All India Test Series (JEE–2024)

AVJLM1/04 | **Test- 04** | **Lakshya JEE**

DURATION : 180 Minutes | **DATE : 31/12/2023** | **M.MARKS : 300**

Topics Covered

Physics:	Electric charges and field, Electrostatic potential and Capacitance, Current Electricity, Moving Charges and Magnetism, Magnetism and Matter, Electromagnetic Induction, Alternating Current, Electromagnetic Waves, Ray Optics and Optical Instruments, Wave Optics, Dual nature of radiation and matter, Atomic physics, Nuclear physics, Semiconductor Electronics Materials, Devices and Simple Circuits
Chemistry:	The P-Block Elements, D & F - Block Elements, Coordination compounds, Haloalkanes and Haloarenes, Alcohols, Phenols and Ether, Solutions, Aldehyde, Ketones and Carboxylic Acids, Chemical kinetics, Organic compounds containing nitrogen, Biomolecules, Electrochemistry, Salt Analysis
Mathematics:	Determinants, Matrices, Relations & Functions, Inverse Trigonometric Functions, Limit of Functions, Continuity & Differentiability, MOD, Application of Derivatives, Indefinite Integration, Definite Integration, Application of Integrals, Differential Equations, Vector Algebra, Three Dimensional Geometry, Probability

General Instructions:

1. Immediately fill in the particulars on this page of the test booklet.
2. The test is of **3 hours** duration.
3. The test booklet consists of 90 questions. The maximum marks are **300**.
4. There are three sections in the question paper, Section I, II & III consisting of Section-I **(Physics),** Section-II **(Chemistry),** Section-III **(Mathematics)** and having **30 questions** in each part in which first **20** questions are compulsory and are of Objective Type and last **10** questions are integer type with answers ranging from **'0'** to **'999'** where answer needs to be rounded off to the nearest integer. Only 5 questions have to be attempted out of the last 10 questions of each section.
5. There is only one correct response for each objective type question.
6. Each correct answer will give **4** marks while **1** Mark will be deducted for a wrong response of Objective type Questions.
7. No student is allowed to carry any textual material, printed or written, bits of papers, pager, mobile phone, any electronic device, etc. inside the examination room/hall.
8. On completion of the test, the candidate must hand over the Answer Sheet to the Invigilator on duty in the Room/Hall. However, the candidates are allowed to take away this Test Booklet with them.
9. **Do not fold or make any stray mark on the Answer Sheet (OMR).**

OMR Instructions:

1. Use blue/black dark ballpoint pens.
2. Darken the bubbles completely. Don't put a tick mark or a cross mark where it is specified that you fill the bubbles completely. Half-filled or over-filled bubbles will not be read by the software.
3. Never use pencils to mark your answers.
4. Never use whiteners to rectify filling errors as they may disrupt the scanning and evaluation process.
5. Writing on the OMR Sheet is permitted on the specified area only and even small marks other than the specified area may create problems during the evaluation.
6. Multiple markings will be treated as invalid responses.
7. **Do not fold or make any stray mark on the Answer Sheet (OMR).**

Name of the Student (In CAPITALS) : _____

Roll Number : _____

OMR Bar Code Number : _____

Candidate's Signature : _____ **Invigilator's Signature** _____

IMPORTANT CONSTANTS

Speed of light in free space,	:	$3.00 \times 10^{8}\ ms^{-1}$
Permeability of free space,	:	$4\pi \times 10^{-7}\ Hm^{-1}$
Permittivity of free space,	:	$8.85 \times 10^{-12}\ Fm^{-1}$
The Planck constant,	:	$6.63 \times 10^{-34}\ Js$
Rest mass of electron,	:	$9.1 \times 10^{-31}\ kg$
Rest mass of proton,	:	$1.67 \times 10^{-27}\ kg$
Molar gas constant,	:	$8.31\ JK^{-1}\ mol^{-1}$
The Avogadro constant,	:	$6.02 \times 10^{23}\ mol^{-1}$
The Boltzmann constant,	:	$1.38 \times 10^{-23}\ JK^{-1}$
Gravitational constant,	:	$6.67 \times 10^{-11}\ N\ m^2kg^{-2}$
Acceleration of free fall	:	$9.8\ ms^{-2}$
Rydberg Constant	:	$1.097 \times 10^{7}\ m^{-1}$
Atomic mass unit	:	$1.67 \times 10^{-27}\ kg$
Charge on proton	:	$1.6 \times 10^{-19}\ C$

IMPORTANT VALUES

$\sqrt{2}$ = 1.414

$\sqrt{3}$ = 1.732

$\sqrt{5}$ = 2.236

π = 3.142

e (Euler's constant) = 2.718

ln 10 = 2.303

$\log_{10}2$ = 0.3010

$\log_{10}3$= 0.4770

$\log_{10}7$ = 0.845

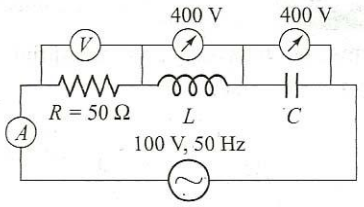
**** Use above values unless otherwise specified in a question.***

❑❑❑

SECTION-I (PHYSICS)

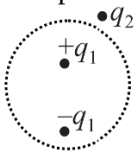
Single Correct Type Questions

1. In the series *LCR* circuit shown, three ideal AC hotwire voltmeters are attached across Inductor, capacitor and resistor. With the inductor and capacitor voltmeter readings as shown, what is the reading of voltmeter *V* and hotwire ammeter *A*.



(1) $V = 100\,\text{V}, I = 2\,\text{A}$
(2) $V = 100\,\text{V}, I = 5\,\text{A}$
(3) $V = 1000\,\text{V}, I = 2\,\text{A}$
(4) $V = 300\,\text{V}, I = 1\,\text{A}$

2. In the shown charge configuration with a special gaussian surface (represented by a dotted boundary engulfing charge $+q_1$ and $-q_1$ inside it) the electric field at any point on the gaussian surface will be due to (q_1 and q_2 are positive constants)



(1) Charge q_2 only
(2) Positive charges only
(3) Due to all charges (q_2, $+q_1$, $-q_1$)
(4) Only charges engulfed withing the Gaussian surface

3. When an isolated conducting spherical shell hung from a ceiling with a long insulting thread is exposed to radiations of frequency $\frac{c}{\lambda_1}$ (c is speed of light wave), the stopping potential required is equal to *V*. If the radiation wavelength is had been λ_2, stopping potential required was thrice the previous value. If *e* is the magnitude of charge on an electron, then what is required stopping potential if the radiation wavelength had been λ_3. (Assume all radiations of wavelength λ_1, λ_2 and λ_3 were capable to give photoelectric effect)

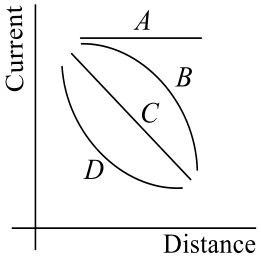
(1) $\frac{hc}{e}\left[\frac{1}{2\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{\lambda_1}\right]$
(2) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{2\lambda_1}\right]$
(3) $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{3}{2\lambda_2}-\frac{1}{2\lambda_1}\right]$
(4) $\frac{hc}{e}\left[\frac{3}{2\lambda_3}-\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right]$

4. The frequency of light wave in a material is 2×10^{14} Hz and wavelength is 5000 Å. The refractive index of material will be :
(1) 1.40 (2) 1.50
(3) 3.00 (4) 1.33

5. A parallel plate ideal capacitor of capacitance *C*, charged to potential *V* is connected across a battery of emf 2*V* with initial opposite polarity. If energy lost during the time interval of connection with 2*V* potential battery is *x* time than the final energy stored on the capacitor, then value of *x* is equal to _____. (Assume that connection with 2*V* potential battery is maintained till steady state is achieved)
(1) 1.75 (2) 2.25
(3) 2.5 (4) 0.50

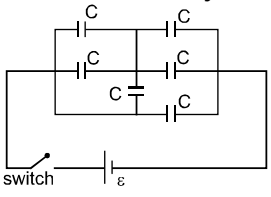
6. A point source consuming electrical power of 1500W radiates it all out as EM Wave of same wavelength uniformly in all directions. The peak value of electric field at a distance of 3 m from the point source (in Vm^{-1}) is equal to
(1) 500 (2) 100
(3) $\frac{500}{3}$ (4) $\frac{250}{3}$

7. The graph shown in the figure *A*, *B*, *C* and *D* attempt to depict the variation of the photo current from a small metal plate with respect to its distance from a point light source. Which of the graphs most appropriately represents the relation?



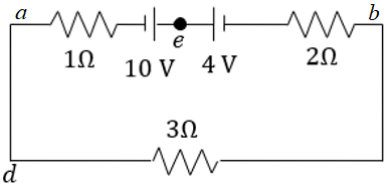
(1) A (2) B
(3) C (4) D

8. In the circuit shown below, what is the charge that will flow through the switch after it is closed. All the six capacitors used in the circuit are of identical nature and capacitance *C*. (Assume all the capacitors were initially uncharged)



(1) $\frac{23C\varepsilon}{5}$ (2) $\frac{11\,C\varepsilon}{5}$
(3) $\frac{17\,C\varepsilon}{5}$ (4) $\frac{4\,C\varepsilon}{5}$

9. Which of the following options gives the correct magnitude and direction of flow of the current in the circuit as shown in the diagram below?



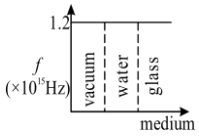
(1) $\frac{7}{3}$ A from a to b via e

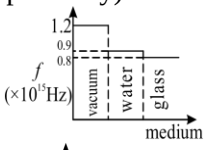
(2) $\frac{7}{3}$ A from b to a via e

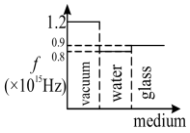
(3) 1 A from b to a via e

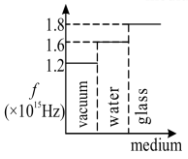
(4) 1 A from a to b via e

10. Electromagnetic waves of frequency 1.2×10^{15} Hz enters into water and subsequently into glass from vacuum. Which of the following graphs correctly represents the variation of frequency f with medium? (Given that indices of refraction for water and glass are 4/3 and 3/2 respectively).

(1) 

(2) 

(3) 

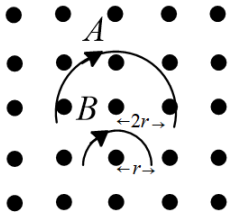
(4) 

11. In a standard YDSE setup slits are made at a separation of 0.5mm while the screen is kept at a separation of 0.5m from the plane carring the slit. Which of the following options gives the most approximate value of distance between 3rd maxima and 2nd minima created on the opposite side of central maxima using monochromatic light of wavelength 5000Å?

(1) 2.75 mm (2) 2.5 mm

(3) 22.5 mm (4) 2.25 mm

12. As shown in the figure two identically charged particles A and B of masses m_A and m_B, projected with velocity u_A and u_B respectively in plane perpendiculars to the lines of uniform magnetic field, present in the region, move along the circular paths of radii 2r and r respectively. Chose the correct option from below.



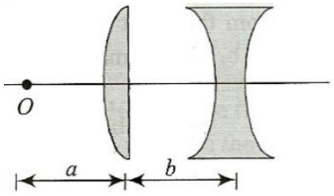
(1) $m_A v_A < m_B v_B$

(2) $m_A v_A > m_B v_B$

(3) $m_A < m_B$ and $v_A < v_B$

(4) $m_A = m_B$ and $v_A = v_B$

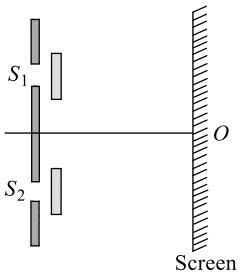
13. A thin concave lens of focal length 20 cm is placed at some distance from a coaxial thin convexo-plane lens ($\mu = 1.5$) with radius of curvature of its spherical surface equal to 10 cm as shown. At what distance an object should be kept on the opposite side of convexo- plane lens such that the position of final image from the thin concave lens is independent from the separation between two lenses.



(1) 40 cm (2) 60 cm

(3) 30 cm (4) 20 cm

14. In a standard *YDSE* setup two thin sheets of refractive indices 1.52 and 1.40 are placed infront of slits S_1 and S_2 respectively as shown. If both the films have same thickness of 10.4μm and the setup uses a while light sources with all wavelength between 400nm and 700nm available, then which of the following option has correct wavelength available that make maxima centre of screen at point O? (Assume refractive indices of sheets remains same for all the wavelengths in the given range)



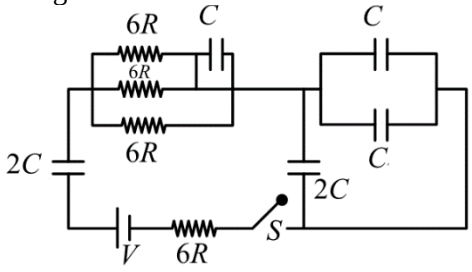
(1) 416 nm only

(2) 624 nm only

(3) 416 nm and 624 nm only

(4) None of these

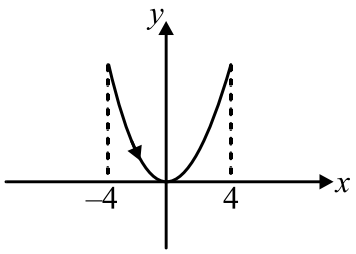
15. The circuit as shown below has three identical capacitors each of capacitance C and two other capacitors of capacitance 2C each. Which of the following options gives the correct value of time constant of the circuit after closing the switch. Assume that all the capacitors were initially uncharged.



(1) $3\,RC$ (2) $\frac{3RC}{5}$

(3) $\frac{32RC}{3}$ (4) None of these

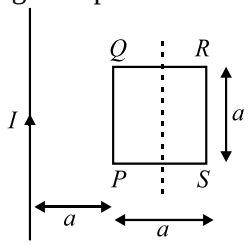
16. In gravity free space, a curved piece of wire of mass 0.2 kg (free to move) is placed in *xy* plane as shown, along the curve $y = 2x^2$ ($-4\text{m} \le x \le +4\text{m}$). A current of 4A is flown through the wire in direction of increasing *x*-coordinate. In this region of this wire a uniform magnetic field $\vec{B} = -0.04\hat{k}$ Tesla is switched on. The acceleration of wire (in m/s^2) is:



(1) $6.4\hat{j}$ (2) $-6.4\hat{j}$

(3) $-1.28\hat{j}$ (4) $12.8\hat{j}$

17. A long straight wire carrying current *I* is placed in a plane of a square loop *PQRS* of side length *a* and resistance *r* with its sides *PQ* and *RS* initially parallel to the straight wire as shown. What is the magnitude of charge that will flow through only cross- section of the loop during a 180° rotation of loop about an axis shown as dotted line which passes through midpoints of sides *QR* and *SP*.



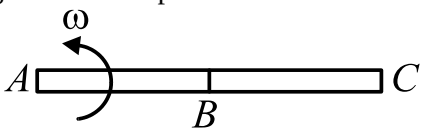
(1) $\frac{\mu_0 Ia}{2\pi r}\ln 2$

(2) $\frac{\mu_0 Ia}{\pi r}\ln 2$

(3) $\frac{\mu_0 Ia^2}{2\pi r}$

(4) Cannot be found because time of rotation is not given

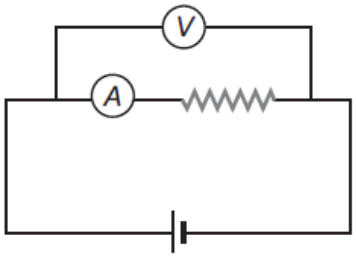
18. In the figure shown there is a non-conducting rod *AC* in which half part *AB* has no charge and part *BC* has uniform linear charge density of λ. If the rod rotates about its left end *A* with a constant angular velocity ω in the plane of the diagram, then magnetic field at point *A* will be:



(1) $\frac{\mu_0\omega\lambda}{4\pi}\ln 2$ (2) $\frac{\mu_0\omega\lambda}{\pi}\ln 3$

(3) $\frac{\mu_0\omega\lambda}{4\pi}\ln 6$ (4) $\frac{\mu_0\omega\lambda}{6\pi}\ln 2$

19. **Assertion:** On swapping the position of non- ideal ammeter and non- ideal voltmeter, (both built using identical galvanometers), from the shown position in the circuit, the ammeter reading will increase while the reading of voltmeter will decreases



Reason: Resistance of an ideal ammeter is zero while that of an ideal voltmeter is infinite.

Choose the correct option.

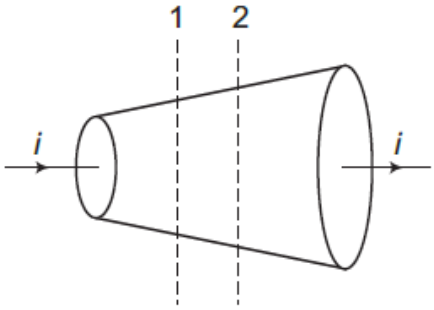
(1) If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

(2) If both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

(3) If Assertion is true, but the Reason is false.

(4) If Assertion is false but the Reason is true.

20. Current *i* is flowing through a wire of non-uniform cross-section as shown. Match the following two columns comparing various physical quantities for the wire at cross sections 1 and 2.



Column I		Column II	
A	Current density	P	is more at 1
B	Electric field	Q	is more at 2
C	Conductance per unit length	R	is same at both sections 1 and 2
D	Potential difference per unit length	S	data is insufficient

	A	B	C	D
(1)	P	Q	S	R
(2)	P	P	Q	P
(3)	Q	R	R	R
(4)	P	P	Q	Q

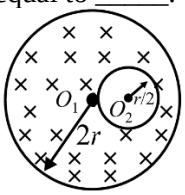
Integer Type Questions

21. The de- Broglie wavelength of an electron, with initial kinetic energy 100 eV, becomes xÅ after it is accelerated through a potential difference of 50V. The nearest integer value of x is equal to ___.

22. If the shortest wavelength in the Balmer series of hydrogen emission spectra is x than the shortest wavelength in its Brackett series will be Nx. Value of N is equal to____.

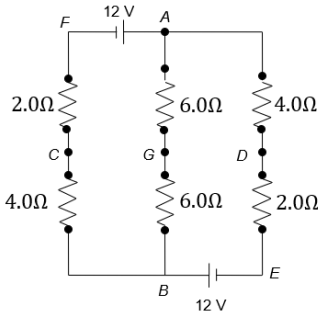
23. In a setup, two Polaroid's are oriented with their planes perpendicular to incident light and their transmission axes making an angle 60° with each other. Percentage of intensity of incident unpolarised light that gets transmitted through the setup is equal to x. Value of $2x$ is equal to _____.

24. A non conducting solid sphere centred at O_1 and of radius $2r$ has a spherical cavity centred at O_2 with radius $r/2$ as shown. The rest of the sphere left is uniformly charged with charged density ρ. The electric field inside the cavity is E_0. Now, an equal and opposite charge is distributed uniformly on the outer surface of the sphere. The magnitude of electric field inside the cavity becomes N times E_0. Value of N is equal to _____.



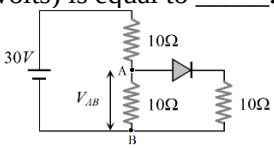
25. In, series LCR, AC circuit consisting of a capacitor with capacitance $C = 200$ μF and a coil with active resistance $R = 20$ Ω and inductance $L = 0.35$ H is connected to a source of alternating voltage with amplitude $V_m = 180$ volt and angular frequency ω = 100 rad/sec. The amplitude of voltage across the capacitor is _____volts.

26. In the circuit diagram shown below the potential difference (in V) between junction points A and B is equal to _____.

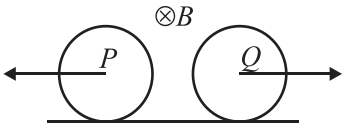


27. In a free space a point mass particle of mass 3m at rest initially blasts into two smaller particles of masses m and 2m with de-Broglie wavelength λ_1 and λ_2 respectively. Value of ratio $\frac{\lambda_2}{\lambda_1}$ is equal to _____.

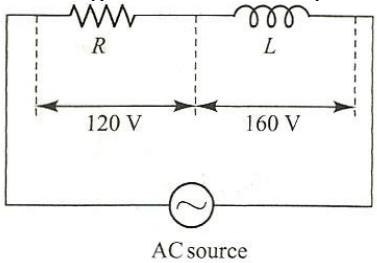
28. In the circuit with ideal diode as shown the magnitude of potential difference between points A and B (in volts) is equal to _____.



29. Two identical conducting rings P and Q of radius R are rolling over a horizontal conducting plane with same speed v but in opposite direction. A constant magnetic filed B is present pointing into the plane of paper. Then the potential difference between the highest points of the two rings is $NBvR$. The value of N is



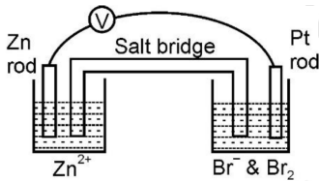
30. A series combination of a resistance of value R and an ideal coil of inductance L is put across an AC source such that the two component have voltage across them as shown in the figure. If the value of applied voltage is $2x$ then x is equal to ____volts.



SECTION-II (CHEMISTRY)

Single Correct Type Questions

31. Consider the following diagram representing a working galvanic cell



Which of the following decreases during the working of cell?

(1) $[Zn^{2+}]$, $[Br_2]$ & $[Br^-]$

(2) $[Br_2]$, mass of Zn rod, Mass of Pt rod

(3) $[Br_2]$, mass of Zn rod

(4) $[Br_2]$, $[Br^-]$, mass of Pt rod

32. Among the given options, identify the option representing incorrect statement?

(1) Ammonium salts on reaction with strong alkalies produce a non-inflammable gas.

(2) fac-$[Co(NO_3)_3(dien)]$ is achiral.

(3) Solid potassium dichromate and concentrated H_2SO_4 liberates chlorine gas with solid sodium chloride which is used to confirm presence of $Cl^{\ominus}$ ion.

(4) The increasing order of paramagnetic properties amongst VCl_3, $VOSO_4$, Na_3VO_4, $[V(H_2O)_6]\ SO_4.H_2O$ is $Na_3VO_4 < VOSO_4 < VCl_3 < [V(H_2O)_6]\ SO_4.H_2O$.

33. For a hydrogen half cell, reduction potential will be negative if (T = 298 K)

(1) P_{H_2} = 1 atm and $[H^+]$ = 1.0 M

(2) P_{H_2} = 2 atm and $[H^+]$ = 2.0 M

(3) P_{H_2} = 2 atm and $[H^+]$ = 1.0 M

(4) P_{H_2} = 1 atm and $[H^+]$ = 2.0 M

34. A hypothetical reaction :

$A_2 + B_2 \longrightarrow 2AB$ follows mechanism as given below :

$A_2 \underset{}{\overset{K_C}{\rightleftharpoons}} A + A$ ..... (fast)

(K_C is equilibrium constant)

$A + B_2 \xrightarrow{K_1} AB + B$ .....(slow)

(k_1 = rate constant)

$A + B \underset{k_3}{\overset{k_2}{\rightleftharpoons}} AB$ ..... (fast)

(k_2, k_3 are rate constant)

Give the rate law.

(1) $r = k_1 \sqrt{k_c}\ [A_2]^{1/2}\ [B_2]$

(2) $r = \frac{k_1}{k_c}\ [A_2]^{1/2}\ [B_2]$

(3) $r = \sqrt{k_1 k_c}\ [A_2]^{1/2}\ [B_2]$

(4) $r = \frac{k_1}{\sqrt{k_c}}\ [A_2]^{1/2}\ [B_2]$

35. 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 : $NH_3 > SbH_3 > AsH_3 > PH_3$

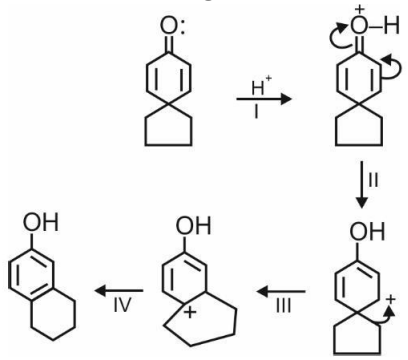
(c) Boiling point : $NH_3 > SbH_3 > AsH_3 > PH_3$

(d) Dipole moment order : $NH_3 > SbH_3 > AsH_3 > PH_3$

(1) FTFT (2) TFTF

(3) FFTT (4) FFTF

36. Consider the following mechanism.



Identify the correct statement.

(1) Step-II is the RDS of the reaction

(2) Step-III is the RDS of the reaction

(3) Overall ΔH of the reaction is positive

(4) In step-III, the degree of unsaturation is increased by one

37. Consider the following statements regarding the complex $[Co(NH_3)_4\ (NO_2)_2]\ (NO_3)$

(i) The complex shows only ionisation and geometrical isomerism

(ii) The 'spin only' magnetic moment of the complex is equal to that of $[V(CO)_6]^-$

(iii) As per crystal field theory, electronic configuration of the complex given is same as that of $[Mn[CN)_6]^{-3}$

(iv) The complex shows ionisation, linkage and geometrical isomerism As per the electronic distribution, it is known as an 'inner orbital complex

The option representing correct statements is:

(1) (i), (ii) only (2) (ii), (iii) only

(3) (ii), (iv) only (4) (iii), (iv) only

38. Decomposition of A(g) occurs according to the following equation and follows first order kinetics

$A(g) \rightarrow 4B(g) + C(g)$

A plot of log P_A versus time results with slope of -3.01×10^3 and a Y-intercept of 0.301. If the pressure is measured in atmospheres and time in seconds, the rate constant for the reaction is

(1) $2s^{-1}$

(2) $6.93 \times 10^3 s^{-1}$

(3) $3.01 \times 10^3 s^{-1}$

(4) $6.03 \times 10^3 s^{-1}$

39. On heating with NaOH solution and zinc, $NaNO_3$ liberates a gas which can also be obtained by:

(1) Heating NH_4NO_3.

(2) Heating NH_4NO_2 with sodium hydroxide solution.

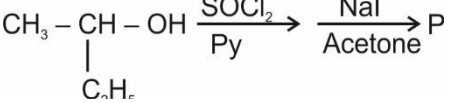
(3) Heating $(NH_4)_2Cr_2O_7$.

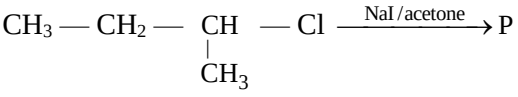
(4) Heating $Ca(NO_3)_2$.

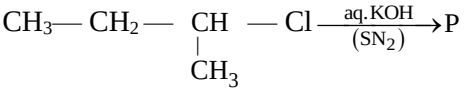
40. Among the compounds given in the options, identify the one which does not gives a precipitate with excess of both NaOH solution and NH_3 solution?

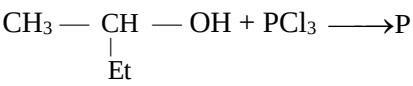
(1) $Pb(NO_3)_2$ (2) $Zn(NO_3)_2$
(3) $Al(NO_3)_3$ (4) $Cu(NO_3)_2$

41. Out of the following, in which retention of configuration in product P will take place?

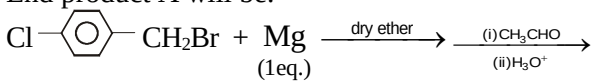
(1) 

(2) 

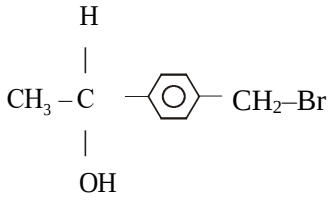
(3) 

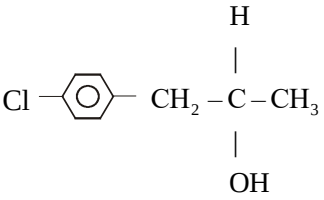
(4) 

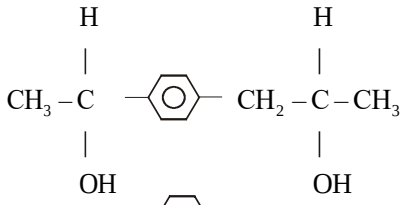
42. End product A will be.

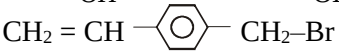


A

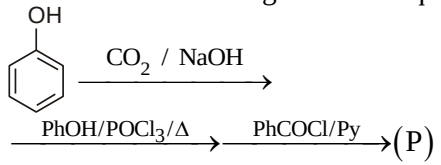
(1) 

(2) 

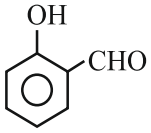
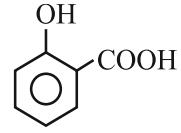
(3) 

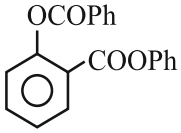
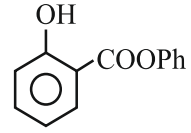
(4) 

43. Consider the following reaction sequence:



The final product (P) in the given reaction sequence is:

(1)  (2) 

(3)  (4) 

44. Monomer of cellulose is

(1) Fructose (2) Maltose
(3) Sucrose (4) Glucose

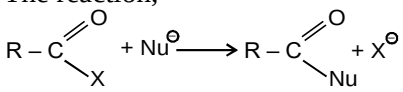
45. Consider the reactions sequence:

$CH_3–CH_2–C\equiv CH \xrightarrow{Na} X \xrightarrow{CH_3–I}$ Product

Final product in the above reaction sequence is:

(1) $CH_2=CH–CH_2–CH_2–CH_3$
(2) $CH_3–CH_2–C\equiv C–CH_3$
(3) $CH\equiv C–CH_2–CH_2–CH_3$
(4) $CH_3–CH_2–C\equiv C–CH_2–CH_3$

46. The reaction,



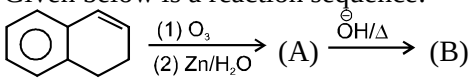
is fastest when X is:

(1) –Cl (2) $–NH_2$
(3) $–OC_2H_5$ (4) $–OCOCH_3$

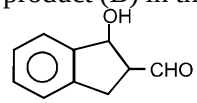
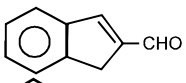
47. Among the acids given in the options, identify the acid which has maximum tendency to ionize in aqueous solution

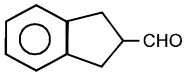
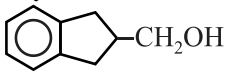
(1) HCOOH (2) CH_3COOH
(3) FCH_2COOH (4) $BrCH_2COOH$

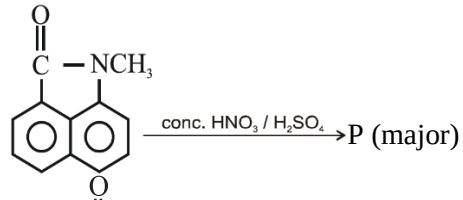
48. Given below is a reaction sequence:

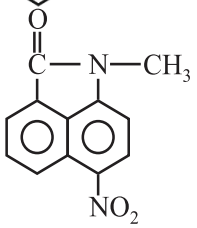


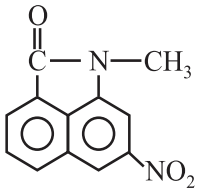
The product (B) in the above reaction sequence is:

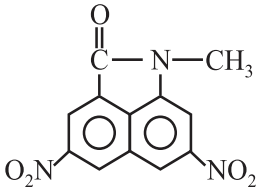
(1)  (2) 

(3)  (4) 

49. 

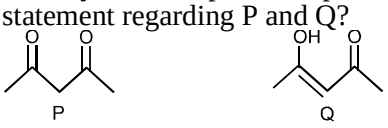
(1) 

(2) 

(3) 

(4) None of these

50. Identify the option representing **incorrect** statement regarding P and Q?



(1) P & Q are tautomers
(2) P & Q are positional isomers
(3) Q is a stable enol
(4) Q has resonance stability

Integer Type Questions

51. For 30% decomposition, a first order reaction takes 40 minutes. If $t_{1/2}$ (in min) is X, then $\frac{X}{11}$ is (Nearest integer) (Given log 7 = 0.845)

52. Consider the following reaction with their $\Delta G°$ value

$C + O_2 \rightarrow CO_2$, $\Delta G° = -395$ kJ/mole,

$$2Al(l) + \frac{3}{2}O_2 \rightarrow Al_2O_3(s), \Delta G° = -1269 kJ/mole$$

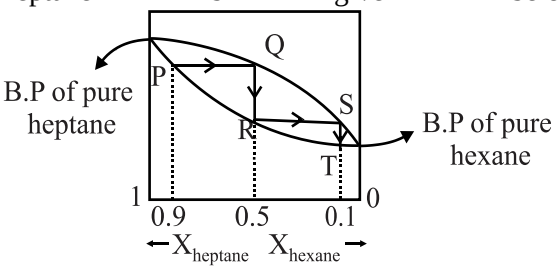
$Al_2O_3(s) \rightarrow Al_2O_3$ (melt), $\Delta G° = +16$ kJ/mole

Cell Reaction: $2Al_2O_3$ (melt) + $3C \rightarrow 4Al(l) + 3CO_2$ (g), If the EMF for the above cell reaction is – x V, then find 7x (nearest integer)

53. 5 g Na_2SO_4 is dissolved in 45 g H_2O. As a result of dissolution, the freezing point of H_2O decreases by – 3.82°C. If the Vant Hoff factor for Na_2SO_4 is y, then find 2y (Nearest integer)
(Given cryoscopic constant for H_2O (K_f) = 1.86 K kg mol^{-1})
(Atomic mass; H = 1; O = 16; Na = 23; S = 32)

54. Heptane and octane form an ideal solution on mixing. Vapour pressure of heptane (C_7H_{16}) and octane (C_8H_{18}) are 75 kPa and 50 kPa respectively at 373 K. The solution obtained by mixing 25 g of heptane and 35 g of octane has a vapour pressure of 'y' kPa. Find the value of 5y. (Nearest integer)

55. A graph of a solution containing hexane and heptane is given below.



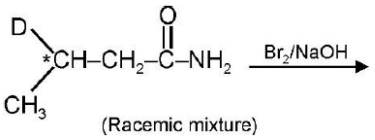
The mole fraction of heptane in vapour phase is x, when mole fraction of hexane in liquid phase is 0.1 at boiling point of the solution. The value of 4x is :
[Consider isobaric distillation as represented by the curve.]

56. Consider the following cell representation:
Pt(s) $|Br_2(l)|Br^{\ominus}(0.010)||H^{\oplus}(0.030M)|H_2(g)(1\ bar)|Pt(s)$
The EMF of the above cell at 298 K is – xV. Find 3x (nearest integer)
[Given $E^{\circ}_{\frac{1}{2}Br_2|Br^-}$ (Reduction potential of Br_2) = + 1.08V]

57. Total number of geometrical isomers for the complex $[RhBr(H_2O)(PPh_3)(NH_3)]$ is.

58. Consider the following polypeptide.
Gly – Ala – Val – Gly – Leu – Ile – Asp – Gly
After hydrolysis the number of different optically active amino acids obtained are x and different optically inactive amino acids are y then find $\frac{x}{y}$:

59. Consider the following reaction



(Racemic mixture)

How many different amines are obtained at the end of the reaction?

60. After disproportionation of one mole of MnO_4^{-2} ion, X moles of MnO_4^- and Y moles of MnO_2 are formed. Then (X + Y) is:

SECTION-III (MATHEMATICS)

Single Correct Type Questions

61. $\bar{a}, \bar{b}, \bar{c}$ are unit vectors such that $\bar{b}$ and $\bar{c}$ are perpendicular to each other and projections of $\bar{b}$, $\bar{c}$ along $\bar{a}$ are equal, then the value of $|\bar{c} - \bar{b} + 2\bar{a}|$ is equal to

(1) $\sqrt{3}$
(2) $\sqrt{6}$
(3) $2\sqrt{2}$
(4) 2

62. **Assertion (A):** $f_1(x) = 2x$, $f_2(x) = 3\sin x - x\cos x$ then for $x \in (0, \pi/2)$, $f_1(x) > f_2(x)$.

Reason (R): $h'''(x) > 0$, $h''(x) > 0$ and $h'(x) > 0$ for $x \in (0, \pi/2)$ and $h'''(0) = h''(0) = h'(0) = 0$ where $h(x) = f_1(x) - f_2(x)$

(1) Both (A) and (R) are true and (R) is correct explanation of (A).
(2) Both (A) and (R) true but (R) is not correct explanation of (A)
(3) (A) is true, (R) is false
(4) (A) is false (R) is true

63. A five digit number (having all different digits) is formed using the digits 1, 2, 3, 4, 5, 6, 7, 8 and 9. The probability that the formed number either begins or ends with an odd digit, is equal to

(1) $\frac{5}{6}$ (2) $\frac{1}{6}$
(3) $\frac{1}{3}$ (4) $\frac{2}{3}$

64. Locus of centroid of tetrahedron $OABC$ of volume 64 (where O is origin and A, B, C lies on x, y, z axis respectively) is $xyz = \lambda$, then

(1) $\lambda = 2$ (2) $\lambda = 6$
(3) $\lambda = 1$ (4) $\lambda = 4$

65. Let two points $A(\bar{a})$ and $B(\bar{b})$ are given then locus of a variable point $P(\bar{r})$ (where $\bar{r}$ is position vector of point P) such that $|\overline{PA}| = |\overline{PB}|$, is

(1) $\left(2\vec{r} - \left(\vec{a} + \vec{b}\right)\right).\left(\vec{a} + \vec{b}\right) = 0$
(2) $\left(2\vec{r} - \left(\vec{a} + \vec{b}\right)\right).\left(\vec{a} - \vec{b}\right) = 0$
(3) $\left(\vec{r} - \left(\vec{a} + \vec{b}\right)\right).\vec{a} = 0$
(4) $\left(\vec{r} - \left(\vec{a} + \vec{b}\right)\right).\vec{b} = 0$

66. The probabilities of solving a problem by students A, B and C independently are $\frac{1}{2}, \frac{1}{3}$, and $\frac{1}{4}$ respectively. If they start solving the given problem independently, then the probability that atleast two of them will solve the problem successfully, is equal to

(1) $\frac{5}{24}$ (2) $\frac{9}{24}$
(3) $\frac{7}{24}$ (4) $\frac{11}{24}$

67. $\begin{vmatrix} 1 & \cos(A-B) & \cos(A-C) \\ \cos(B-A) & 1 & \cos(B-C) \\ \cos(C-A) & \cos(C-B) & 1 \end{vmatrix}$ is equal to:

(1) 0 (2) 1
(3) –1 (4) 2

68. If $\lim\limits_{x \to 0^+} \frac{\frac{\pi}{2} - \sin^{-1}(1-x)}{\sqrt{x}} = l$, then

(1) $l = 1$ (2) $l^2 = 2$
(3) $l = 3$ (4) $l^2 = 4$

69. If 6 Boys and 5 Girls sit on a circle, then probability of no two girls sit together is given by

(1) $\frac{1}{42}$ (2) $\frac{1}{21}$
(3) $\frac{1}{7}$ (4) $\frac{1}{6}$

70. $\int (2\cos x + 3)(3\cos x + 2)^{-2}\, dx$ is equal to

(1) $\frac{1}{2\operatorname{cosec} x + 3\cot x} + C$
(2) $\frac{1}{3\operatorname{cosec} x + 2\cot x} + C$
(3) $\frac{1}{2\operatorname{cosec} x - 3\cot x} + C$
(4) $\frac{1}{3\operatorname{cosec} x - 2\cot x} + C$

71. Relation R is defined by $R = \{(a, b) \mid a - b + \sqrt{3}$ is an irrational number$\}$ on real numbers, then relation R is

(1) only reflexive
(2) only reflexive and symmetric
(3) only reflexive and transitive
(4) Equivalence

72. Which of the following relation R on set of natural numbers is not symmetric?

(1) $R = \{(a, a); a \in N\}$
(2) $R = \{(1, 1), (2, 2), (3, 3)\}$
(3) $R = \{(1, 2), (2, 1), (1, 1)\}$
(4) $R = \{(-1, 2), (2, -1), (1, 2), (2, 1)\}$

73. If matrix $A = \begin{bmatrix} 1 & x & x^2 \\ x & x^2 & 1 \\ x^2 & 1 & x \end{bmatrix}$ and

$B = \begin{bmatrix} x^3 - 1 & 0 & x - x^4 \\ 0 & x - x^4 & x^3 - 1 \\ x - x^4 & x^3 - 1 & 0 \end{bmatrix}$, then correct option is

(1) $|B| = |A|$
(2) $|B| = |A|^2$
(3) $|B|^2 = |A|$
(4) $|B| = |A|^3$

74. Area bounded by curve $y^2 = \frac{2-x}{x}$ with $x = 0$ is

(1) 2π (2) π

(3) π^2 (4) $\frac{\pi}{2}$

75. The function $f(x) = \cos(|x|) - |x^2 - 3x + 2|\,(1 - x^2)$ is

(1) differentiable for $x \in R$

(2) not differentiable at $x = 0, 1, 2$

(3) not differentiable at $x = 1, 2$

(4) not differentiable at $x = 2$

76. If a vector $\vec{r}$ is such that $\vec{r} \times \left(\hat{i} + 2\hat{j} - \hat{k}\right) = \left(\hat{i} + \hat{k}\right)$ then $\vec{r}$ can be

(1) $-2\hat{i} - 5\hat{j} + \hat{k}$ (2) $\hat{i} - \hat{j} + 3\hat{k}$

(3) $2\hat{i} + 5\hat{j} - \hat{k}$ (4) $3\hat{i} + 5\hat{j} - 3\hat{k}$

77. If $\int \left(\frac{x^2 + 3(x+1)}{(x+2)^2}\right) e^x dx = e^x f(x) + c$, then range of $f(x)$ does not contain

(1) 0 (2) 1

(3) 2 (4) –1

78. The function $f(x) = x^3 + x^{-3}$ is

(1) one-one and onto

(2) many one and onto

(3) one-one and into

(4) many-one and into

79. Equation of the curve having $\frac{dy}{dx} = -1$ at a point $A(1, 1)$ and satisfying the differential equation $x\frac{d^2y}{dx^2} + \frac{dy}{dx} = \ln x$, is

(1) $y = x\ln x + x + 3$

(2) $y = x\ln x + 3$

(3) $y = x\ln x + 2x - 3$

(4) $y = x\ln x - 2x + 3$

80. If $x + \frac{a}{x^2} > 3$ for $x \in (0, \infty)$, then

(1) $a > 0$ (2) $a > -1$

(3) $a > 4$ (4) $a > 2$

Integer Type Questions

81. If range of $f(x) = \sin\left(\tan^{-1}\left(\cos\left(\cot^{-1} x\right)\right)\right)$ is (α, β) then $\alpha + \beta$ is

82. If $y = f(z)$, $z = \frac{2x-1}{x^2+1}$, $f'(z) = \sin z^2$, then value of $\frac{dy}{dx}$ at $x = \frac{1}{2}$ is equal to

83. The digits 1, 2, 3, 4, 5, 6, 7, 8 and 9 are written in random order to form a nine digit number. Let p be the probability that this number is divisible by 36. Then the value of $36p$ is

84. If the equations of curve passing through (3, 4) and satisfying the differential equation $y\left(\frac{dy}{dx}\right)^2 + (x - y)\frac{dy}{dx} - x = 0$ are $x^2 + cy^2 = k$ and $x + by + c = 0$, then $k + b^3 + c^3$ is

85. If $I_1 = \int_0^{-1} e^{(x+1)^2} dx$ and $I_2 = 3\int_{1/3}^{2/3} e^{9\left(x-\frac{2}{3}\right)^2} dx$, then $I_1 + I_2$ is

86. Let $f : R \to \left(0, \frac{\pi}{2}\right]$ defined by $f(x) = \text{cosec}^{-1}(ax^2 - 2px + 4)$ where $a, p \in N$ is surjective then find smallest value of $\frac{20}{3}(a + p)$.

87. Let $f(x) = \left(-x^2 - 2x + k\right)^{\frac{1}{2}}$ has at least 5 positive integers in domain, then minimum value of k is

88. Let $A = \begin{bmatrix} 0 & \alpha \\ 0 & 0 \end{bmatrix}$, and $(A + I)^{80} - 80A = \begin{bmatrix} a+1 & b+1 \\ c+1 & d-200 \end{bmatrix}$, then value of $a + b + c + d$ is

89. Let $P(\alpha, 0, 0)$ be the foot of perpendicular of the point $Q(-1, 2, 6)$ on line $\frac{2-x}{6} = \frac{3-y}{3} = \frac{z+4}{4}$. If $b = \left|\overrightarrow{PQ}\right|$, then $\alpha + b$ is equal to

90. Let $I_1 = \int_0^{\pi} f(x)\sin x\, dx$ and $I_2 = \int_0^{\pi} f''(x)\sin x\, dx$ (where $f(x)$ is continuous function in $[0, \pi]$). If $I_1 + I_2 = 5$ and $f(\pi) = 2$, then $10\,f(0)$ is equal to