1)**

**Sol:** Mole of $CoCl_3 . 6NH_3 = \dfrac{2.675}{267.5} = 0.01$

$AgNO_3 (aq) + Cl^- (aq) \longrightarrow AgCl \downarrow$ (white)

Mole of $AgCl = \dfrac{4.305}{143.5} = 0.03$

0.01 mole of $CoCl_3.6NH_3$ gives 0.03 mole of AgCl

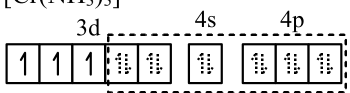
$\therefore$ 1 mole of $CoCl_3 . 6NH_3$ ionises to give 3 moles of $Cl^-$.

Hence the formula of compound is $[Co(NH_3)_6] Cl_3$.

**48. (3)**

**Sol:** In case of $d^3$ configuration, the number of unpaired electrons remains 3 whether the ligand is strong field or weak field. The hybridisation scheme can be shown as follow :

$[Cr(NH_3)_3]^{3+}$ =




$d^2sp^3$ hybridization

Hence the complex is inner orbital complex as it involves (n – 1) d orbitals for hybridisation, $3.93 = \sqrt{n\ (n+2)}$ ; so n = 3 (here n is number of unpaired electron(s)).

**49. (3)**

**Sol:** $[Co(NH_3)_3Cl_3]$ show facial as well as meridional isomerism. But both contain plane of symmetry.

**50. (2)**

**Sol:**

| | $L_1$ | $L_2$ | $L_3$ | $L_4$ |
|---|---|---|---|---|
| $\lambda$ absorbed | red | green | yellow | blue |

$\therefore$ Increasing order of energy of wavelengths absorbed reflect greater extent of crystal-field splitting, hence higher field strength of the ligand.

Energy: Blue ($L_4$) > green ($L_2$) > yellow ($L_3$) > red ($L_1$)

$\therefore L_4 > L_2 > L_3 > L_1$ in field strength of ligands.

**51. (3)**

**Sol:** 10 millimoles of Complex or 0.01 mol

$1.2 \times 10^{22}$ ions $= \dfrac{1.2\times10^{22}}{6\times10^{23}}$ mol or 0.02 mol

$$\left[Co(H_2O)_5 Cl\right]Cl_2.H_2O \xrightarrow{+AgNO_3(excess)} 2\ AgCl\downarrow$$

0.01 mol      0.02 mol

**52. (1)**

$\left[Fe(CN)_6\right]^{3-}$ has one unpaired electron and $\left[FeF_6\right]^{3-}$ has five unpaired electrons.

**53. (2)**

Pentacyanomanganate (III) ion.

**54. (1)**

**Sol:** (1) $Fe^{3+}(d^5) \rightarrow t_{2g}^3, e_g^2$ (symmetrically filled)

(2) $Mn^{2+}(d^5) \rightarrow t_{2g}^5, e_g^0$ ($t_{2g}$ unsymmetrically filled)

(3) $Co^{3+}(d^6) \rightarrow t_{2g}^4, e_g^2$ (non-unsymmetrical)

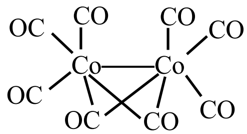
(4) $Co^{2+}(d^7) \rightarrow t_{2g}^6, e_g^1$ (non-symmetrical)

**55.** **(4)**

**Sol:** $\Delta_o \propto$ CFSE (Crystal field stabilization energy)
$\Delta_o$ of $[Cr(H_2O)_6]^{2+} < \Delta_o$ of $[Mo(H_2O)_6]^{2+}$
Because here $\Delta_o$ depends on $Z_{eff}$ & $Z_{eff}$ of 4d series is more than 3d series.
But $\Delta_o$ of $[Ti(H_2O)_6]^{3+} > \Delta_o$ of $[Ti(H_2O)_6]^{2+}$

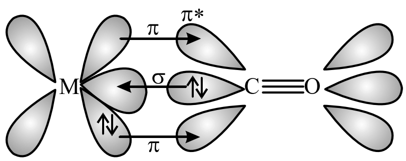
**56.** **(2)**

**Sol:**




**57.** **(1)**

**Sol:** On account of synergic interaction between metal and CO bond order of CO reduces to approximately two and half from three in carbonmonoxide. Thus bond length increases to 1.158 Å.



Synergic Bonding

**58.** **(2)**

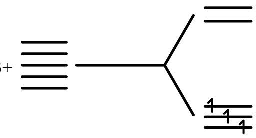
**Sol:** As formal negative charge increases on the complex the tendency of π back bonding between metal ion and CO increases and thus the bond order of CO decreases. Hence the CO bond order is lowest in $[V(CO)_6]^-$.

**59.** **(2)**

**Sol.** (I) $[Cr(NH_3)_4Cl_2]Cl \rightarrow Cr^{+3}$ is $d^3$. It is paramagnetic and it shows cis-trans isomerism.
(II) $[Ti(H_2O)_5Cl](NO_3)_2 \rightarrow Ti^{+3}$ is $d^1$. It is paramagnetic and it show ionisation isomerism.
(III) $[Pt(en)(NH_3)Cl]NO_3 \rightarrow Pt^{+2}$ is $d^8$. But this complex is square planar and all electron are paired. So it is diamagnatic. It exhibit ionisation isomerism.
(IV) $[Co(NH_3)_4(NO_3)_2]NO_3 \rightarrow Co^{+3}$ is $d^6$. Since ligands are strong, so electron are paired. it is diamagnetic. It exhibit cis-trans isomerism.

**60.** **(3)**

**Sol:** **$S_1$:** $Cr^{3+}$



CFSE = 3 × – 0.4 = – 1.2 $\Delta_0$, hybridization is $d^2sp^3$ ($NH_3$ is strong field ligand)
**$S_2$:** $Fe^{3+}$, $3d^5$ - one unpaired electron after pairing ($CN^-$ is stronger field ligand)
$\therefore \quad \mu = \sqrt{1\ (1+2)} \approx 1.73$ BM
**$S_3$:**
$$\overset{III}{[Fe}(\overset{-5}{CN})_5NO]^{2-} \text{ and } \overset{II}{[Fe}(\overset{-5}{CN})_5NOS^{-1}]^{4-}$$
.
In reactant and product, the iron have different oxidation state.

## *Integer Type Questions (61 to 75)*

**61.** **(1)**

**Sol:** x + 1 = +2 ; x = +1

**62.** **(2)**

**Sol:** It exists in cis and trans forms.

**63.** **(4)**

**Sol:** Geometrical isomers (cis and trans) and linkage isomers (–SCN and –NCS).

**64.** **(4)**

**Sol:** In complex ion $[CoF_6]^{3-}$, Co is present in + 3 oxidation state.
${}_{27}Co = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^7, 4s^2$
$Co^{3+} = 1s^2, 2s^2\ 2p^6, 3s^2\ 3p^6\ 3d^6$

**65.** **(1)**

**Sol:**
$$[Cr(H_2O)_4Cl_2]Cl + AgNO_3 \longrightarrow \underset{ppt}{AgCl} + [Cr(H_2O)_4Cl_2]NO_3$$
$$\text{Mole} = 0.01 \times \frac{10}{1000} = 10^{-3}$$
millimole of AgCl = 1

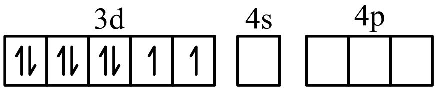
**66.** **(1)**

**Sol:** EDTA has four carboxylate oxygens and two ammine nitrogens as donor atoms. So it is a hexadentate ligand.

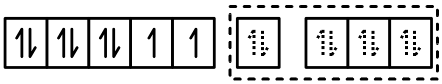
**67.** **(3)**

**Sol:** In the paramagnetic and tetrahedral complex $[NiCl_4]^{2-}$, the nickel is in +2 oxidation state and the ion has the electronic configuration $3d^8$. The hybridisation scheme is as shown in figure.

$Ni^{2+}$, $[Ar]3d^8$




$[NiCl_4]^{2-}$



$sp^3$ hybrid orbitals

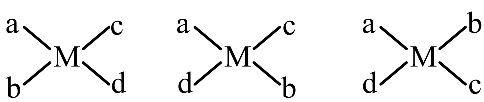
$\mu_{B.M.} = \sqrt{n\ (n+2)} = \sqrt{2\ (2+2)} = \sqrt{8} =$ 2.82 BM

**68.** **(3)**

**Sol:** The complex is of the type [Mabcd]

M = metal

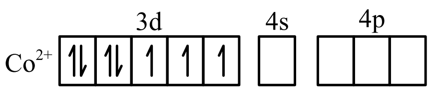
a, b, c, d = Monodentate ligands.



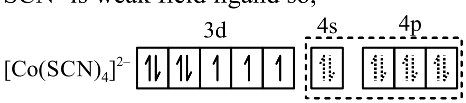
3 geometrical isomers

**69.** **(4)**

**Sol:** In the complex $[Co(SCN)_4]^{2-}$ cobalt is in +2 oxidation state. So




$SCN^-$ is weak field ligand so,




As it contains three unpaired electrons, so $\mu = \sqrt{3(3+2)} = \sqrt{15} = 3.87$ BM.

**70.** **(4)**

**Sol:** K–$[Fe(CN)_6]^{3-}$ : $3d^5$ electron configuration after pairing of electrons for $d^2sp^3$ hybridisation it contains one unapaired electrons.

L–$[Co(NH_3)_6]^{3+}$ : $3d^6$ electron configuration, $d^2sp^3$, diamagnetic.

M–$[Co(ox)_3]^{3-}$ : $3d^6$ electron configuration, $d^2sp^3$, diamagnetic.

N–$[Ni(H_2O)_6]^{2+}$ : $3d^8$ electron configuration, $sp^3d^2$, with two unpaired electrons paramagnetic.

O–$[Pt(CN)_4]^{2-}$ : $5d^8$ electron configuration, $dsp^2$, diamagnetic.

P–$[Zn(H_2O)_6]^{2+}$ : $3d^{10}$ electron configuration, $sp^3d^2$, diamagnetic.

**71.** **(5)**

**Sol:** According to EAN rule

$26 - 0 + 2x = 36$

$x = 5$

**72.** **(3)**

**Sol:** $3d^3 = t_{2g}^{1,\,1,\,1}\ eg^{0,\,0}$

**73.** **(240)**

**Sol:** $[CoCl_2(en)_2]Cl$, One mole complex contains, one mole of ionizable $Cl^-$.

One mole of complex = one mole of $Cl^-$

$\therefore$ One mole of AgCl = One mole of complex $= \dfrac{100 \times 2.4}{1000} = 00.24$ mole

= 240 millimole

**74.** **(2)**

**Sol:** Let the oxidation state of Fe is x

$4 + x - 5 - 1 = 0$

So, $x = 2$

**75.** **(6)**

**Sol:** Coordination number of nickel in $\left[Ni(C_2O_4)_3\right]^{4-}$ is 6 because $C_2O_4^{2-}$ is a bidentate ligand.

# HALOALKANES AND HALOARENES

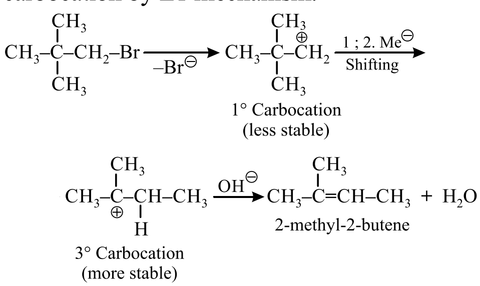
*Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:** $S_N2$ reactions occur with inversion of configuration. Therefore; an optically active reactant gives an optically active product whose sign of rotation cannot be predicted.

**2.** **(3)**

**Sol:** Neopentyl bromide undergoes dehydro-halogenation to give alkene even though it has no β-hydrogen atom. This is due to rearrangement of carbocation by E1 mechanism.




**3.** **(2)**

**Sol:** Due to resonance C–Cl bond in chlorobenzene does not ionize to give $Cl^-$ ion.

**4.** **(2)**

**Sol:** $RX + \text{Dry } Ag_2O \longrightarrow R\text{–}O\text{–}R + 2AgX$

**5.** **(2)**

**Sol:** Ethanol is prevents chloroform from converting into phosgene gas because it float over chloroform and prevent its oxidation.

**6.** **(1)**

**Sol:** Rate of hydrolysis ∝ stability of carbocation

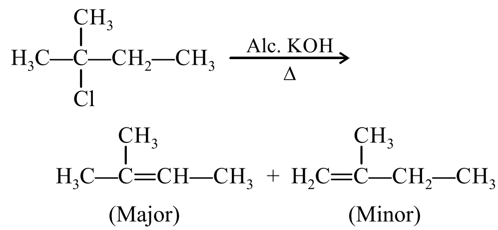
A < B < C < D

**7.** **(1)**

**Sol:** Reactive for E1 reaction ∝ stability of carbocation

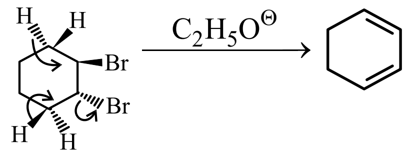
**8.** **(3)**

**Sol:**




**9.** **(3)**

**Sol:**




Trans

**10.** **(1)**

**Sol:** Bulky base will form Hofman Product.

**11.** **(4)**

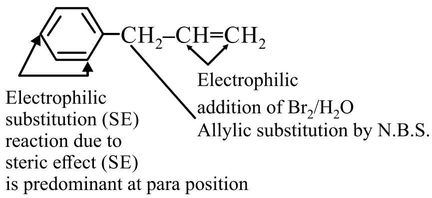
**Sol:** Due to steric hindrance Hofmann product is major product.

**12.** **(4)**

**Sol:** –CN group is converted into –COOH group under given reaction since –COOH group is at $C_2$ that means one of the chlorine atom is present at $C_2$ carbon and always when two –COOH groups are at same carbon atom subsequent heating loses $CO_2$ so both chlorine atoms are at same $C_2$ position.

**13.** **(1)**

**Sol:**




**14.** **(2)**

**Sol:** E2 elimination

**15.** **(4)**

**Sol:** $NH_3$ (Protic solvent) helps in formation of carbocation.

**16.** **(2)**

**Sol:** Reactivity of R–X : 3° > 2° > 1°

**17.** **(4)**

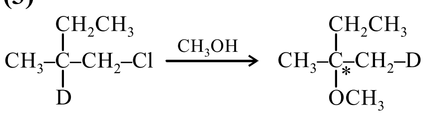
**Sol:** $S_N2$ reaction is a stereopecific reaction so gives only a single steroisomer.

**18.** **(4)**

**Sol:** Step-1 and 2 are $S_N2$ reactions, so x and y are identical compounds.

**19.** **(3)**

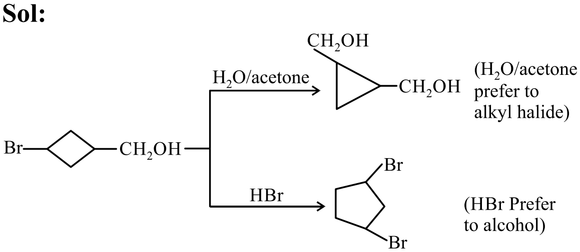
**Sol:**




Racemic mixture

**20.** **(3)**

**Sol:**

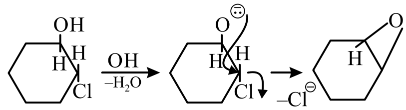



**21.** **(1)**

**Sol:**

**22.** **(4)**

**Sol:**




**23.** **(4)**

**Sol:** E1 involves carbocation intermediate. It has no stereospecificity.

**24.** **(1)**

**Sol:** More Stable.

**25.** **(2)**

**Sol:** Ethanol is polar and it has acidic hydrogen.

**26.** **(1)**

**Sol:** On going left to right in period nucleophilicity decreases.

**27.** **(1)**

**Sol:** Acetate ion is more stable than phenoxide ion.

**28.** **(1)**

**Sol:** Sulphur belongs to III[rd] period so it has maximum nucleophilicity.

**29.** **(4)**

**Sol:** On going top to bottom in group nucleophilicity increases.

**30.** **(2)**

**Sol:** Leaving group ability $\propto$ stability of anion.

**31.** **(4)**

**Sol:** Strength of nucleophile generally increases on going down a group in the periodic table, because polarising strength of anion increases.

**32.** **(4)**

**Sol:** Poor base are good leaving group.

Leaving group ability : $F^- < Cl^- < Br^- < I^-$.

**33.** **(1)**

**Sol:** If the nucleopilic atom or the centre is same, nucleophilicity parallels basicity, i.e., more basic the species stronger is the nucleophile.

$CH_3O^- > HO^- > PhO^- > AcO^-$

Here, the nucleophilic atom i.e. O is the same in all these species, This order can be easily explained on the general concept that a weaker acid has a stronger conjugate base.

**34.** **(3)**

**Sol:** Kharasch effect.

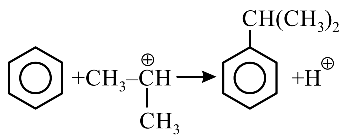
**35.** **(3)**

**Sol:** Chlorine withdraws electrons through inductive effect and release electrons through resonance.

**36.** **(2)**

**Sol:** $CH_3-CH_2-CH_2-Cl + AlCl_3 \longrightarrow AlCl_4^{\ominus} +$

$$CH_3-CH_2-\overset{\oplus}{C}H_2 \xrightarrow[\text{shiffting}]{H^{\ominus}} CH_3-\overset{\oplus}{C}H-CH_3$$



$$H^{\oplus} + AlCl_4^{\ominus} \longrightarrow AlCl_3 + HCl$$

**37.** **(2)**

**Sol:** Lindane is another name of B.H.C

**38.** **(1)**

**Sol:** Reactivity of H-atom

$3°H > 2°H > 1°H$.

**39.** **(2)**

**Sol:** Halogenation of alkanes is an example of free radical substitution reaction

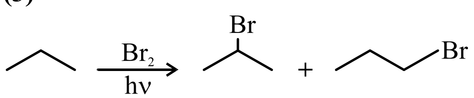
**40.** **(2)**

**Sol:** $CH_4 \xrightarrow[Cl_2]{h\nu} CH_3Cl \xrightarrow[-HCl]{h\nu/Cl_2} CH_3Cl_2$

$$\xrightarrow[-HCl]{h\nu/Cl_2} CHCl_3 \xrightarrow[-HCl]{h\nu/Cl_2} CCl_4$$

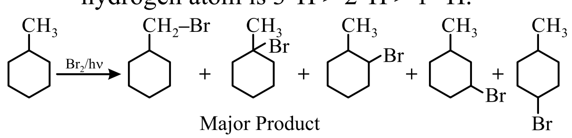
**41.** **(3)**

**Sol:**



**42.** **(3)**

**Sol:** For photochemical bromination reactivity of hydrogen atom is $3°H > 2°H > 1°H$.

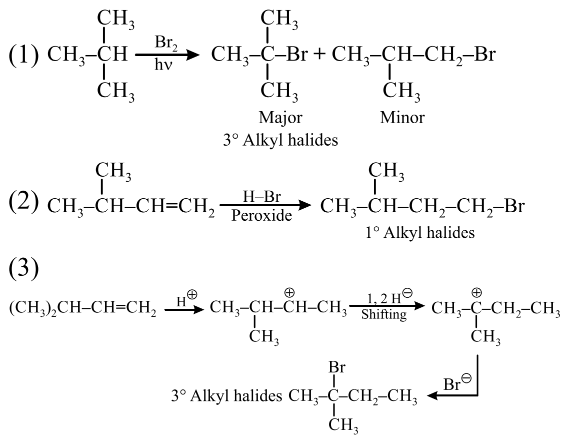


**43.** **(3)**

**Sol:** Iodination of an alkane is carried out in presence of $HNO_3$ or $HIO_3$

**44.** **(4)**

**Sol:**



**45.** **(1)**

**Sol:** HCl undergoes electrophilic addition even in the presence of peroxides.

**46.** **(2)**

**Sol:** $CH_2{=}CH-CH_2-CH=CH_2 \xrightarrow{NBS} CH_2=CH-\dot{C}H-CH=CH_2 \longleftrightarrow CH_2=CH-CH=CH-\dot{C}H_2$ $CH_2=CH-CH=CH-CH_2$ $\xleftarrow{NBS}$ $-Br$

**47.** **(2)**

**Sol:** Bromination is anti-addition.

**48.** **(3)**

**Sol:** $CH_3-C\equiv C-CH_3 \xrightarrow[\text{Lindlar's}]{(1)\ H_2/Pd/CaCO_3}$

$H_3C(H)C=C(H)CH_3$ (Cis) $\xrightarrow[\text{Anti addition}]{Br_2}$ $(d\ell)$ - 2, 3 dibromo butane

**49.** **(2)**

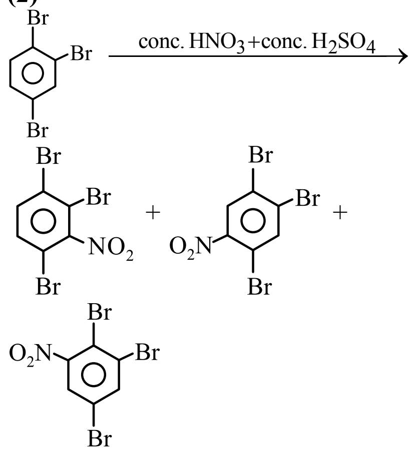
**Sol:** 1-Butyne can be converted into 1-bromo-1-butene by antimarkownikoff, Addition of H-Br in presence of peroxide.

**50.** **(1)**

**Sol:** $-NO_2$ group is meta directing

**51.** **(2)**

**Sol:**



**52.** **(3)**

**Sol:** $CH_3-CH_2-CH_2-CH_3 \xrightarrow{Br_2,\ h\upsilon} \underset{\underset{\text{(equimolar ratio)}}{\text{2-bromobutane}}}{CH_3-\underset{Br}{CH}-CH_2-CH_3} + \underset{\text{1-bromobutane}}{Br-CH_2-CH_2-CH_2-CH_3}$

**53.** **(2)**

**Sol:** Bromination of alkene is an anti-addition

**54.** **(3)**

**Sol:** (P) → c, (Q) → b, (R) → d, (S) → a

**55.** **(2)**

**Sol:** $CH_2{=}CH{-}CH{=}CH_2 \xrightarrow[40°]{HBr} CH_2\ (Br)$

$CH{=}CHCH_3 + CH_3\ CH(Br){-}CH{=}CH_2$

1, 4–addition

1, 2–addition

Therefore, 1-bromo-2-butene will be the main product under themodynamically controlled conditions.

**56.** **(4)**

**Sol:** $CH_3-\overset{\overset{H}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2\ CH_3 + Br_2 \xrightarrow{hv}$

$CH_3-\overset{\overset{Br}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_2-CH_3$

3°(R – X)

2-Bromo-2-methyl butane

**57.** **(2)**

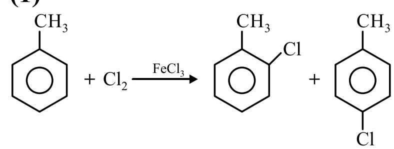
**Sol:**

$H_3C-\overset{\overset{CH_3}{|}}{CH}-\overset{\overset{CH_3}{|}}{CH}-CH_3 \xrightarrow{Cl_2/h\nu}$

$H_3C-\overset{\overset{CH_3}{|}}{CH}-\underset{\underset{Cl}{|}}{\overset{\overset{CH_3}{|}}{C}}-CH_3 + H_3C-\overset{\overset{CH_3}{|}}{CH}-\overset{\overset{CH_3}{|}}{CH}-CH_2-Cl$

**58.** **(1)**

**Sol:**



**59.** **(1)**

**Sol:** $CH_3-C\equiv CH \xrightarrow{H^+} CH_3-\overset{\oplus}{C}=CH_2 \xrightarrow{Br^{\ominus}}$

$CH_3-\underset{\underset{Br}{|}}{C}=CH_2 \xrightarrow{H^+} CH_3-\underset{\underset{Br}{|}}{\overset{\oplus}{C}}-CH_3 \xrightarrow{Br^{\ominus}} \underset{\text{2,2-dibromopropane}}{CH_3-\underset{\underset{Br}{|}}{\overset{\overset{Br}{|}}{C}}-CH_3}$

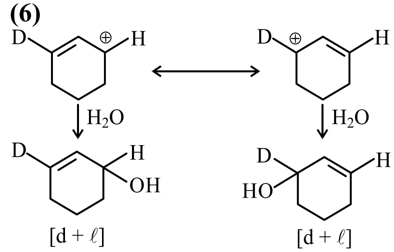
**60.** **(2)**

**Sol:** Addition of bromine to an alkene is an anti addition and symmetrical trans alkene on anti addition forms a meso compound.

## *Integer Type Questions (61 to 75)*

**61.** **(6)**

**Sol:**



$x = 4,\ y = 2$

**62. (3)**

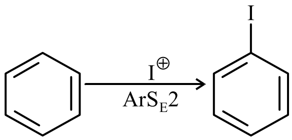
**Sol:** Electron deficient species is called an electrophile.

(iii), (iv), (v)

**63. (67)**

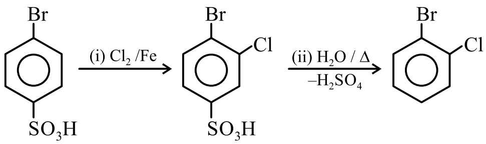
**Sol:** $\frac{12}{18} \times 100 = 66.6\ \%$

**64. (204)**




**65. (2)**

**Sol:**




**66. (5)**

**Sol:**
$$\begin{array}{l} \quad(1)\quad(2)\quad(3)\quad(4)\quad(5) \\ CH_3\text{–}\underset{\displaystyle|\atop\displaystyle CH_3}{CH}\text{–}CH_2\text{–}CH_2\text{–}CH_3 \end{array}$$

**67. (4)**

**Sol:** $CH_3 - CH_2 - C \equiv C - H \xrightarrow{HBr}$

$CH_3 - CH_2 - \underset{\displaystyle|\atop\displaystyle Br}{C} = CH_2$

$\xrightarrow{HBr} CH_3 - CH_2 - \underset{\displaystyle|\atop\displaystyle Br}{\overset{\displaystyle Br\atop\displaystyle|}{C}} - CH_3$

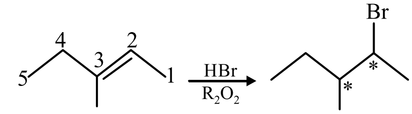
(2, 2-dibromobutane)

p = 2, q = 2

**68. (2)**

**Sol:**

**69. (4)**




**Sol:** 3-methyl pent-2-ene

Total stereo centers = 2, Total stereo isomers = 4

**70. (4)**

**Sol:** In this step, two radicals react together in a way such that chain can no longer be propagated.

**71. (4)**

**Sol:** (ii), (iii), (v), (vi) have no any symmetry hence they are chiral.

**72. (3)**

**Sol:** (oct-2-ene, oct-3-ene, oct-4-ene)

**73. (4)**

**Sol:** $CH_3\text{–}HC\text{=}CH\text{–}CH_2\text{–}CH\text{=}CH\text{–}COOH$

has 2-stereocentre

The no. of geometrical isomers = $2^2 = 4$.

**74. (4)**

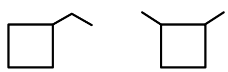
**Sol:** $CH_3 - \underset{\displaystyle|\atop\displaystyle OH}{\overset{*}{C}H} - CH \overset{*}{=} CH - CH_3$

Number of stereocentres = 2 so total number of stereoisomers = $2^2 = 4$

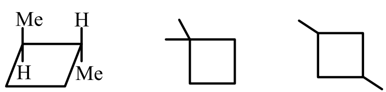
All 4 isomers are optically active.

**75. (7)**

**Sol:** Total = 7



cis




trans(d & ℓ) (cis & trans)

# ALCOHOLS, PHENOLS AND ETHERS

*Single Option Correct Type Questions (01 to 60)*

**1.** **(2)**

**Sol:** $LiAlH_4$ reduces —COO—, —COCl and > C=O groups. While $NaBH_4$ reduces > C=O and —COCl group not —COO— group.

**2.** **(1)**

**Sol:** $LiAlH_4$ cannot reduce isolated carbon-carbon double bond even it is present in conjugation with carbonyl group.

**3.** **(4)**

**Sol:** HBO involves syn addition

**4.** **(4)**

**Sol:** $$CH_3\ CH_2\underset{\underset{OH}{|}}{CH}-CH_3 \xrightarrow[\Delta]{Conc.H_2SO_4}$$

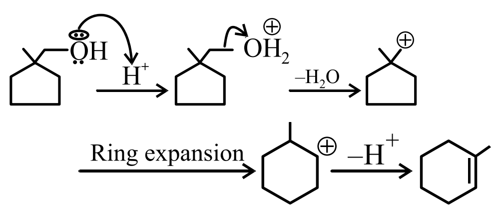
$$CH_3CH=CHCH_3 \xrightarrow{O_3/Zn} \underset{\text{Acetaldehyde}}{2CH_3CHO}$$

**5.** **(4)**

**Sol:** $C_3H_6O$ does not give a precipitate with 2, 4 – dinitrophenyl hydrazine. So, it can't be aldehyde and ketone. $C_3H_6O$ also does not react with Sodium metal. So, it can't unsaturated alcohol also. Hence, $C_3H_6O$ must be

$CH_2 = CH - OCH_3$

**6.** **(3)**

**Sol:** 


**7.** **(2)**

**Sol:** $MnO_2$ oxidies only allylic alcohol with the protection of double bond. While PCC in $CH_2Cl_2$ oxidises allylic alcohol as well as non-allylic alcohol with the protection of double bond.

**8.** **(1)**

**Sol:** $C_6H_6OH$ is phenol because it gives violet colour with neutral $FeCl_3$ and produces no effervescence with $NaHCO_3$.

**9.** **(2)**

**Sol:** Tertiary alkyl bromide gives alkene as a major product in presence of sodium ethoxide because tertiary carbocation readily gives elimination reaction and converted into most stable alkene.

$$CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-Br + CH_3CH_2ONa$$

$$\longrightarrow CH_3-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_2}{||}}{C}} + NaBr + CH_3CH_2OH$$

**10.** **(1)**

**Sol:** Major product is decided by $E_1$ mechanism

**11.** **(2)**

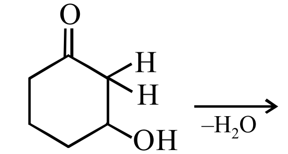
**Sol:** Migration of methyl occurs to form major product

**12.** **(4)**

**Sol:** According to stability of carbocation.

**13.** **(2)**

**Sol:** Dehydrated product will be conjugated with –C = O and carbocation is also more stable.

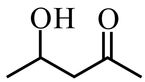



**14.** **(1)**

**Sol:** $R-OH \xrightarrow{H^{\oplus}} R-\overset{\oplus}{O}H_2$

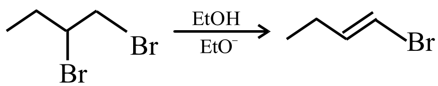
This step is initiation step.

**15.** **(1)**

**Sol:**  will most readily be dehydrated to give conjugated alkene.

**16.** **(3)**

**Sol:**

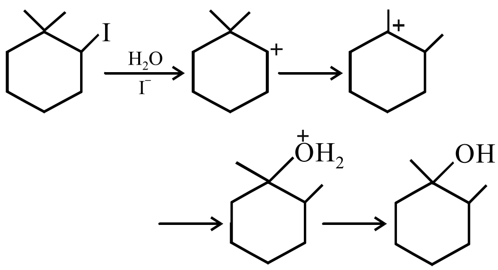



$\xrightarrow{NaNH_2} CH_3-CH_2-C\equiv CH$

(Both steps are E2 elimation reaction)

**17.** **(1)**

**Sol:**

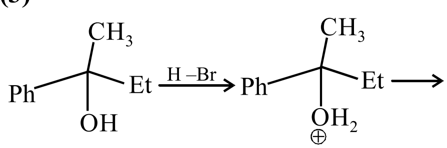



**18.** **(2)**

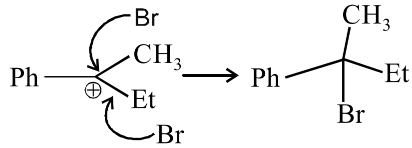
Due to rearrangement.

**19.** **(3)**

**Sol:**




(Chiral carbon atom)




(±) Racemic Mixture

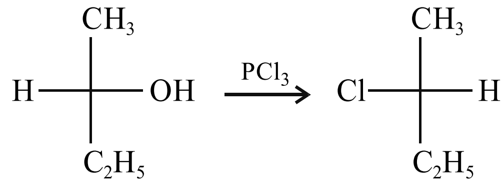
**20.** **(2)**

**Sol:** $CH_3–CH_2–CH_2–CH_2–OH$

$\xrightarrow{HBr} CH_3–CH_2–CH_2–CH_2–Br$

**21.** **(2)**

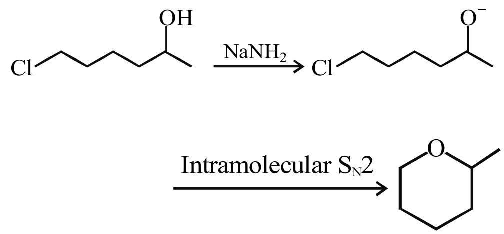
**Sol:**




Product is R-2-Chlorobutane

**22.** **(4)**

**Sol:**




**23.** **(2)**

**Sol:** $CH_3-CH_2-\underset{}{\overset{OH}{\overset{|}{C}H}}-CH_3$

$\xrightarrow{SOCl_2} CH_3-CH_2-\overset{Cl}{\overset{|}{C}H}-CH_3$

It is $S_Ni$ mech so retenion of configuration.

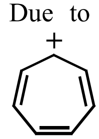
**24.** **(1)**

**Sol:** $CH_3–CH_2–CH_2–O–CH_2–CH_3 \xrightarrow{HCl/\Delta}$

$CH_3–CH_2–CH_2–OH + CH_3–CH_2–Cl$

**25.** **(2)**

**Sol:** Due to formation of stable carbocation →



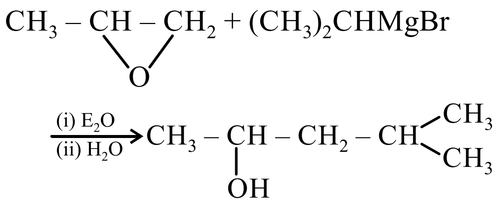
(Tropyllium cation)

**26.** **(3)**

**Sol:** Major product is formed by more stable carbocation

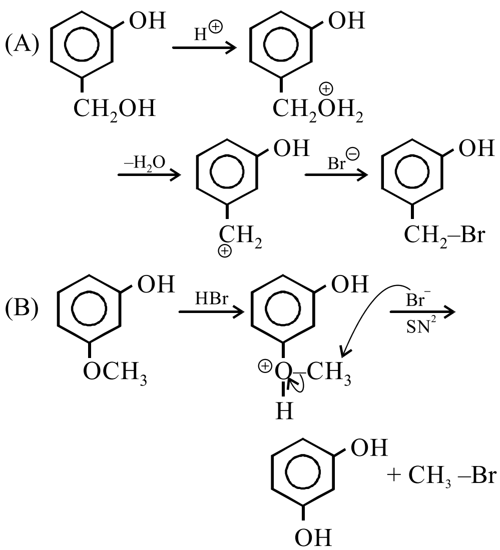
**27.** **(3)**

**Sol:**



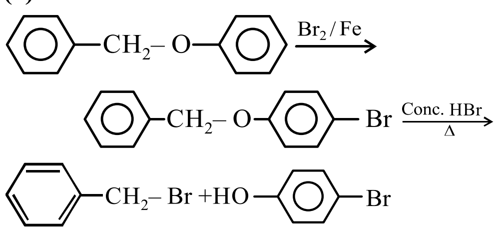
**28.** **(1)**

**Sol:**



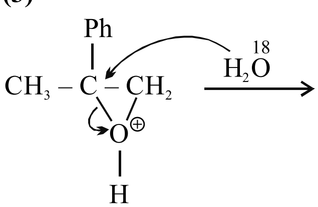
**29.** **(1)**

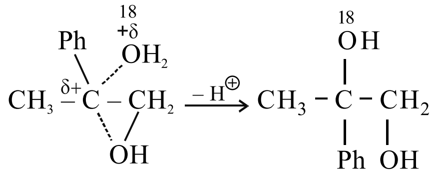
**Sol:**



**30.** **(3)**

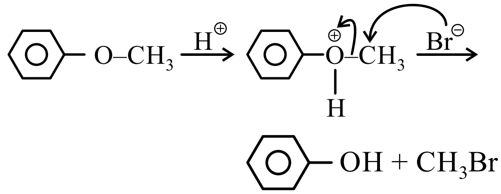
**Sol:**





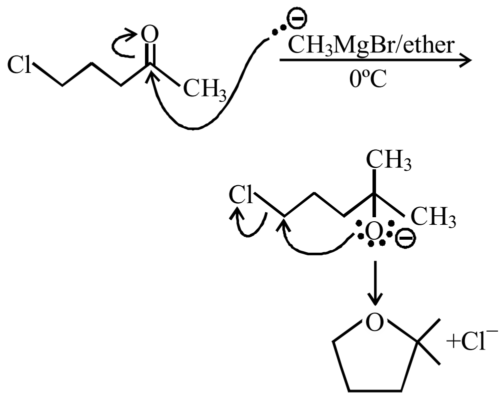
**31.** **(4)**

**Sol:**



**32.** **(4)**

**Sol:**



**33.** **(2)**

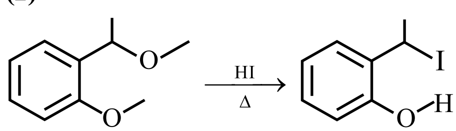
**Sol:** 3° alcohol react faster with HCl and anhydrous $ZnCl_2$ since it forms more stable carbocation intermediate.

**34.** **(2)**

**Sol:** The reaction of alcohol with lucas reagent is mostly an $S_N1$ reaction and the rate of reaction is directly proportional to the carbocation stability formed in the reaction, since 3° R–OH forms 3° carbocation hence it will react fastest.

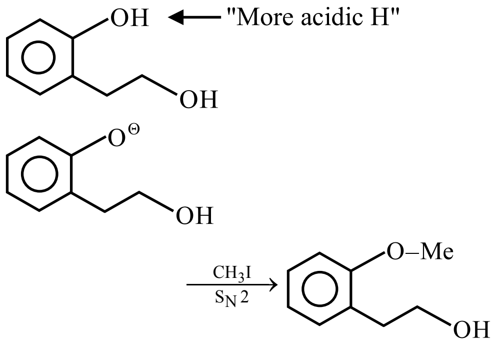
**35.** **(2)**

**Sol:**



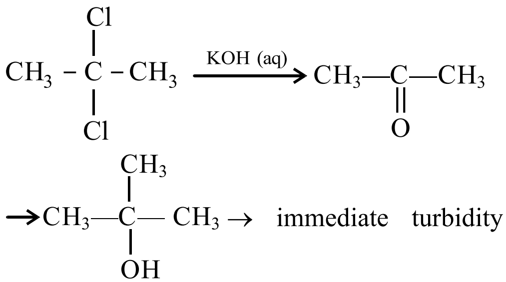
**36.** **(4)**

**Sol:**




**37.** **(2)**

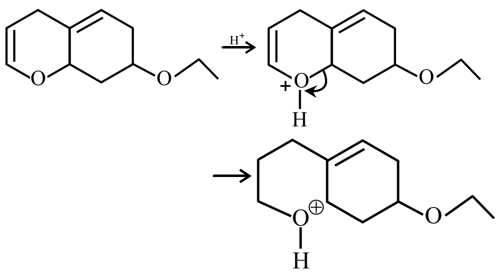
**Sol:**




with Lucas reagent.

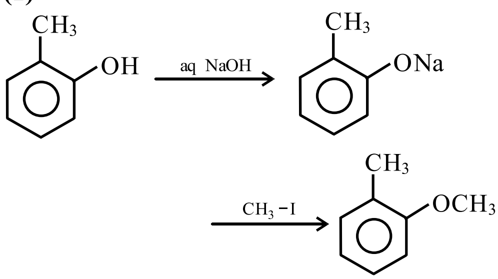
**38.** **(2)**

**Sol:**




**39.** **(1)**

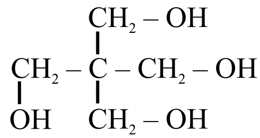
**Sol:**




**40.** **(3)**

**Sol.** $C_5H_{12}O_4 \xrightarrow{CH_3MgBr} 4CH_4 \uparrow$

It means compound (X) contains 4 acidic hydrogen.

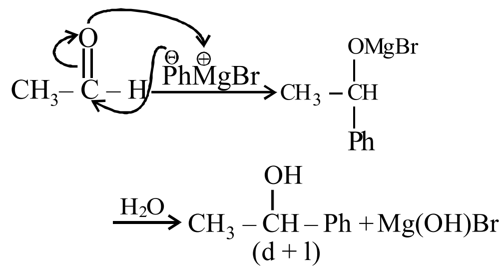



**41.** **(1)**

**Sol:** Major product is 3° alcohol formed by reaction of G.R. on ketone

**42.** **(4)**

**Sol:**

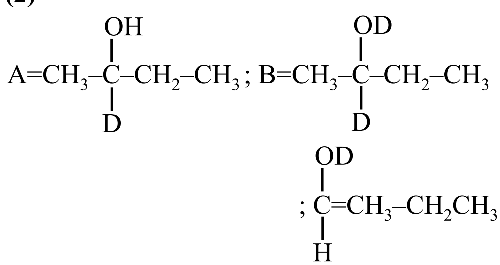



**43.** **(2)**

**Sol:** Based on general reaction of aldehydes & ketones.

**44.** **(2)**

**Sol:**

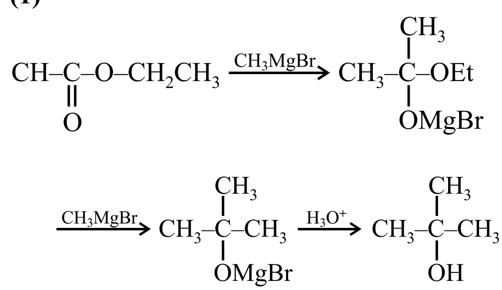



**45.** **(1)**

**Sol:** Based on general reaction of G.R.

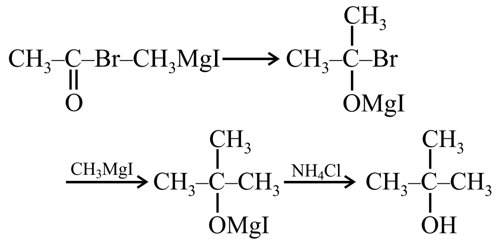
**46.** **(1)**

**Sol:**



**47.** **(3)**

**Sol:**



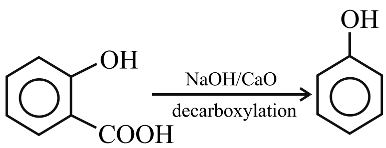
2-Methyl-2-propanol

**48.** **(1)**

**Sol:** HCHO with GR always gives 1º alcohol

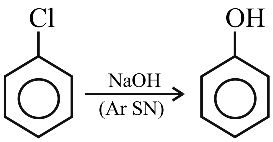
**49.** **(2)**

**Sol:** (1)

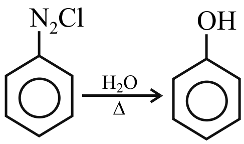


(2) $C_6H_5MgBr \xrightarrow{H_3O^+} C_6H_6 + Mg\begin{matrix} Br \\ OH \end{matrix}$

(3)

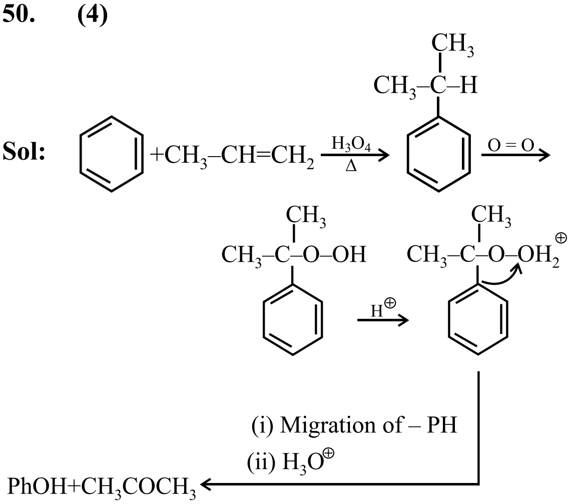


(4)



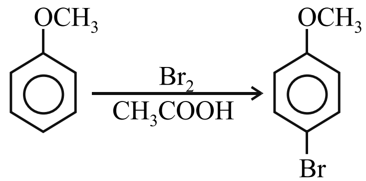
**50.** **(4)**

**Sol:**



**51.** **(2)**

**Sol.** If bromine in acetic acid is used, bromination takes place without decarboxylation.

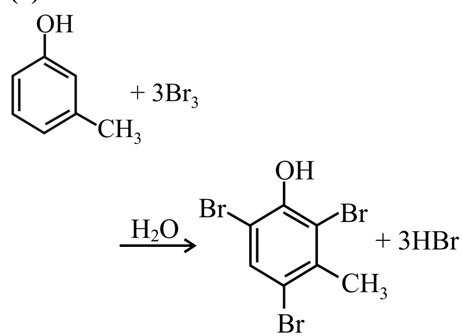


**52.** **(4)**

**Sol:** Salicylic acid undergoes decarboxylation with the formation of 2,4,6-tribromophenol when treated with bromine water. The displacement of carboxyl group occurs only when the reaction is carried out in aqueous solution.

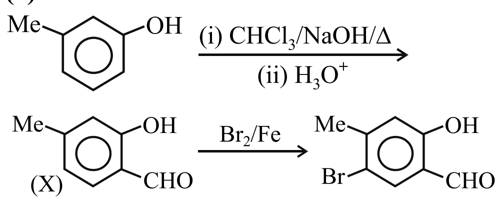
**53.** **(2)**

**Sol:**



**54.** **(3)**

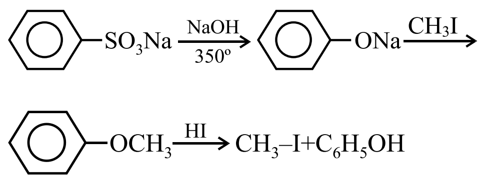
**Sol:**



Attack will take place on the ring which is more electron rich. Benzene with –OH group attached is more electron rich.

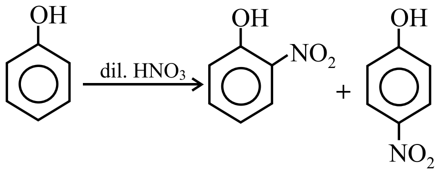
**55.** **(3)**

**Sol:**

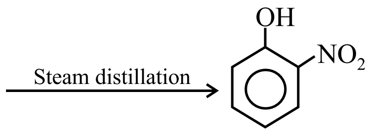


**56.** **(4)**

**Sol:**



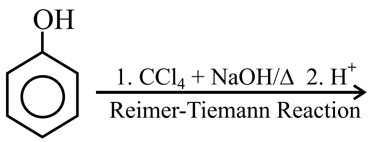

[X] [Y]

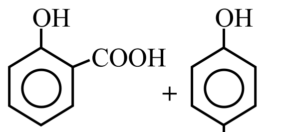



[Low B.P. due to intramolecular H-bonding]

**57.** **(4)**

**Sol:**




(x) (pKa = 2.98)

(y) (pKa = 4.58)

(Ka) = x> y (Carboxylate anion stabilized By H-bonding)

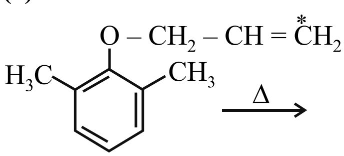
(Sol.) = y > z (Intermolecular H-bonding in y)

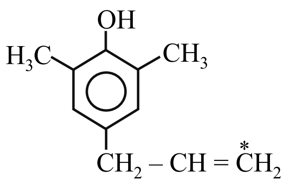
(Vol.) = x> y (Intramolecular H-bonding in x)

(MP) = y > x (More symmetrical structure of y)

**58.** **(1)**

**Sol:**



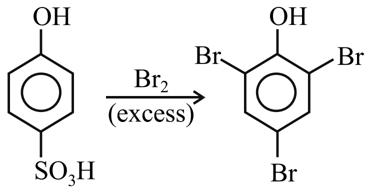




**59.** **(3)**

**Sol:** It is 2, 4, 6-trinitrophenol

**60.** **(2)**

**Sol.**




It is EAS activating ring

## *Integer Type Questions (61 to 75)*

**61.** **(60)**

**Sol.** Number of millimoles of alcohol

$$= \frac{1.12}{22.4\,\text{ml/m mole}}$$

molecular weight of alcohol

$$= \frac{\text{Wt. of alcohol (mg)}}{\text{No. of milli moles of alcohol}}$$

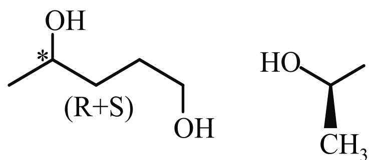
$$= \frac{3}{1.12/22.4} = 60$$

**62.** **(3)**

**Sol.** $CH_3MgBr$, $C_2H_5MgBr$, $Me_2CHMgBr$

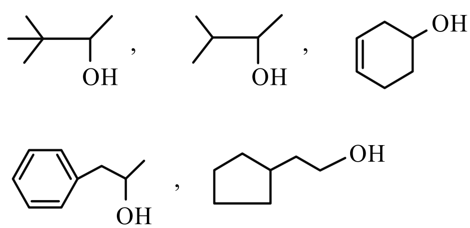
**63.** **(3)**

**Sol.**



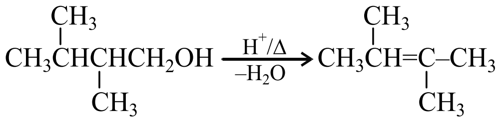

**64.** **(5)**

**Sol:**



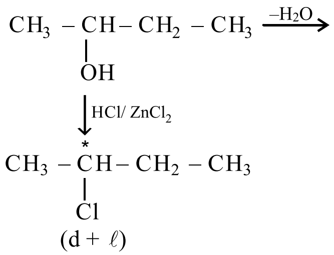
**65.** **(12)**

**Sol.**



**66.** **(23)**

**Sol**:

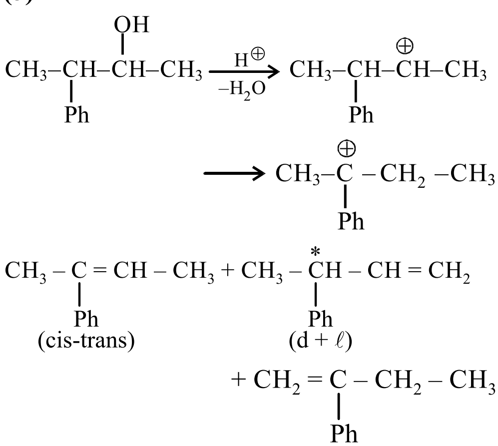


Y = 3, Z = 2

$CH_3-CH=CH-CH_3+CH_2=CH-CH_2-CH_3$
(cis & trans)

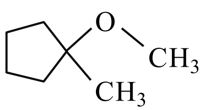
**67.** **(5)**

**Sol:**



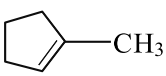
**68.** **(32)**

**Sol:** P =



[M.F. $C_7H_{14}O$ M.W. 84 + 14 + 16 = 114]

Q =



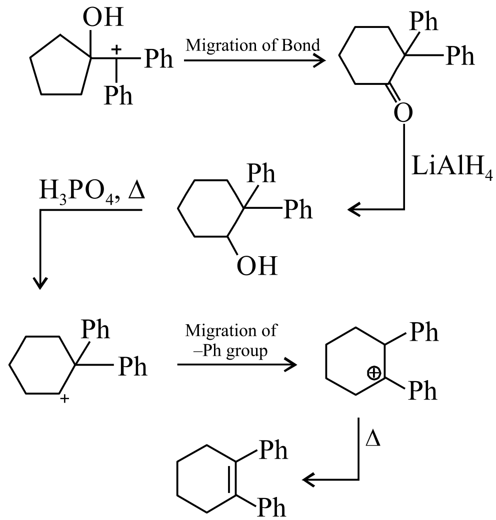
[M.F. $C_6H_{10}$ M.W. 72 + 10 = 82]

[Molecular Weights (P – Q)

= 114 – 82 = 32]

**69.** **(78)**

**Sol:**

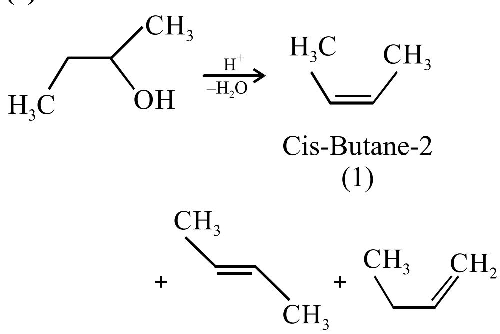



Molecular mass [W] = 234

N = 234/3 = 78

**70.** **(3)**

**Sol:**




In [F] order of quantity of alkene 2 > 1 > 3.

These on addition with $Br_2$ / $CCl_4$ to give their addition products which have $C_4H_8Br_2$ as molecular formula

These five products are

(1) $CH_3-\underset{Br}{CH}-\underset{Br}{CH}-CH_3$ (Meso)

(2) $CH_3-\underset{\underset{}{}}{\overset{\overset{Br}{|}}{C}H}-\underset{\underset{Br}{|}}{C}H-CH_3$ (dI)

(3) $BrH_2C-\underset{\underset{Br}{|}}{C}H-CH_2-CH_3$ (dI)

**71. (88)**

**Sol:** $ROH + CH_3MgX \rightarrow CH_4 + ROMgX$

Let molecular mass of alcohol is M

$$\frac{56}{22400} = \frac{0.22}{M}$$

$$M = \frac{22400 \times 0.22}{56} = 88$$

**72. (3)**

**Sol:**

(i) $C-C-C-\overset{\overset{O}{\|}}{C}-C$ (ii) $C-C-\overset{\overset{O}{\|}}{C}-C-C$

(iii) $C-\underset{\underset{C}{|}}{C}-\overset{\overset{O}{\|}}{C}-C$

**73. (3)**

**Sol:** Ketone and esters reacts with Grignard reagent to give tertiary alcohols and aldehyde reacts with Grignard to form secondary alcohols. The reaction with formaldehyde will produce primary alcohol

**74. (88)**

**Sol:** $CH_3-\underset{\underset{O}{\|}}{C}-O-CH_2-CH_3$

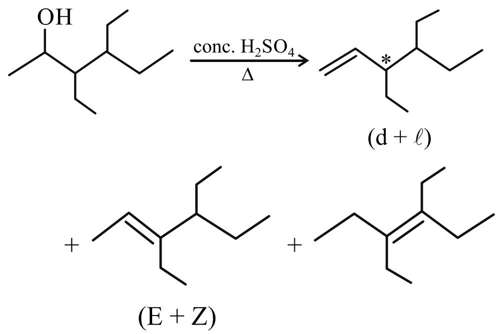
$$\xrightarrow{LiAlH_4} 2CH_3-CH_2-OH$$

Molecular formula = $C_4H_8O_2$

Molecular weight = 88

**75. (5)**

**Sol:**

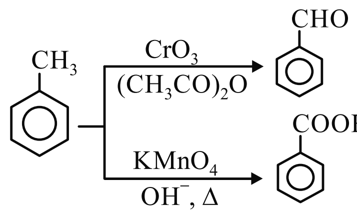


# ALDEHYDES, KETONES AND CARBOXYLIC ACIDS

*Single Option Correct Type Questions (01 to 60)*

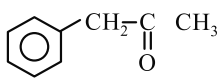
**1.** **(4)**

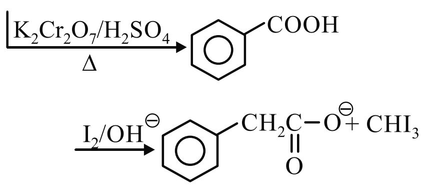
**Sol:**




**2.** **(3)**

**Sol:** X is




**3.** **(1)**

**Sol:** b. p $\propto$ extent of intermolecular H-bonding.

**4.** **(3)**

**Sol:** Tollen's reagent gives black precipitate with aldehydes

**5.** **(1)**

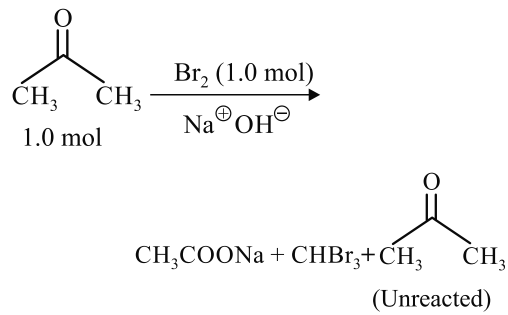
**Sol:** $CH \equiv CH \xrightarrow[H_2SO_4]{HgSO_4} CH_3 - CHO$

$\xrightarrow[H_2O]{CH_3MgBr} CH_3 - \underset{\displaystyle OH}{\underset{|}{CH}} - CH_3$

$\xrightarrow{Red\,P/Br_2} CH_3 - \underset{\displaystyle Br}{\underset{|}{CH}} - CH_3$

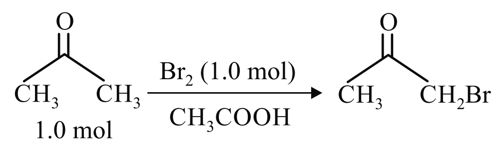
**6.** **(3)**

**Sol:** Reaction I:




(In basic medium complete haloform reaction takes place since the rate of reaction increases with each α-halogenation)

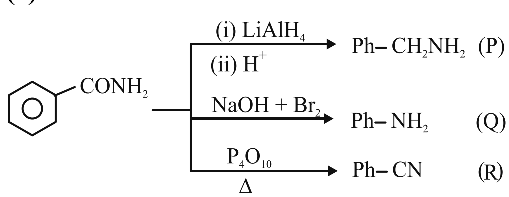
Reaction II:




(In acidic medium monohalogenation takes place with 1-mol of halogen)

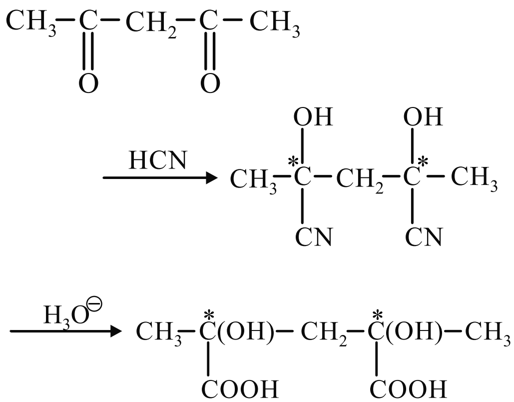
**7.** **(1)**

**Sol:**



**8.** **(3)**

**Sol:**



product has three stereoisomers $\longrightarrow$ d + $\ell$ + meso and product mixture is optically inactive.

**9.** **(3)**

**Sol:** 1-propanol & 2-propanol can be distinguished by the reagents Cu/Δ & Fehling solution Cu converts 1-propanol into propanal & 2-propanol into acetone which are easily distinguished by Fehling solution.

$$\underset{\text{1-propanol}}{CH_3-CH_2-CH_2OH} \xrightarrow[\text{heat } 300^{o}C]{Cu}$$

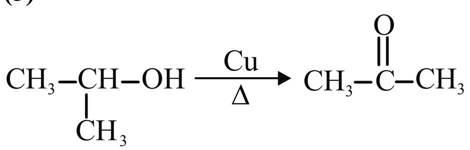
$$CH_3-CH_2-CHO \xrightarrow[\text{Fehling Solution}]{} \underset{\text{red ppt}}{Cu_2O\downarrow}$$

$$\underset{\text{2-propanol}}{CH_3-CHOH-CH_3} \xrightarrow[\text{heat } 300^{o}C]{Cu}$$

$$CH_3-CO-CH_3 \xrightarrow[\text{Fehling Solution}]{} \text{No reaction}$$

**10.** **(3)**

**Sol:**



**11.** **(2)**

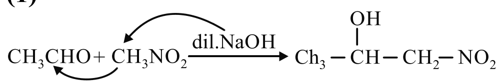
**Sol:** Aldehydes and ketones having atleast one α-H, give aldol condensation.

**12.** **(1)**

**Sol:** It is aldol condensation reaction and base will break C–H bond not C–D bond, as we know that C–D bond is stronger than C–H bond.

**13.** **(1)**

**Sol:**



**14.** **(3)**

**Sol:** $CH_3CHO$ have α-hydrogen. So, it will not give Cannizaro reaction.

**15.** **(2)**

**Sol:** Haloform reaction is given by $-\overset{\overset{O}{\|}}{C}-CH_3$ group.

$CH_3CHO$ has this group.

**16.** **(1)**

**Sol:** Compound containing chiral carbon with carbonyl group $\left(-\overset{\overset{O}{\|}}{C}-CH_3\right)$

**17.** **(2)**

**Sol:** Compound containing $-\overset{\overset{O}{\|}}{C}-CH_3$ group give iodoform test and compound containing carbonyl group gives 2, 4 - DNP derivative.

**18.** **(4)**

**Sol:** Acetic acid do not gives tollen's test

**19.** **(3)**

**Sol:** Aldehydes give silver mirror test but ketones do not.

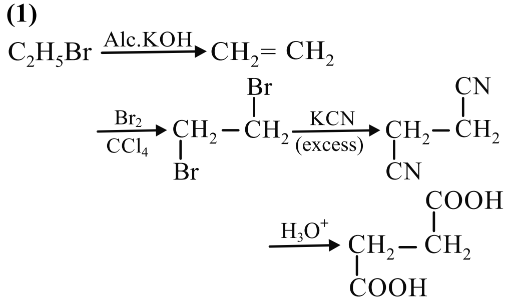
$$(CH_3)_2CHOH \xrightarrow{[O]} (CH_3)_2C{=}O$$

→ No silver mirror

→ Phenyl hydrazine formation is possible

**20.** **(1)**

**Sol:**



**21.** **(3)**

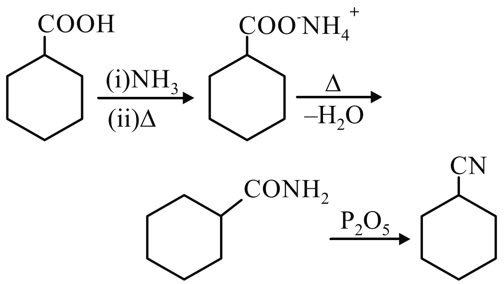
**Sol:** Aromatic aldehyde do not give Fehling solution test.

**22.** **(1)**

**Sol:** α-halogenation reaction [α-H must present].

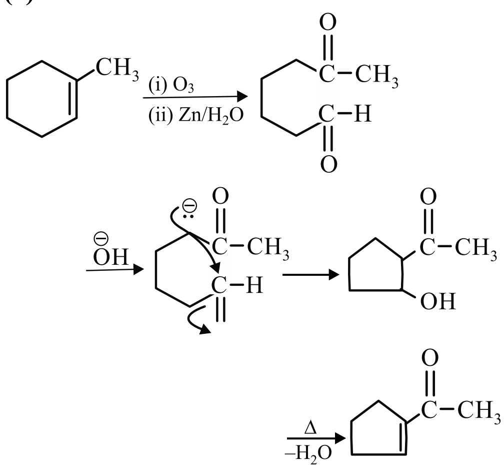
**23.** **(2)**

**Sol:**



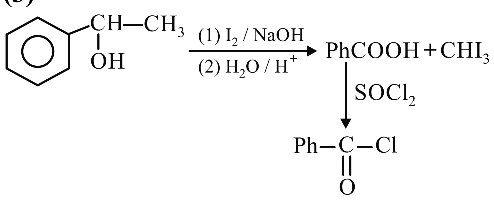

**24.** **(2)**

**Sol:**




**25.** **(3)**

**Sol:**




**26.** **(3)**

**Sol:** $CH_3-\underset{\displaystyle CH_2-OH}{\underset{|}{C}H}-COOH \xrightarrow{LiAlH_4} CH_3-\underset{\displaystyle CH_2-OH}{\underset{|}{C}H}-CH_2OH$

**27.** **(1)**

**Sol:** Rate of esterification ∝ electrophilicity of $>C=O$ groups in acid.

**28.** **(1)**

**Sol:** Less hindered $>C=O$ group oxidised in cross Cannizzaro reaction.

**29.** **(2)**

**Sol:** Iodoform test is given by $CH_3-\overset{O}{\overset{\|}{C}}-$ group.

**30.** **(1)**

**Sol:** $PhCHO \xrightarrow[2\ H^+]{1\ NaOH} PhCH_2OH + PhCOOH$

**31.** **(1)**

**Sol:** Assertion is correct and reason is the correct explanation of assertion

**32.** **(1)**

**Sol:** **I - Q ; II - P ; III - S ; IV - R**

**33.** **(2)**

**Sol:** **I - P ; II - S ; III - P ; IV - Q**

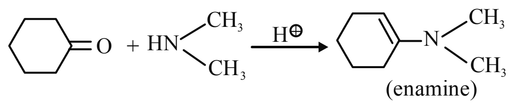
**34.** **(4)**

**Sol:** Benzaldehyde undergoes disproportionation with 50% NaOH to given benzyl alcohol and sodium benzoate

$C_6H_6CHO \xrightarrow{50\%\ NaOH} C_6H_5CH_2OH + C_6H_5COONa$

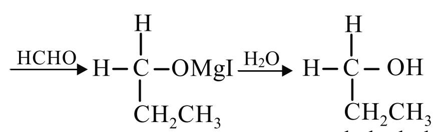
**35.** **(3)**

**Sol:**




**36.** **(1)**

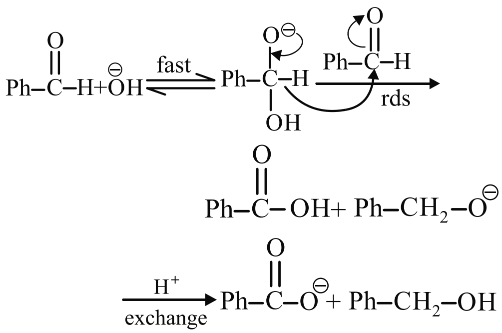
**Sol:** $CH_3CH_2OH \xrightarrow[I_2]{Red\ P} CH_3CH_2I \xrightarrow{Mg} CH_3CH_2MgI$




n-propyl alcohol
(D)

**37. (1)**

**Sol:**




**38. (1)**

**Sol:** The cannizzaro product of given reaction yields 2, 2, 2-trichloroethanol.

$$Cl_3CHO \xrightarrow{NaOH} Cl_3CCOO^- + Cl_3CCH_2OH$$

**39. (3)**

**Sol:** $CH_3-C(CH_3)=CH-CH_2-CH_3 \xrightarrow{O_3/Zn,\ H_2O}$

(2-Methyl-2-pentene)
(A)

$$CH_3-C(CH_3)=O + CH_3-CH_2-CHO$$

Acetone    Propionaldehyde

**40. (4)**

**Sol:** $CH_3-CH(CH_3)-CH_2-OH$ (isobutyl alcohol) does not give iodoform test.

**41. (4)**

**Sol:** $H_3C-C(CH_3)=CH-CH_2-CHO \xrightarrow{[O]}$

$$H_3C-C(=O)-CH_3 + CH_2(COOH)-COOH$$

**42. (3)**

**Sol:** $CH_3CH_2COOH \xrightarrow[\text{Red P}]{Cl_2} CH_3CH(Cl)-COOH$

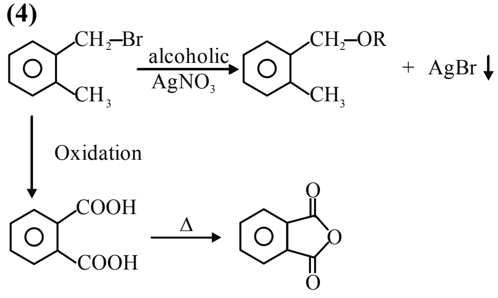
$$\xrightarrow{KOH(alc.)} CH_2 = CHCOOH$$

**43. (3)**

**Sol:** When two electron releasing groups are present the incoming group will occupy para or ortho position to the group which has more + R effect.

**44. (4)**

**Sol:**




(Phthalic anhydride)

**45. (2)**

**Sol:** It is aldol condensation reaction.

**46. (4)**

**Sol:** The synthesis requires three aldol & one cannizzaro reaction.

$$CH_3-CH=O + HCHO\ (4\ \text{moles}) \xrightarrow{\bar{O}H} C(CH_2OH)_4$$

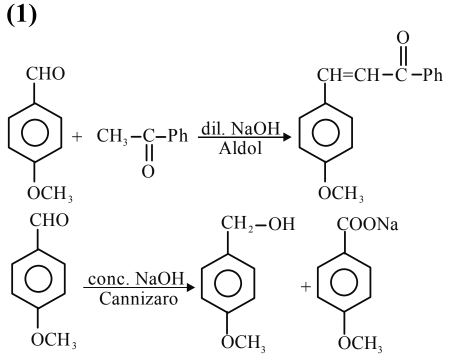
**47. (2)**

**Sol:** $CH_3-CCl_2-CH_3 \xrightarrow{KOH(aq)} CH_3-C(=O)-CH_3$

$$\xrightarrow[\text{(ii) } H_2O/H^+]{\text{(i) } CH_3MgBr} CH_3-C(CH_3)(OH)-CH_3$$

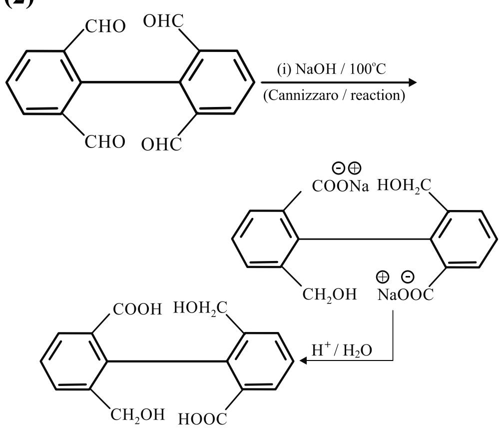
**48. (1)**

**Sol:**



**49. (2)**

**Sol:**



**50. (3)**

**Sol:**

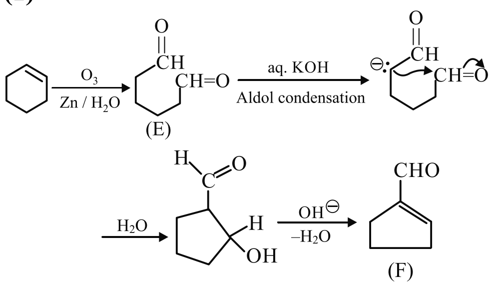
$$CH_3-\underset{\underset{O}{\parallel}}{C}-CH_2-CH_3 \xrightarrow{I_2} CI_3-\underset{\underset{O}{\parallel}}{C}-CH_2-CH_3$$

$$\xrightarrow{OH^-} CHI_3 + CH_3-CH_2-\underset{\underset{O}{\parallel}}{C}-O^-$$

$$\xrightarrow{H^+} CH_3CH_2COOH$$

**51. (1)**

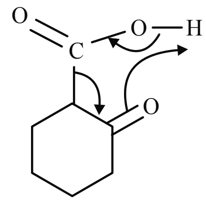
**Sol:**



Ozonolysis product of cyclohexene will give hexandial and this undergoes intramolecular aldol condensation in presence of alkali to give cyclic α,β-unsaturated aldehyde.

**52. (2)**

**Sol:** In decarboxylation, β-carbon acquires δ– charge. Whenever δ– charge is stabilized, decarboxylation becomes simple. In (B), it is stabilized by –M & –I of C = O, which is best amongst the options offered,



**53. (4)**

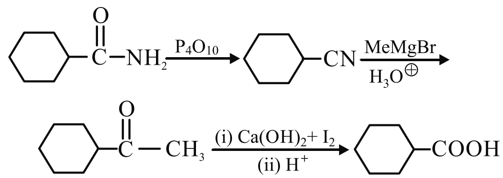
**Sol:** Rate of hydrolysis ∝ partial positive charge on > C= O groups.

**54. (1)**

**Sol:** $\text{Rate} \propto \dfrac{1}{\text{basicty of leaving group}}$

**55. (1)**

**Sol:**

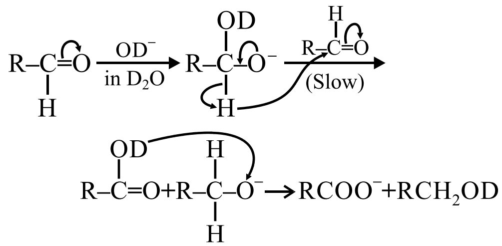


**56. (3)**

**Sol:** Iodoform test is carried out in hot alkaline medium. Under these conditions the esters will hydrolyse to give corresponding alcohols. Now ethyl alcohol will respond to iodoform test to give yellow ppt. of iodoform while methanol will not give iodoform.

**57. (2)**

**Sol:** If $D_2O$ (heavy water) is taken instead of $H_2O$, as solvent, the reaction takes place in the following manner:



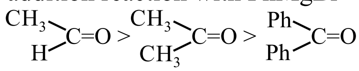
**58. (2)**

**Sol:** Clemmensen reduction

$$>C=O \xrightarrow{\text{Zn-Hg/HCl}} >CH_2$$

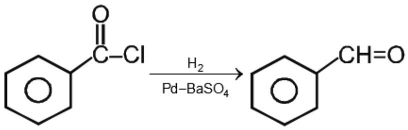
**59. (4)**

**Sol:** Correct reactivity order for nucleophilic addition reaction with PhMgBr



(due to steric crowding)

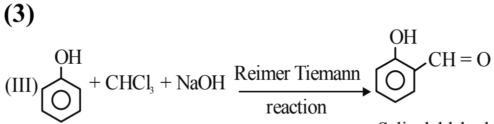
**60. (1)**

**Sol:** 

It is Rosenmund reaction.

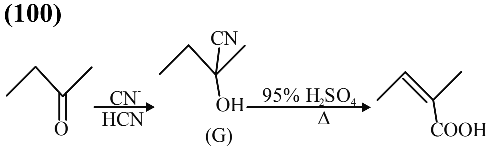
## Integer Type Questions (61 to 75)

**61. (3)**

**Sol:** 

Salicylaldehyde

**62. (100)**

**Sol:** 

**63. (82)**

**Sol:** $CH_3-\underset{|}{CH}(OH)-CH_3 \xrightarrow[K_2Cr_2O_7 / H_2SO_4]{[O]} CH_3-\underset{||}{C}(O)-CH_3$

$\xrightarrow{I_2 / NaOH} CHI_3 + CH_3COONa$

**64. (1)**

**Sol:** $Ph-CH_3 \xrightarrow{\text{Hot Alkaline KMnO}_4} Ph-COO^-$

$Ph-CH=CH-CH_3$

$\xrightarrow{\text{Hot Alkaline KMnO}_4} Ph-COO^-$

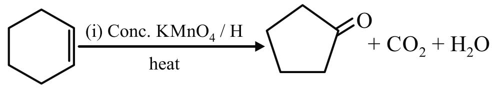
$Ph-C\equiv C-CH_3 \xrightarrow{\text{Hot Alkaline KMnO}_4} Ph-COO^-$

**65. (103)**

**Sol:** $CH_3-CH_2-\underset{||}{C}(O)-CH_2-CH_2-CH_3$

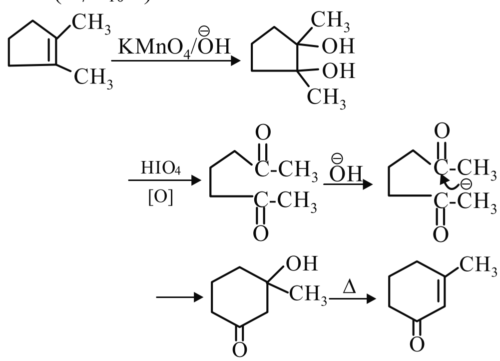
$\xrightarrow[\text{(ii) } D_2O]{\text{(i) } NaBH_4} CH_3CH_2-\underset{|}{CH}(OD)-CH_2-CH_2-CH_3$

**66. (1)**

**Sol:** 

**67. (110)**

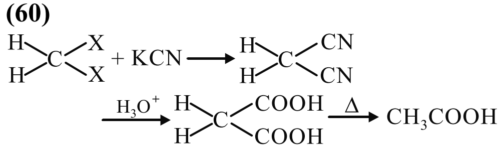
**Sol:** Z is ($C_7H_{10}O$)



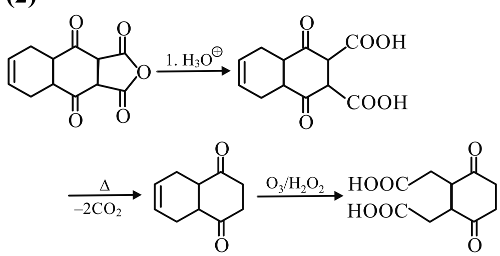
**68. (3)**

**Sol:** The compound which contains $CH_3-\underset{\underset{O}{||}}{C}-$ or $CH_3-\underset{\underset{OH}{|}}{CH}-$ group gives iodoform test.

**69. (60)**

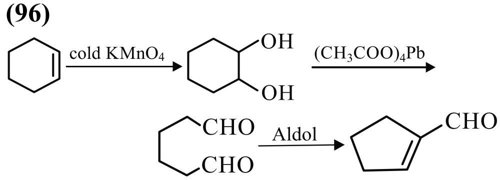
**Sol:** 

**70. (2)**

**Sol:** 

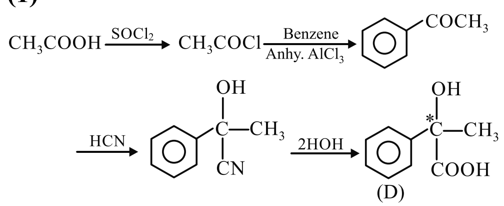
No. of –COOH group is '2'.

**71. (96)**

**Sol:** 

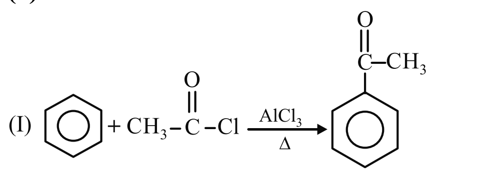
**72. (1)**

**Sol:**

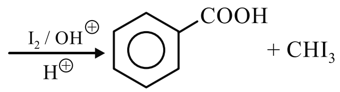


**73. (4)**

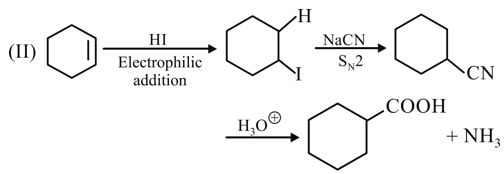
**Sol:**

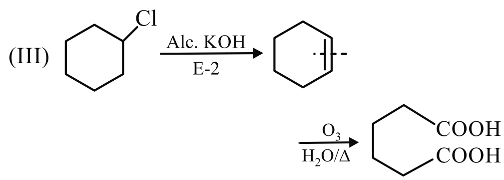


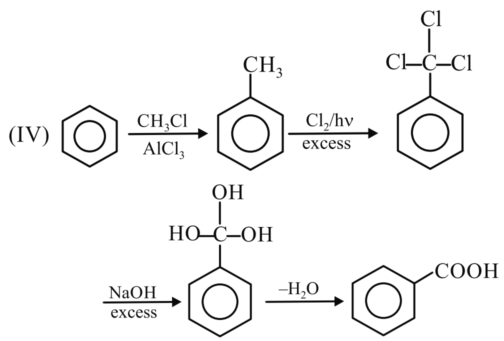
Friedel craft acylation



Iodoform reaction

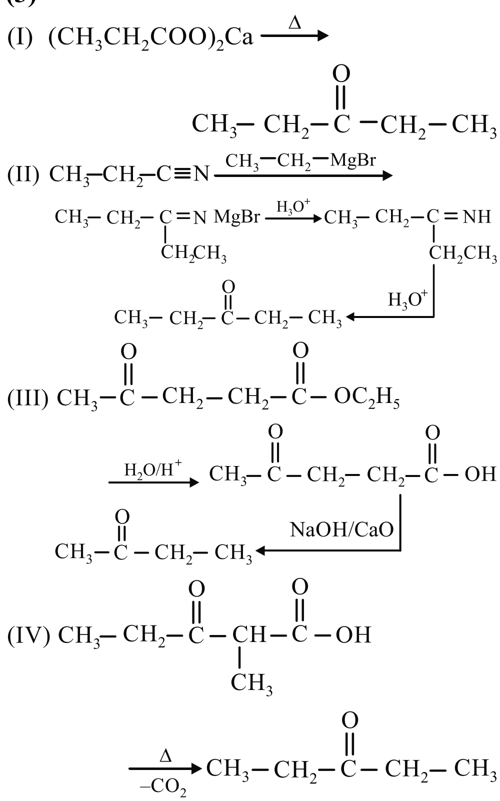






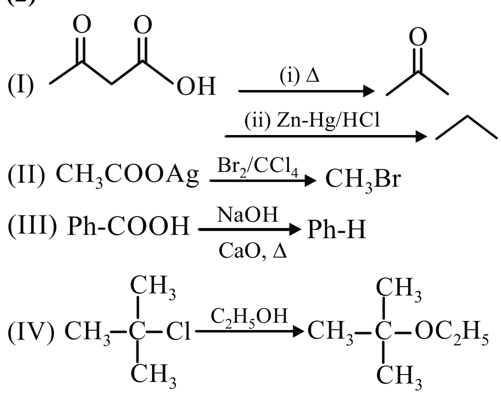
**74. (3)**

**Sol:**



**75. (2)**

**Sol:**

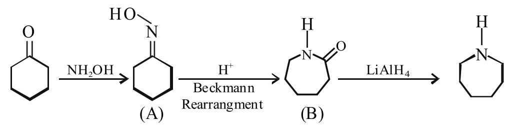


# AMINES

## *Single Option Correct Type Questions (01 to 60)*

**1.** **(4)**

**Sol:**




**2.** **(1)**

**Sol:**

$$CH_3CH_2Cl \xrightarrow{NaCN} \underset{(X)}{CH_3CH_2CN} \xrightarrow{Ni/H_2} \underset{(Y)}{CH_3CH_2CH_2NH_2}$$

$$\xrightarrow{CH_3COOCOCH_3} CH_3COOH + CH_3CH_2CH_2NH-\overset{O}{\overset{||}{C}}-CH_3$$

**3.** **(1)**

**Sol:** When connected with o- or p- carbon of benzene –OMe group is electron releasing.

**4.** **(3)**

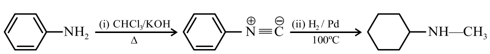
**Sol:** More the delocalization of lone pair of nitrogen, lesser is the basicity, poor will be the nucleophilicity.

**5.** **(2)**

**Sol:** 3° amine do not react with diethyl oxalate. This is the Hofmann's method not Hinsberg's method.

**6.** **(3)**

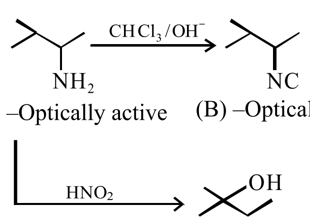
**Sol:**




$H_2$/Pd removes all the double bonds even in the ring at high temperature and high pressure.

**7.** **(2)**

**Sol:**

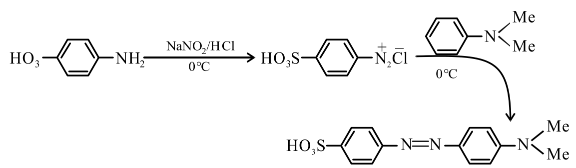



(A) –Optically active (B) –Optically active

(C) –Optically inactive

**8.** **(3)**

**Sol:**




Methyl orange

**9.** **(4)**

**Sol:** Secondary nitro compound gives blue colouration in Victor Meyer's test.

**10.** **(1)**

**Sol:**

$$R–NH_2 + C_6H_5SO_2Cl \longrightarrow C_6H_5SO_2-\underset{H}{\underset{|}{N}}-R + HCl$$

The hydrogen attached to nitrogen in sulfonamide is strongly acidic due to the presence of strong electron withdrawing sulphonyl group. Hence, it is soluble in alkali.

**11.** **(2)**

**Sol:**

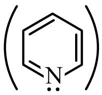
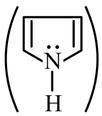
$$C_2H_5NH_2 + HNO_2 \longrightarrow C_2H_5OH \xrightarrow{PCl_5}$$

$$C_2H_5Cl \xrightarrow{NH_3} \underset{\text{(Ethylamine)}}{C_2H_5NH_2}$$

**12.** **(1)**

**Sol:** Aromatic halides do not give nucleophilic substitution due to partial double bond character in C—X bond. So, Aryl amines cannot be prepared by Gabriel's pthalimide synthesis.

**13.** **(3)**

**Sol:** In pyridine  as well as in pyrrole , N-atom is $sp^2$ hybridised. Pyridine is more basic than pyrrole.

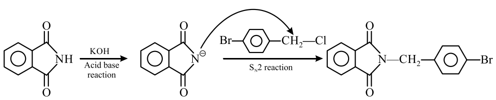
**14.** **(4)**

**Sol:** Aniline on reaction with $NaNO_2/HCl$ at 0° C followed by coupling with β-naphthol gives a orange red dye.

∴ Statement-1 is incorrect but statement 2 is correct.

**15.** **(1)**

**Sol:**

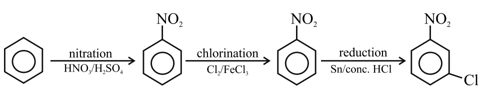



**16.** **(1)**

**Sol:** More nucleophilic nitrogen, more reactive with alkyl halide.

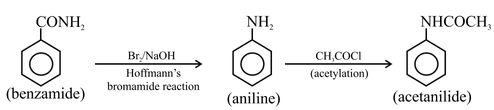
**17.** **(3)**

**Sol:**



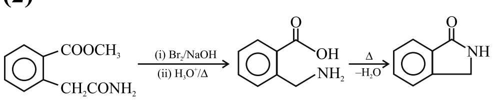

**18.** **(2)**

**Sol:**



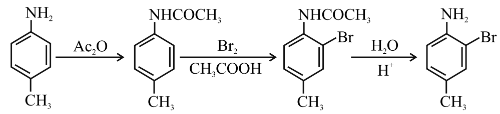

**19.** **(2)**

**Sol:**




**20.** **(4)**

**Sol:**




**21.** **(2)**

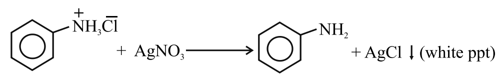
**Sol:**

$$\underset{(X)}{Ph-NH_2} \xrightarrow[CHCl_3(Y)]{KOH} Ph-N \equiv C$$

$$\underset{(Z)}{CH_3COCH_3} \xrightarrow{Cl_2/Ca(OH)_2} (CH_3COO)_2Ca + CHCl_3$$

**22.** **(4)**

**Sol:**




**23.** **(2)**

**Sol.** Amides give Hoffmann bromamide reaction.

**24.** **(2)**

**Sol:**

$$CH_3-\underset{Ph}{\underset{|}{CH}}-\overset{O}{\overset{||}{C}}-NH_2 \xrightarrow{NaOH + Br_2} CH_3-\underset{Ph}{\underset{|}{CH}}-NH_2$$

It is Hoffmann bromamide reaction.

**25.** **(3)**

**Sol:** $R-X \xrightarrow{KCN} R-CN \xrightarrow{[H]} \underset{1^\circ \text{ Amine}}{R-CH_2-NH_2}$

**26.** **(2)**

**Sol:** Gabriel phthalimide synthesis is best method for preparing primary amines from alkyl halides without changing the number of carbon atoms in the chain.

**27.** **(4)**

**Sol:** $CH_3-CONH_2 + Br_2 + NaOH \xrightarrow{\Delta} CH_3NH_2 + Na_2CO_3$ [Hoffmann bromamide reaction]

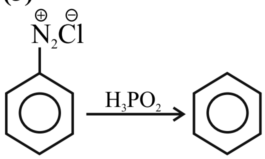
**28.** **(2)**

**Sol:** $C_6H_5NH_2 \xrightarrow[0-5^\circ C]{NaNO_2+HCl} C_6H_5N_2^+Cl^- \xrightarrow[KCN]{CuCN}$

$C_6H_5CN \xrightarrow{H^+/H_2O} C_6H_5COOH$

**29.** **(3)**

**Sol.**

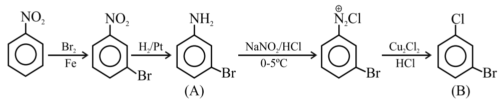


**30.** **(3)**

**Sol:** $C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_2+HCl} C_6H_5\overset{+}{N}_2Cl^- \xrightarrow[\Delta]{H_2O} C_6H_5OH$

**31.** **(4)**

**Sol:**

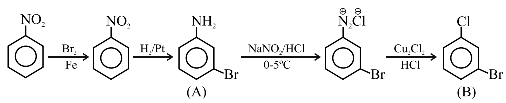


**32.** **(4)**

**Sol:** This reaction is called Gattermann reaction.

**33.** **(2)**

**Sol:**



**34.** **(2)**

**Sol:** Aniline prefer coupling in slightly acidic medium.

**35.** **(1)**

**Sol:** Phenol prefer coupling in slightly basic medium.

**36.** **(3)**

**Sol:** I-R; II-S; III-P; IV-Q

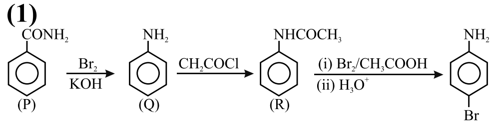
**37.** **(2)**

**Sol:** I-S; II-R; III-P; IV-Q

**38.** **(4)**

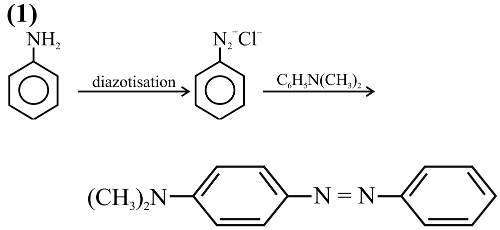
**Sol:** I-Q, S, T ; II-P, T; III-Q, T ; IV-R, T

**39.** **(1)**



**40.** **(1)**

**Sol:**

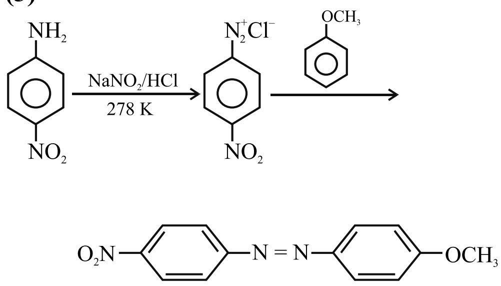


**41.** **(1)**

**Sol:** In the diazotisation of aniline with sodium nitrite and hydrochloric acid, an excess of hydrochloric acid is used primarily to suppress the concentration of free aniline available for coupling

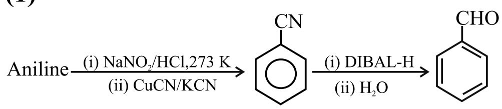
**42.** **(3)**

**Sol:**



**43.** **(1)**

**Sol:**



**44.** **(4)**

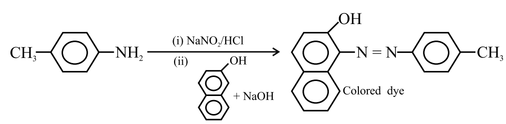
**Sol:** In strongly acidic solutions, aniline converts into anilinium ion i.e. more electron withdrawing nature so the ring deactivates towards electrophilic reagents.

**45.** **(1)**

**Sol:** Since the overall reaction is intramolecular the product under Hoffmann conditions will be self-product only.

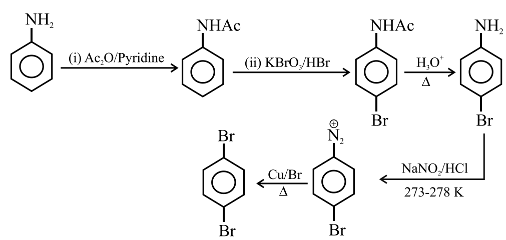
**46.** **(3)**

**Sol:**



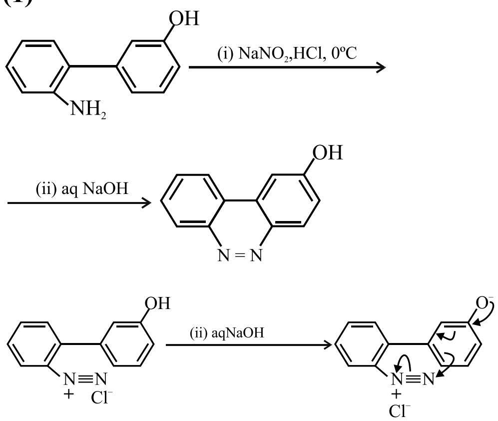
**47.** **(2)**

**Sol:**



**48. (1)**

**Sol:**

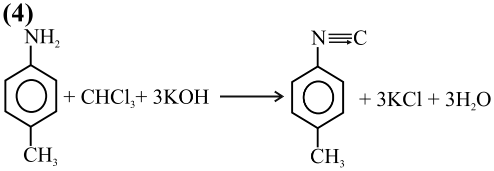


**49. (1)**

**Sol:** $R–CH_2–NH_2 + CHCl_3 + 3KOH \longrightarrow R–CH_2NC + 3KCl + 3H_2O$

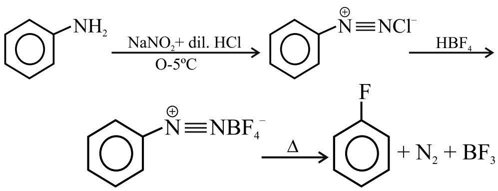
**50. (4)**

**Sol:**



**51. (1)**

**Sol:**

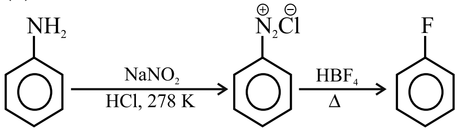


**52. (2)**

**Sol:** $CH_3CH_2NH_2 + CHCl_3 + 3KOH \rightarrow$
$$C_2H_5NC + 3KCl + 3H_2O$$

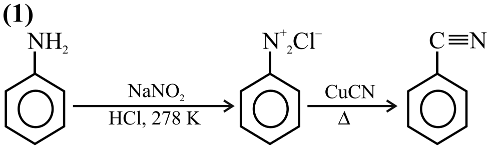
**53. (3)**

**Sol:**



**54. (1)**

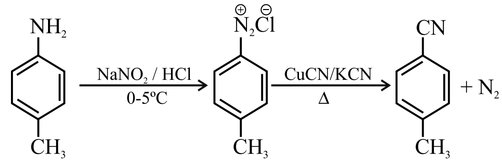
**Sol:**



Benzene diazonium chloride Benzonitrile

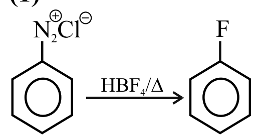
**55. (3)**

**Sol:**



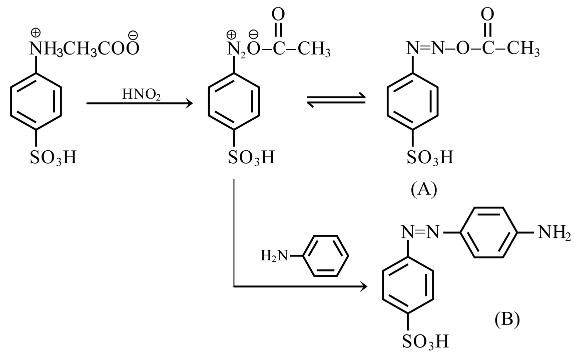
**56. (1)**

**Sol:**



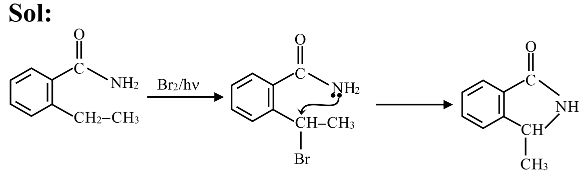
**57. (1)**

**Sol:**

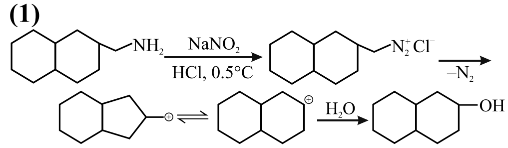


**58. (3)**

**Sol:**



**59. (1)**



**60. (4)**

**Sol:** $CH_3CH_2CH_2CONH_2 \xrightarrow{Br_2 + NaOH}$
$CH_3CH_2CH_2NH_2$
Primary amines give positive carbylamine test

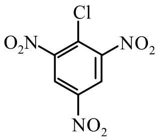
## Integer Type Questions (61 to 75)

**61. (28)**

**Sol:** $CH_3NH_2 + HNO_2 \xrightarrow{NaNO_2 + HCl} [CH_3N_2^+Cl]$
$$\xrightarrow{H_2O} CH_3OH + N_2\uparrow + HCl$$

**62.** **(1)**

**Sol:**



(Picryl Chloride) requires room temperature for hydrolysis because —$NO_2$ group increases the rate of nucleophilic substitution.

**63.** **(3)**

**Sol:** Conjugate acid at N (3) is resonance stabilized (guanidine type)

**64.** **(1)**

Statement (II) is incorrect.

**65.** **(3)**

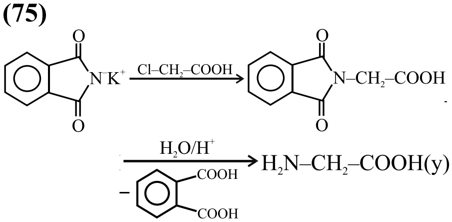
Only statement (III) is correct.

**66.** **(5)**

**Sol:** Five primary amines are possible for the molecular formula $C_4H_{11}N$.

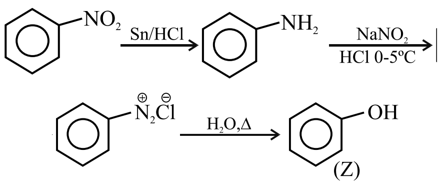
**67.** **(75)**

**Sol:**



**68.** **(94)**

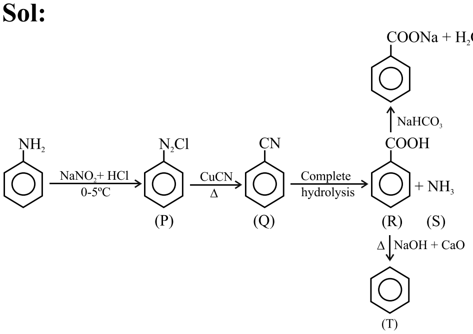
**Sol:**



Molecular weight of Z = 94

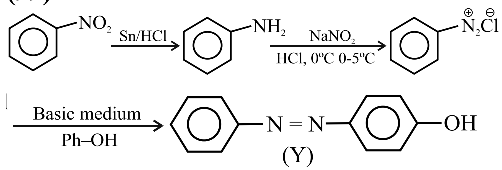
**69.** **(78)**

**Sol:**



**70.** **(99)**

**Sol:**



Molecular weight = 198

$$\frac{198}{2} = 99$$

**71.** **(5)**

**Sol:** By reaction with one mole of $CH_3 - \overset{O}{\overset{\|}{C}} - Cl$ with one $-NH_2$ group the molecular mass increases with 42 unit. Since the mass increases by (390 – 180) = 210 hence the number of $-NH_2$ groups is 5.

$RNH_2 + CH_3COCl$

$$\xrightarrow[(-HCl)]{} R - NH - \overset{O}{\overset{\|}{C}} - CH_3$$

**72.** **(4)**

**Sol.** Hoffmann bromamide degradation reaction

$$R - \overset{O}{\overset{\|}{C}} - NH_2 + Br_2 + 4\,NaOH \longrightarrow$$

$$R - NH_2 + Na_2CO_3 + 2NaBr + 2H_2O$$

1 mole bromine and 4 moles of NaOH are used per mole of amine produced.

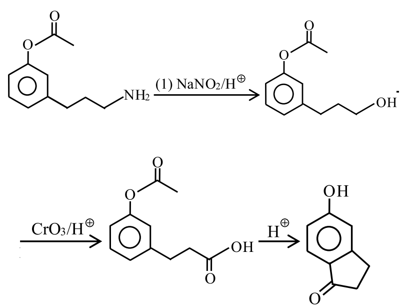
**73.** **(93)**

$$C_6H_5N_2^+Cl^- \xrightarrow{Zn/HCl} C_6H_5NHNH_2$$

$$\xrightarrow{Zn/HCl} C_6H_5NH_2$$

**74.** **(20)**

**Sol:**



**75.** **(1)**

$$CH_3 - CH_2 - \underset{NH_2}{\underset{|}{CH}} - CH_3 + HNO_2 \longrightarrow CH_3 - CH_2 - \underset{OH}{\underset{|}{CH}} - CH_3$$

# BIOMOLECULES

## Single Option Correct Type Questions (01 to 60)

**1.** **(1)**

**Sol:** N-terminal ← Val–Gly–Phe┼Val–Ala–Val → C-terminal
↓
N-terminal

**2.** **(1)**

**Sol:** In acidic (pH = 2) medium $NH_2$ groups accepts $H^+$.

**3.** **(1)**

**Sol:** The above phenomenon is called mutarotation in which specific rotation of the solution changes.

**4.** **(2)**

**Sol:** Aldehydes and α-hydroxy ketones give positive Tollen's test. Glucose has an aldehyde group and fructose is an α-hydroxy ketones.

**5.** **(3)**

**Sol:** Starch gives iodine test but cellulose does not.

**6.** **(1)**

**Sol:** Statements 2, 3 & 4 are correct by definition and concept.

**7.** **(1)**

**Sol:** Glucose and fructose can reduce Tollen's reagent.

**8.** **(1)**

**Sol:** If DNA segment is AATCAGTT then m-RNA segment is AAUCAGUU.

Here Thiamine is replaced by uracil.

**9.** **(4)**

**Sol:** Epimers are diastereomers which differs in configuration about only one chiral center.

**10.** **(3)**

**Sol:** For acidic amino acid.

$$P^I = \frac{P^{Ka_1} + P^{ka_3}}{2} = \frac{1.88 + 3.65}{2} = \frac{5.53}{2} = 2.77$$

For basic amino acids

$$P^I = \frac{P^{Ka_2} + P^{ka_3}}{2} = \frac{8.95 + 10.53}{2} = \frac{19.48}{2} = 9.74$$

**11.** **(3)**

**Sol:** When fructose is treated with dil. solution of an alkali, it undergoes reversible isomerization to form an equilibrium mixture of D-glucose, D-fructose and D-mannose.

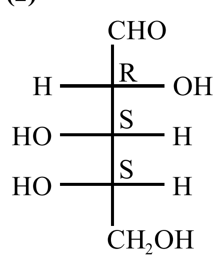
**12.** **(3)**

**Sol:** $$\underset{[\alpha]_D = +66.5^\circ}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow{HCl} \underset{\substack{\text{D-glucose} \\ [\alpha]_D = +52.5^\circ}}{C_6H_{12}O_6} + \underset{\substack{\text{D-fructose} \\ [\alpha]_D = -92.4^\circ}}{C_6H_{12}O_6}$$

Hydrolysis of sucrose to an equimolar mixture of D (+) glucose and D (–) fructose is accompanied by a change in the sign of optical rotation from dextro rotatory to laevorotatory, the overall process is called inversion of sugar

**13.** **(2)**

**Sol:**




**14.** **(4)**

**Sol:** Glucose exist in cyclic hemiacetal form hence do not respond these test.

**15.** **(2)**

**Sol:** $$>C=O+HCN \longrightarrow -\underset{|}{\overset{CN}{\overset{|}{C}}}-OH$$

(cynohydrin)

**16.** **(1)**

**Sol:** Starch is a polymers of α-glucose and amylose is a component of starch.

**17.** **(4)**

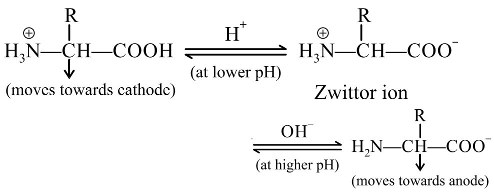
**Sol:** α-helical structure of protein is stabilized by straight H-bonds between imide group (–NH–) of one amino acid and carbonyl group (–CO–) of fourth amino acid residue.

**18.** **(4)**

**Sol:** Protein denaturation is disruption of stabilizing interchain bonds which destroy 3-dimensional form of proteins. The latter becomes non-functional.

**19.** **(4)**

**Sol:** The pH at which there is no net migration of the amino acid under the influence of an electric field is called isoelectric point. At this pH amino acid exist in the form of zwittor ion

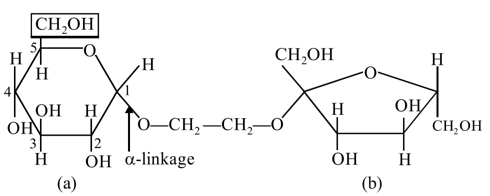



**20.** **(2)**

**Sol:** The complementary bases in DNA are adenine and thymine; guanine and cytosine.

**21.** **(1)**

**Sol:**




Ring (a) is six membered oxygen containing ring.

∴ Pyranose ring and $CH_2OH$ of C—5 and —OR of C—1 are across of one another hence, it is α-glycosidic linkage.

**22.** **(4)**

**Sol:** Glucose and fructose cannot be differentiated by Fehling solution because in alkaline medium an equilibrium mixture of D-glucose, D-fructose, and D-mannose.

**23.** **(1)**

**Sol:** Diastereomers which differ in configuration only at one C atoms

**24.** **(1)**

**Sol:**

$$C_6H_{12}O_6 + \text{Tollen's reagent} \rightarrow (C_6H_{11}O_7)^- + \underset{\text{Silver mirror of Silver element}}{Ag\downarrow}$$

**25.** **(2)**

**Sol:** Monosaccharide containing —CHO group with 6 carbon atoms is called aldohexose.

**26.** **(2)**

**Sol:** Anomer differ in configuration at C-1

**27.** **(2)**

**Sol:** Glycine ($H_2NCH_2NH_2$) do not contain chiral carbon.

**28.** **(3)**

**Sol:** Hydrogen bond

**29.** **(1)**

**Sol:** Vitamin $B_6$ is as also known as Pyridoxine

**30.** **(3)**

**Sol:** In DNA two strands are not identical.

**31.** **(4)**

**Sol:** I-P, Q ; II-P, S ; III-P, R, T ; IV-P, T

**32.** **(2)**

**Sol:** I-Q, R ; II-S ; III-Q ; IV-P

**33.** **(2)**

**Sol:** 3 molecule of phenylhydrazine is used in Osazone formation in which two molecules reacts in similar manner whereas the third reacts in different way.

**34.** **(3)**

**Sol:**

$$C_6H_{12}O_6 + \text{Fehlings solution} \rightarrow \underset{\text{luconic acid}}{(C_6H_{11}O_7)^-} + \underset{\text{(Raddish brown ppt.)}}{Cu_2O}$$

**35.** **(3)**

**Sol:** Cellulose is a linear polymer of D-glucose which on hydrolysis produces D-glucose.

**36.** **(3)**

**Sol:** Hydrogen bonding

**37.** **(2)**

**Sol:** Insulin is a peptide hormone

**38.** **(2)**

**Sol:** The pyrimidine bases present in DNA are Cytosine and thymine

**39.** **(3)**

**Sol:** Anomer differ in configuration at C-1

**40.** **(1)**

**Sol:** The secondary structure of protein refers to α-helical or β-pleated backbone.

**41.** **(2)**

**Sol:** α-D-(+)-glucose and β-D-(+)-glucose are anomers as they differ in configuration at C-1

**42.** **(3)**

**Sol:** The change in the optical rotation of freshly prepared solution of optical active substance is known as Mutarotation

**43.** **(3)**

**Sol:** Glycine ($H_2NCH_2NH_2$) is an optically inactive.

**44.** **(1)**

**Sol:** Vitamin C is water soluble.

**45.** **(3)**

**Sol:** $C_6H_{12}O_6 + HI \rightarrow \text{n-Hexane}$

**46.** **(4)**

**Sol:** Sucrose do not contain free anomeric –OH group.

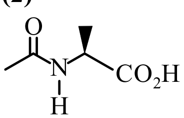
**47.** **(3)**

**Sol:** $pI = \dfrac{1.88 + 3.65}{2} = 2.77$

**48.** **(4)**

**Sol:** α-D-glucose and β-D-glucose are anomers

**49.** **(2)**

**Sol:** 

lone pair of N-atom is delocalised hence, nitrogen have no ability to accept $H^+$.

**50.** **(1)**

**Sol:** Compare the pI values (Asp < Gly < Lys < Arg)

**51.** **(1)**

**Sol:** Given tripeptide is made up of valine, serine and Threonine amino acids.

**52.** **(2)**

**Sol:** I-Q; II-P; III-S; IV-R

**53.** **(1)**

**Sol:** Ring structure of glucose is due to formation of hemiacetal and ring formation between $C_1$ and $C_5$

**54.** **(4)**

**Sol:** $NH_2CH_2CH_2CH_2CH_2\underset{\displaystyle NH_2}{\underset{|}{C}}HCOOH$ (Lysine)

contain 2 amino group

**55.** **(1)**

**Sol:** I-Q ; II-P ; III-S ; IV-R

**56.** **(1)**

**Sol:** During denaturation only weak bond like H-bond are broken.

**57.** **(4)**

**Sol:** Theoretical

**58.** **(3)**

**Sol:** $pI = \dfrac{6.04 + 9.14}{2} = 7.59$ which is near to given pH = 8 hence it exist an zwitter ion.

**59.** **(1)**

**Sol:** I & II are anomer as they differ in configuration at C-1.

**60.** **(3)**

**Sol:** A pair of diastereomeric aldoses which differ in configuration except at C-1 is called epimers.

## *Integer Type Questions (61 to 75)*

**61.** **(6)**

**Sol:** $pH_2 = \dfrac{pk_{a_1} + pk_{a_2}}{2} = \dfrac{2.34 + 9.66}{2} = 6$

**62. (4)**

**Sol:** $—CH(OH) + CH_3COCl \longrightarrow$

$—CH—O—\overset{\overset{\displaystyle O}{||}}{C}—CH_3$ for every acetylation, molecular mass increases by (12 + 16 + 14) = 42.

$\therefore$ number of —OH groups

$= \dfrac{318-150}{42} = 4$

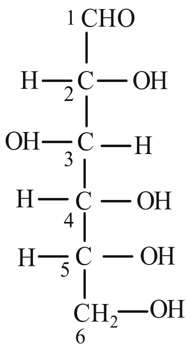
**63. (4)**

**Sol:** $pI = \dfrac{pKa(\beta)+pKa(\gamma)}{2}$

$= \dfrac{-\log(10^{-5})-\log(10^{-3})}{2} = 4$

**64. (4)**

**Sol:**




$C_2, C_3, C_4$ & $C_5$ are chiral

**65. (3)**

**Sol:**

$CHO - (CH_2-OH)_4 - CH_2-OH$ (glucose)

$CH_2-OH - C=O - (CH-OH)_3 - CH_2-OH$ (fructose)

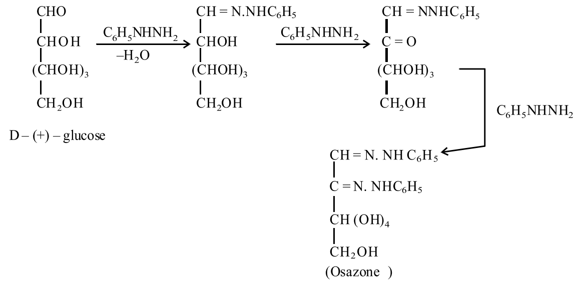
**66. (11)**

**Sol:** 2 + 4 + 5 = 11

Depends upon number of –OH group.

**67. (3)**

**Sol:**




**68. (6)**

**Sol:** Six tripeptides are possible from three different amino acids

**69. (3)**

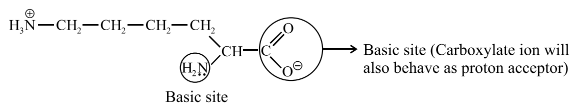
**Sol:** Tripeptide made up of three amino acids.

**70. (2)**

**Sol:** Aspartic acid and glutamic acids are acidic amino acids.

**71. (2)**

**Sol:**




**72. (8)**

**Sol:** Total no. of optical isomers = $2^n = 2^3 = 8$.

**73. (4)**

**Sol:** A pentapeptide has five amino acids joined by four peptide bonds.

**74. (8)**

**Sol:** Sucrose gives octaacetyl derivative.

**75. (4)**

**Sol:** Valine, Leucine, Isoleucine, Threonine.