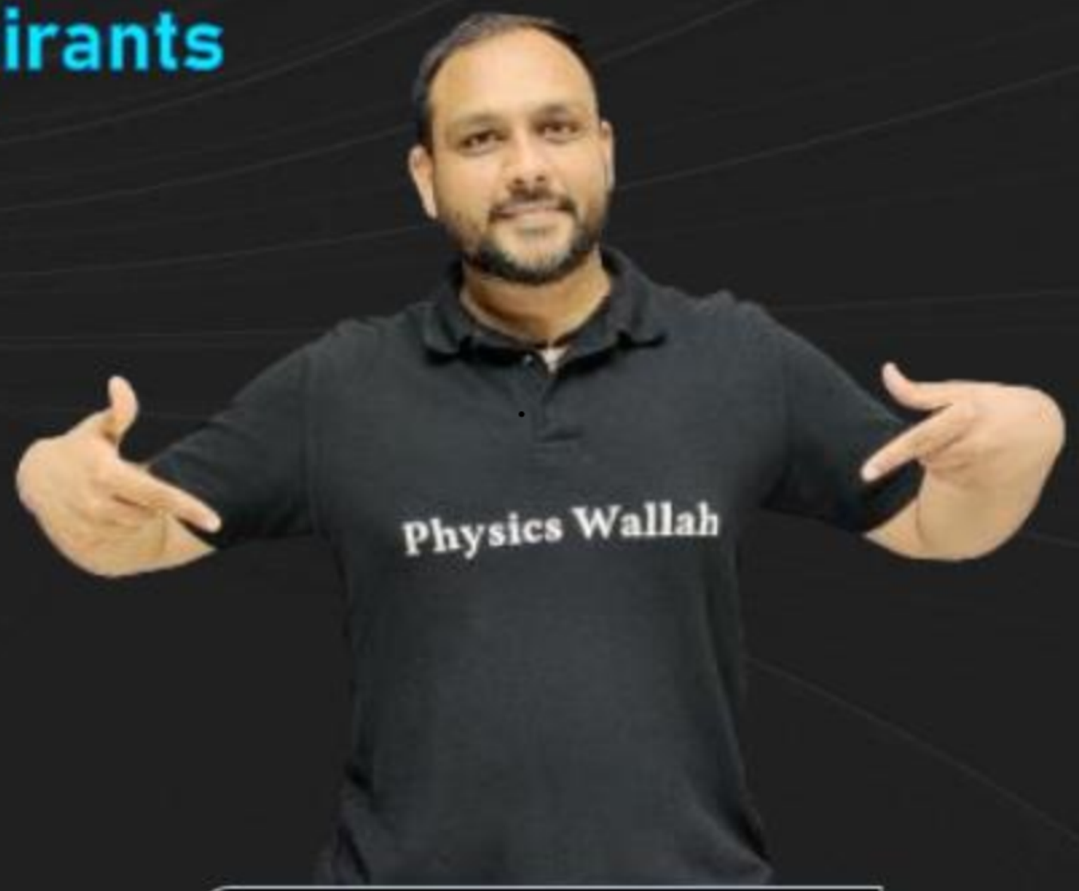
Complete Chapter

For NEET Aspirants

HYDROCARBON



By- Yogesh Jain Sir

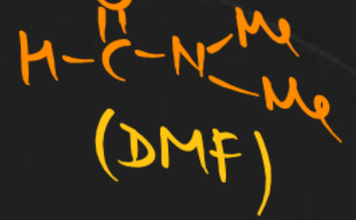
Topics to be covered

- Alkane ✓
- Alkene ✓
- Alkyne ✓
- Aromatic Hydrocarbon ✓

Basic organic Chemistry

Substrate + Reagent $\xrightarrow{\text{Solvent}}$ Product

Solvent

- Non-polar solvent ($\mu = 0$)
  - CCl_4, CBr_4, CS_2,  etc.
- ($\mu \neq 0$) Polar solvent
  - Polar protic solvent (PPS)
    - (H–F|O|N)
    - H_2O, R–OH, NH_3, H–F, R–C(=O)–OH etc.
  - Polar aprotic solvent (PAS)
    - (H✗F|O|N)
    - Ex: CH_3-O-CH_3, $CH_3-C(=O)-CH_3$,  (DMSO),  (THF),  (DMF)

$E^{\oplus}$ * $e^{\ominus}$ deficient specie
* $e^{\ominus}$ loving specie

$Nu^{\ominus}$ * $e^{\ominus}$ rich specie
* Nucleus loving specie

डाकू All $\oplus$ ve charge specie

$H^{\oplus}$, $R^{\oplus}$, $\overset{\oplus}{C}H_3$, $\overset{\oplus}{N}O_2$, $\overset{\oplus}{N}O$, $\overset{\oplus}{X}$ etc.

जल्लाद All $\ominus$ ve charge specie

$H^{\ominus}$, $\overset{\ominus}{N}H_2$, $\overset{\ominus}{O}H$, $\overset{\ominus}{S}H$, $\overset{\ominus}{X}$ etc.

चोर All free radical specie

$H^{\odot}$, $R^{\odot}$, $\overset{\odot}{C}H_3$, $\overset{\odot}{O}H$, $\overset{\odot}{X}$ etc.

कोड़ि All l.p. containing specie

$H_2\ddot{O}:$, $\ddot{N}H_3$, $R-\ddot{\underset{..}{O}}H$, $R-\ddot{N}H_2$ etc.

भिखारी All vacant p/d-orbital specie

BH_3, $AlCl_3$, $FeCl_3$, $SbCl_5$ etc.

लखपति π-bond containing specie

$CH_2=CH_2$, $CH\equiv CH$,  etc.

आम आदमी Miscellaneous

$(Br-Br)$

Role of Solvent (Like dissolve Like)

Non-polar solvent

$\overset{\oplus}{Na}\overset{\ominus}{Cl}$ + 

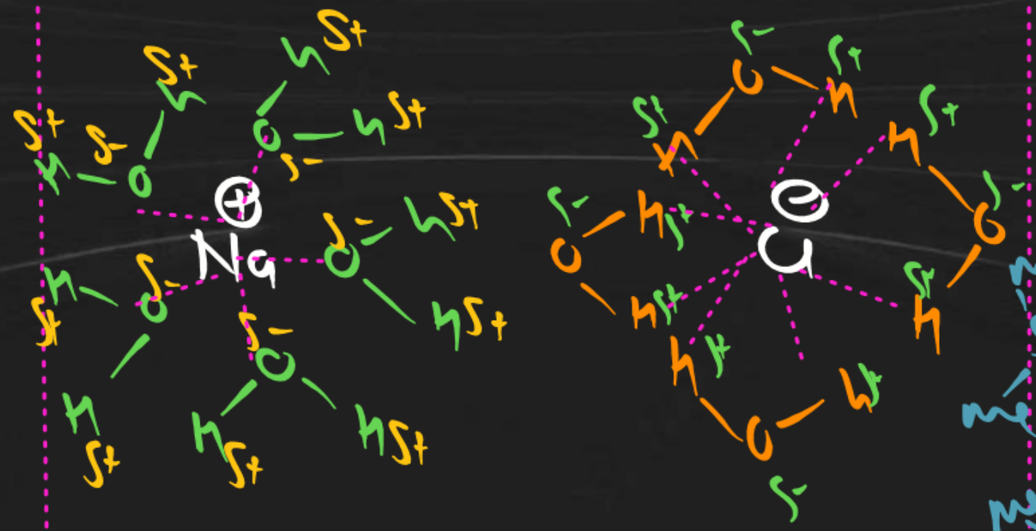
↓

Both cation & anion are Insoluble

Polar protic solvent (PPS)

$\overset{\oplus}{Na}\overset{\ominus}{Cl} + H_2O \longrightarrow$

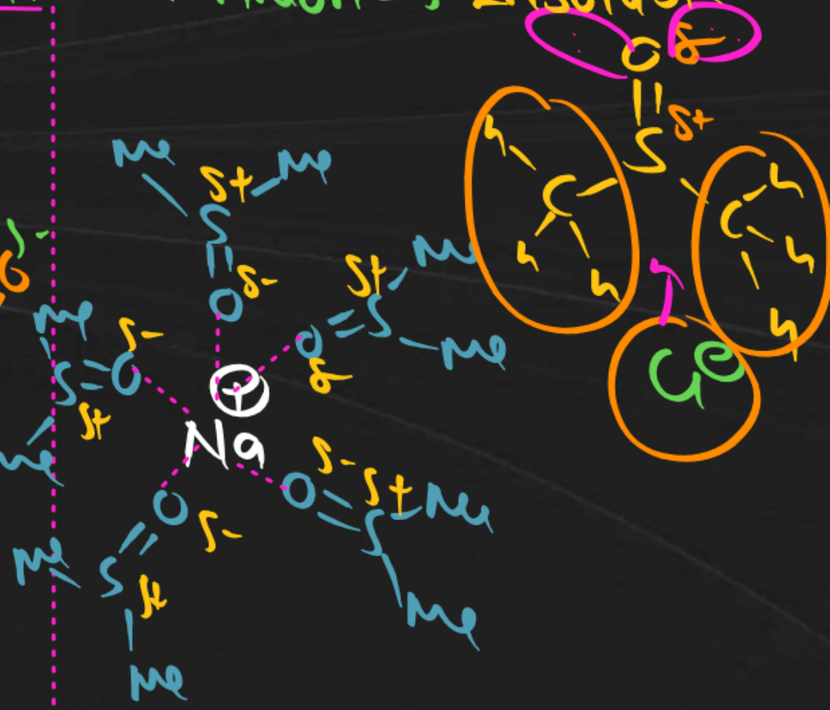
Both cation & anion are Soluble



Polar aprotic solvent (PAS)

$\overset{\oplus}{Na}\overset{\ominus}{Cl}$ + DMSO $\longrightarrow$

* Cation → Soluble
* Anion → Insoluble

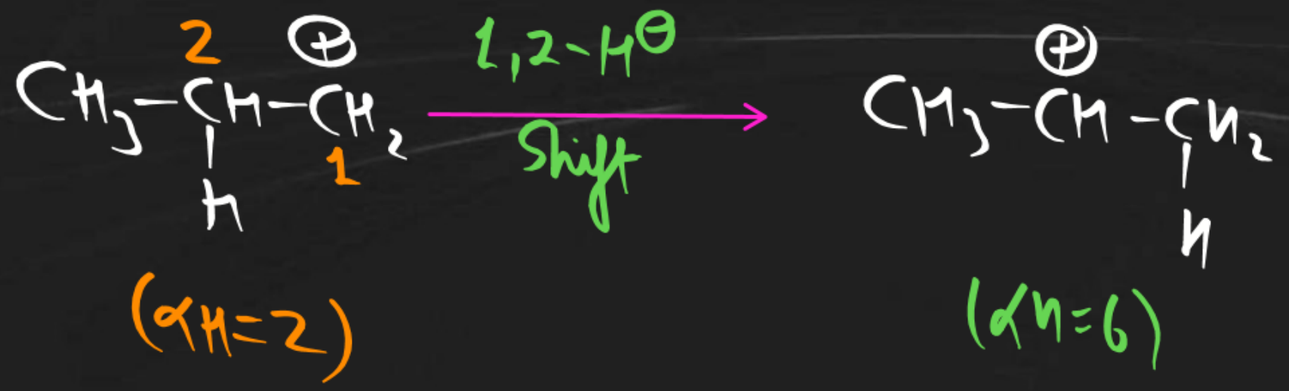


Rearrangement of Carbocation

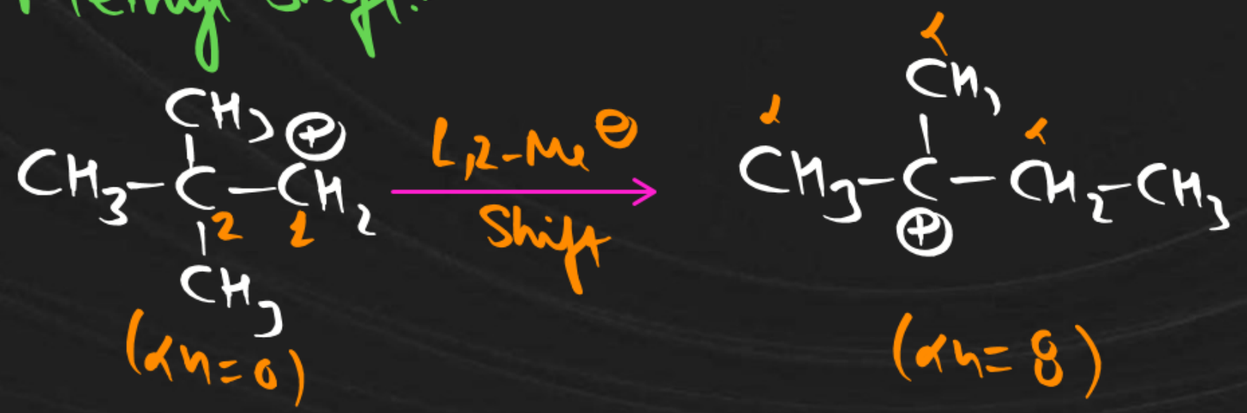
1 ka Maal 2 kodu
2 ka Maal 1 kodu

* $C^{\oplus}$ rearrange into more stable $C^{\oplus}$
* $C^{\oplus}$ rearrange by 1,2-shift or α,β-shift
* $C^{\oplus}$ rearrange more than once but each time stable than previous one.

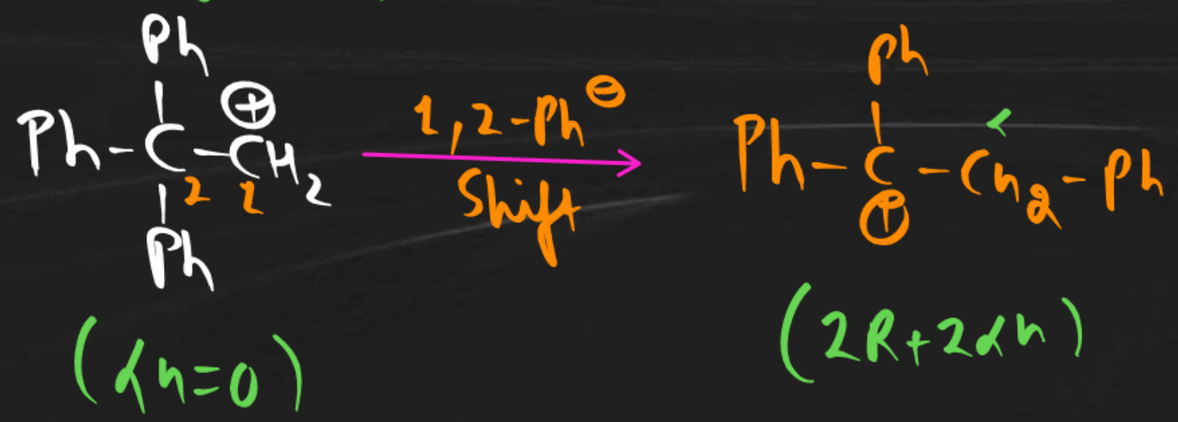
① Hydride Shift :-

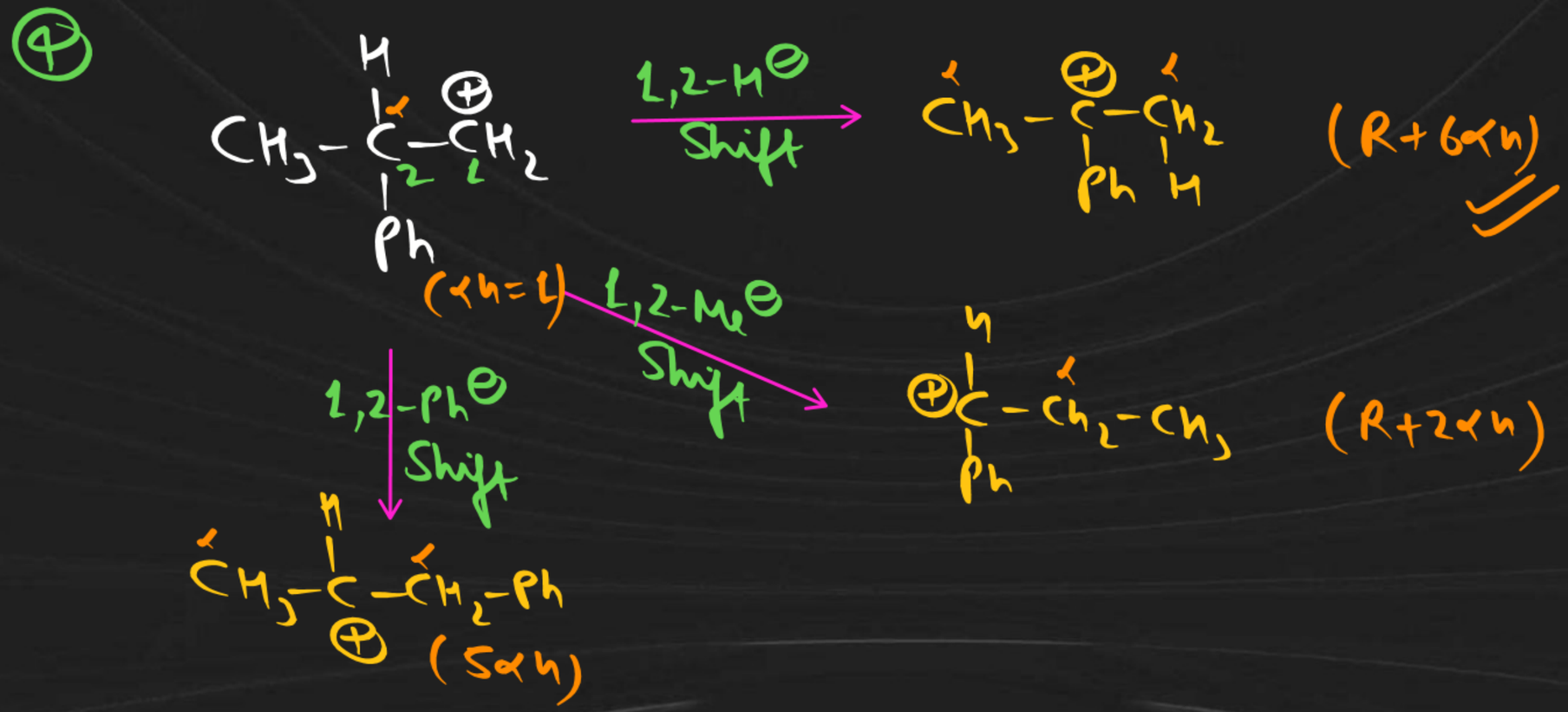


(2) Methyl Shift:-



(3) Phenyl Shift:-





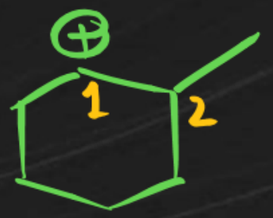
Gehri Baat :→ If ⊕C rearrange more than one type then that rearrangement happens which gives most stable ⊕C.

(5) Ring expansion

St. of Ring :→ 6 > 5 > 4 > 3

Ring expansion →

or



(αh = 3)

↓ 1,2-H⊖ Shift

(αh = 7)

2 se bond todo
1 se jodo

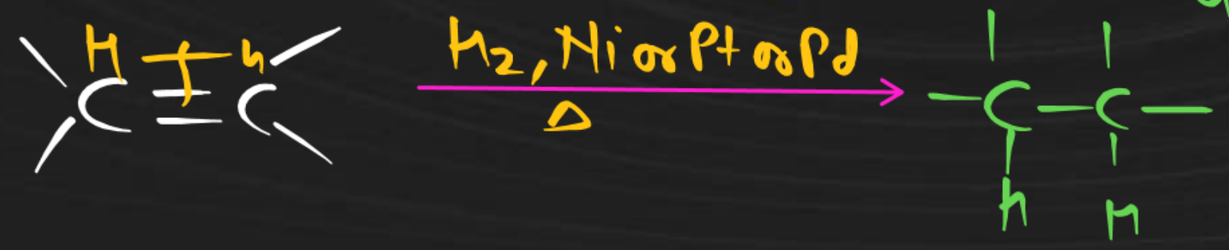
⑥ Ring Contraction

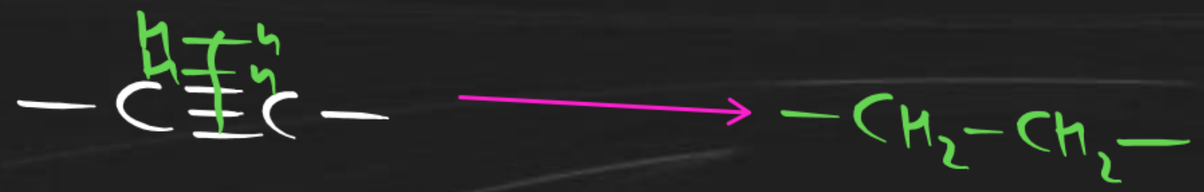
(Dancing Reso)
(σ-bond Reso)
(CPM $C^{\oplus}$)

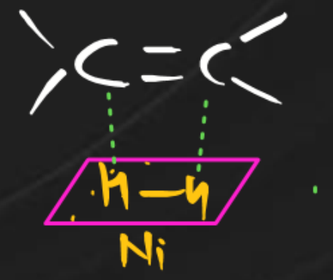
ALKANE

Method of Preparation of Alkane

(1) From Unsaturated Hydrocarbon (syn addⁿ)



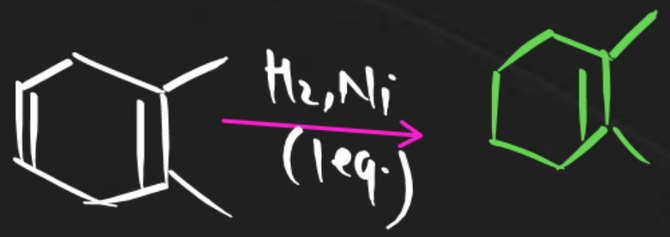




Ex:-

(1)

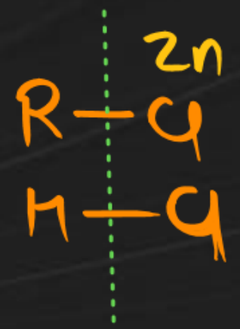
(2)



(2) From Alkyl Halide

$$R-X \xrightarrow[\text{or } Zn, HX]{Zn, H^{\oplus}} R-H + ZnX_2$$

Short Trick :→



Ex:-

① 

② 

(3) Wurtz Reaction

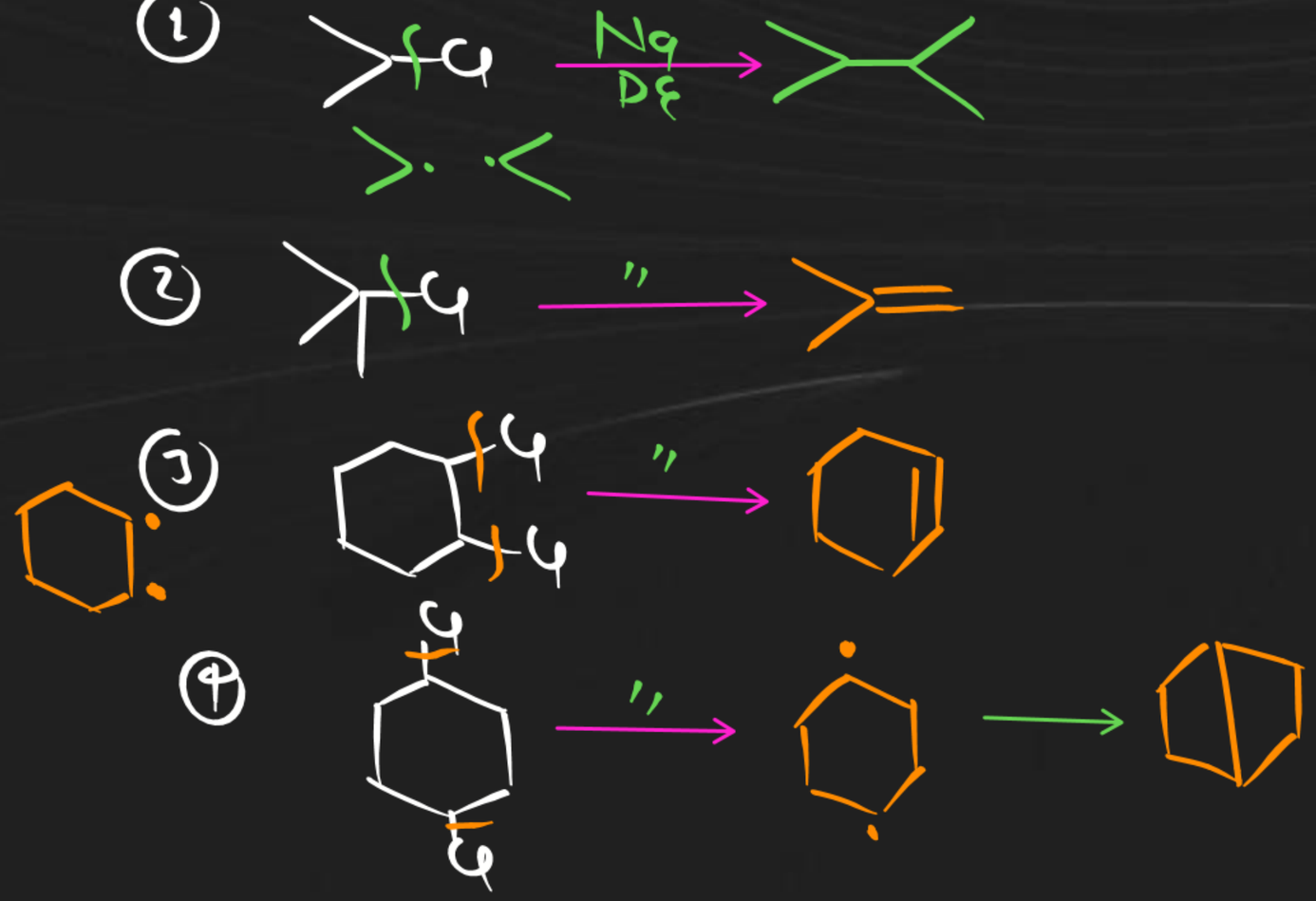
$CH_3|1|2^{\circ} \rightarrow R\text{-}X \xrightarrow[DE]{Na \rightarrow 1e^{\ominus}} R^{\odot} \xrightarrow{\text{dimerize}} R\text{-}R$

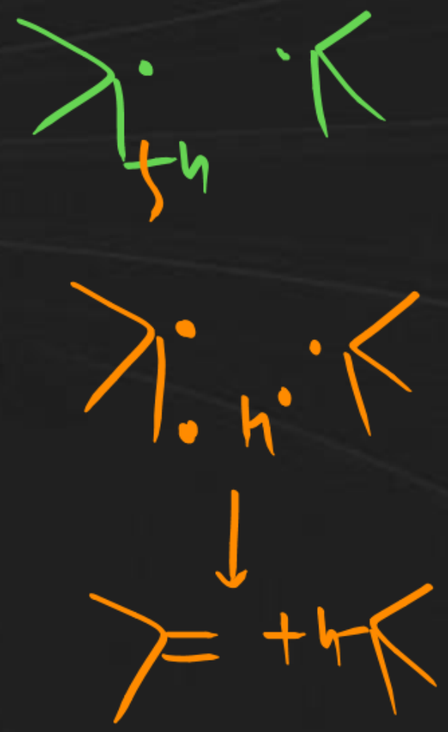
Intra > Inter

Gehri Baat :-

① CH_4 X

② Odd c alkane X



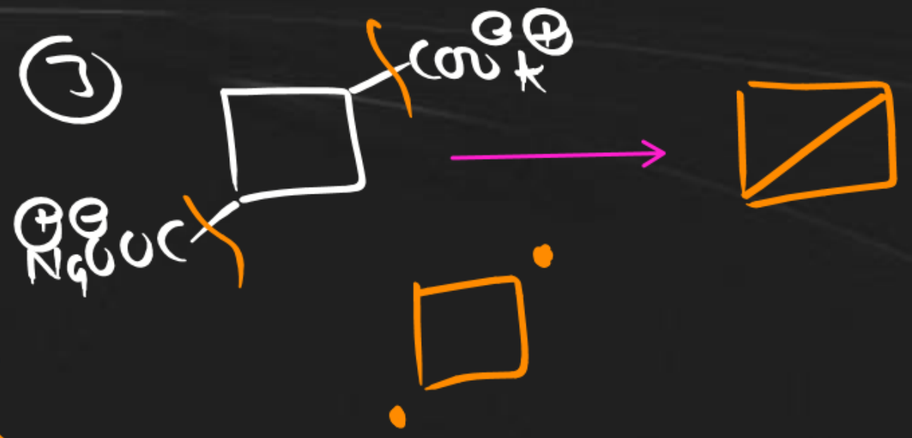


(4) Kolbe's Electrolysis (Same Wurtz)

Ex:- ① $CH_3-C(=O)-O^{\ominus}Na^{\oplus} \longrightarrow CH_3-CH_3$

$\dot{C}H_3$ $\dot{C}H_3$

② 

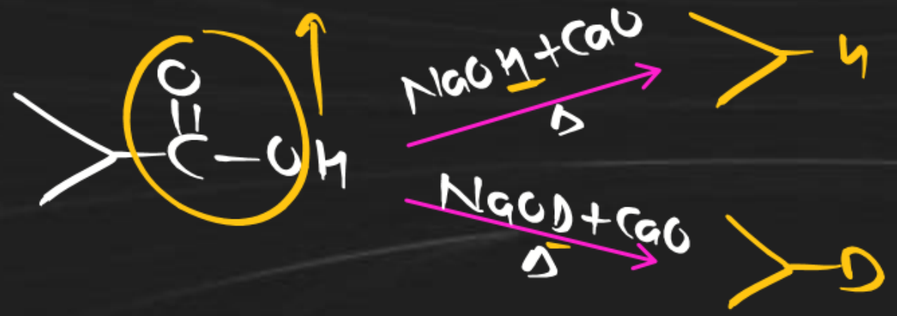
③ 

(5) Decarboxylation by soda lime $(Int \rightarrow C^{\ominus})$ $\{Rate \propto St.\,of\ C^{\ominus}\}$

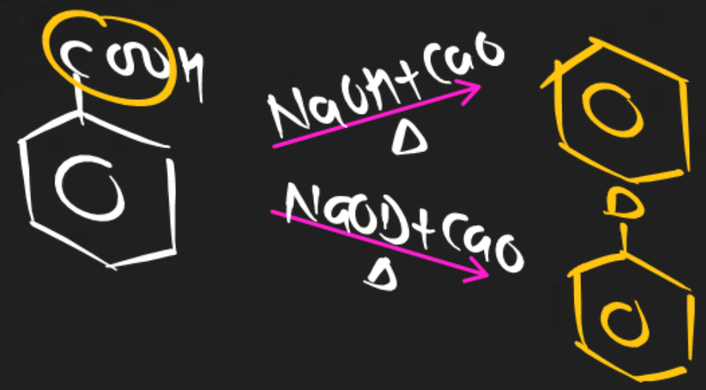
Rxn:- $R-\overset{O}{\overset{\|}{C}}-OH \xrightarrow[\Delta]{NaOH + CaO} R-H + CaCO_3\downarrow$

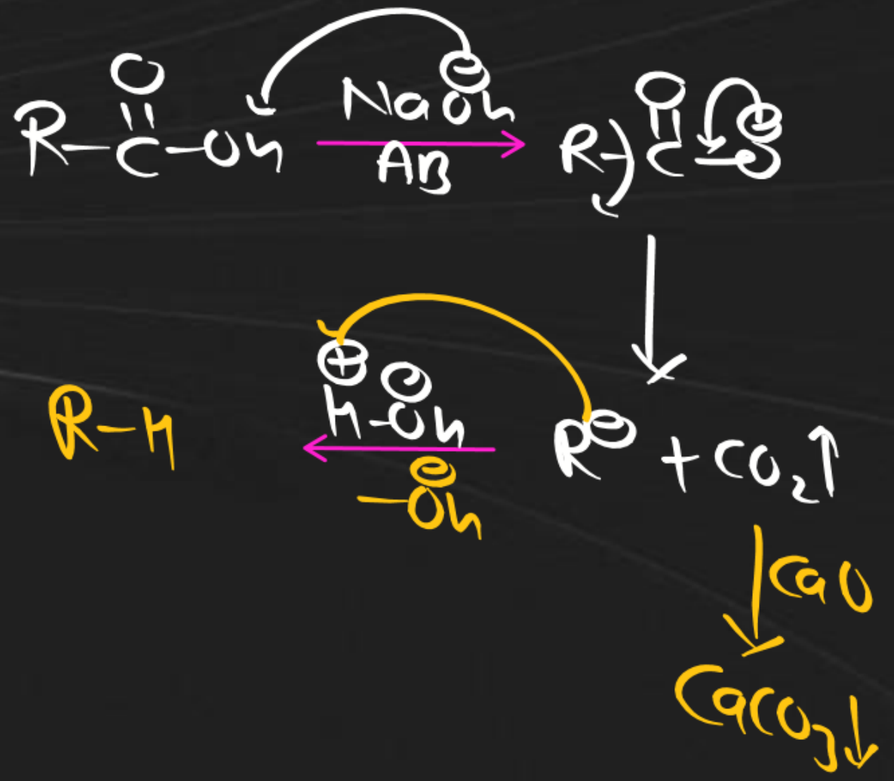
white ppt.

Ex:- ①



②





(6) Reduction by Red P + HI (Baap R.A.)

① $R-OH \xrightarrow{\text{Red P + HI}} R-H$

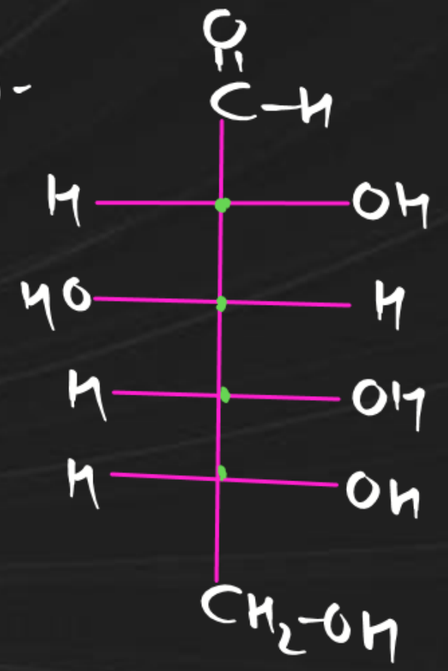
② $R-\overset{O}{\overset{\|}{C}}-H \xrightarrow{''} R-CH_3$

③ $R-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{''} R-CH_3$

④ $R-\overset{O}{\overset{\|}{C}}-O-R' \xrightarrow{''} R-CH_3 + R'-H$

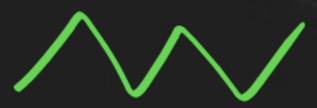
Gehri Baat :→ Sare oxygen Hatado keval C and H rhne do.

Exi-



D-glucose

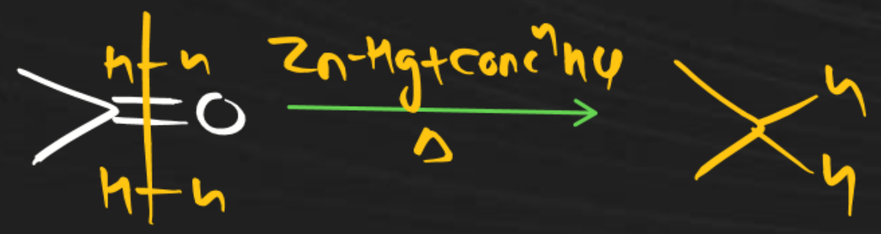
$\xrightarrow{\text{Red P + HI}}$



n-hexane

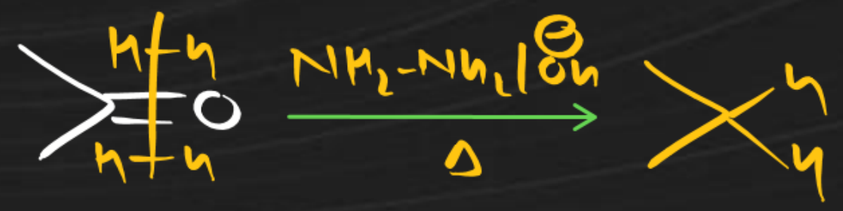
(7) From Aldehyde and Ketone

Clemmensen Reduction



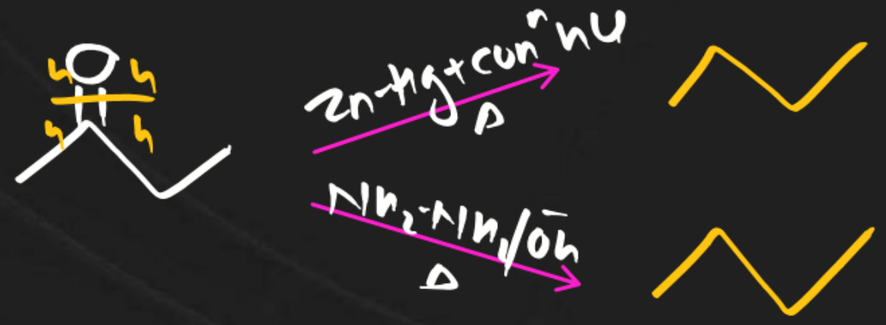
(Ald | Ketone)

Wolff Kischner Reduction

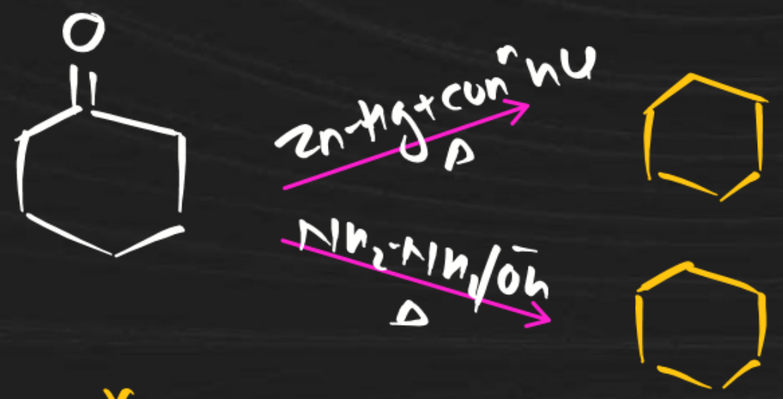


(Ald. | Ketone)

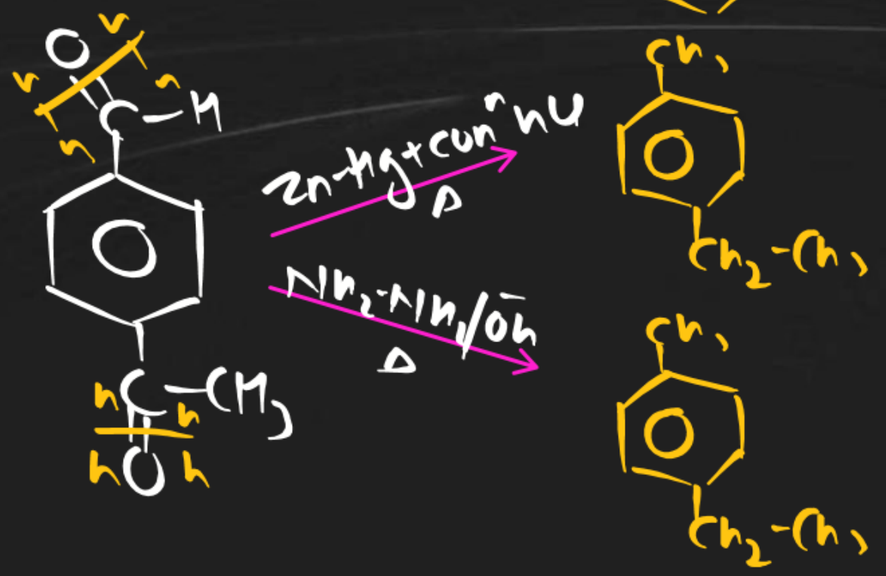
Ex 1 ①


Zn-Hg + conc^n HCl
Δ
NH2-NH2/OH⁻
Δ

②


Zn-Hg + conc^n HCl
Δ
NH2-NH2/OH⁻
Δ

③


Zn-Hg + conc^n HCl
Δ
NH2-NH2/OH⁻
Δ

(8) By hydrolysis of Metal Carbide

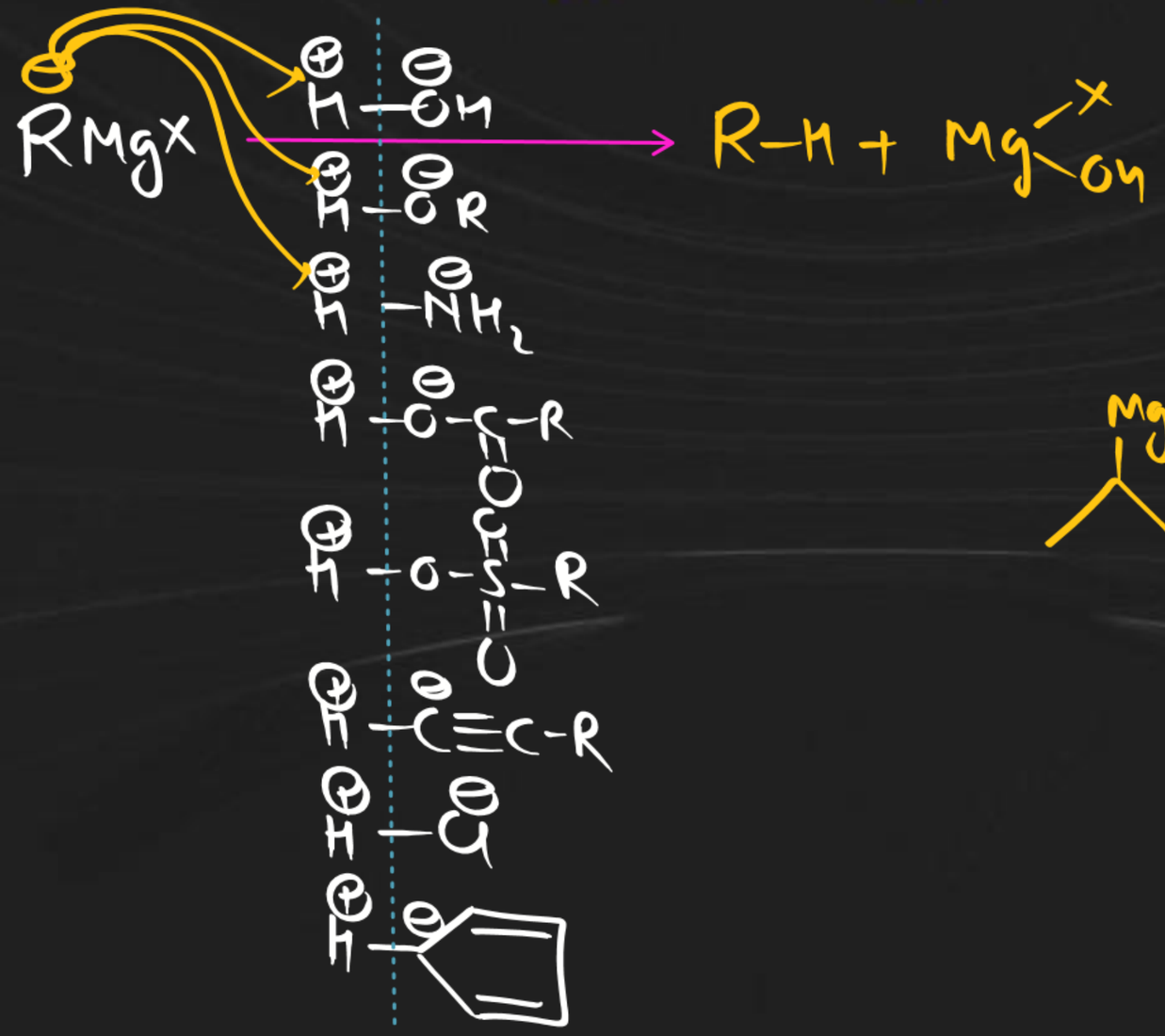
$$Be_2C \xrightarrow{4H_2O} CH_4 + 2Be(OH)_2$$

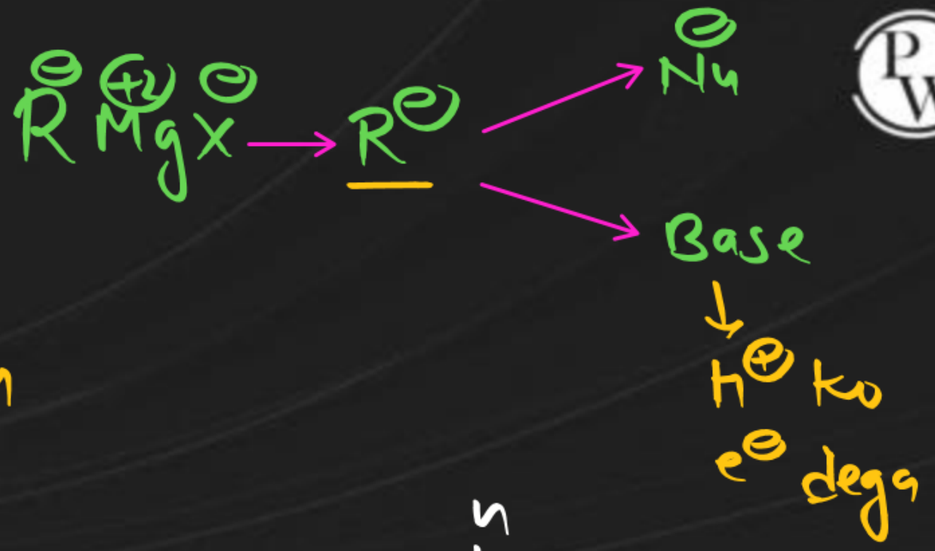
$$Al_4C_3 \xrightarrow{12H_2O} 3CH_4 + 4Al(OH)_3$$

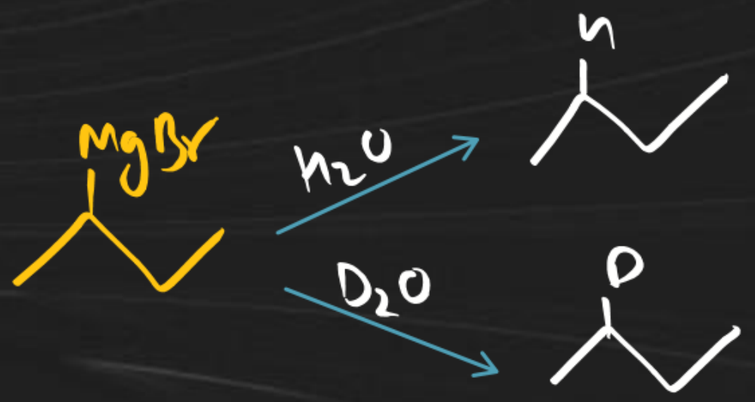
$2Be^{+2}$ C^{-4} $4\overset{+}{H}-\overset{-}{O}H$

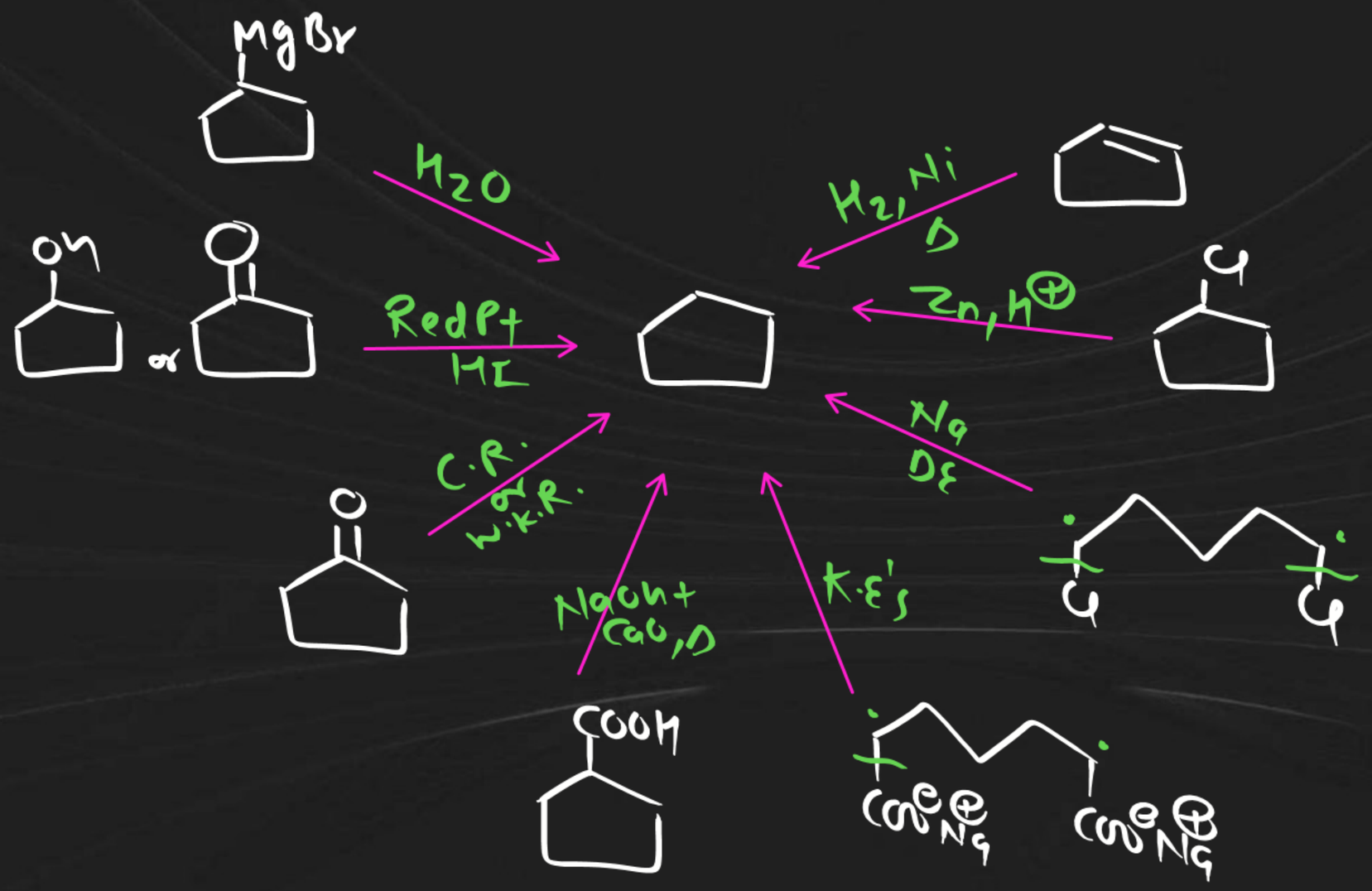
$4Al^{+3}$ C_3^{-12}

(9) Reaction with Grignard Reagent








MgBr
H2O
OH
or
Red P + HI
H2, Ni
Δ
Zn, H⊕
Cl
Na
Δ
C.R.
or
W.K.R.
NaOH + CaO, Δ
K.E's
COOH
COO⊖ ⊕Na
COO⊖ ⊕Na

Chemical Properties of Alkane

(1) Photohalogenation of Alkane

$R-H$ | $X-X$

Rxn:- $R-H \xrightarrow[\text{or } X_2, \Delta]{X_2, h\nu} R-X + H-X$

Int:→ $C^{\odot}$

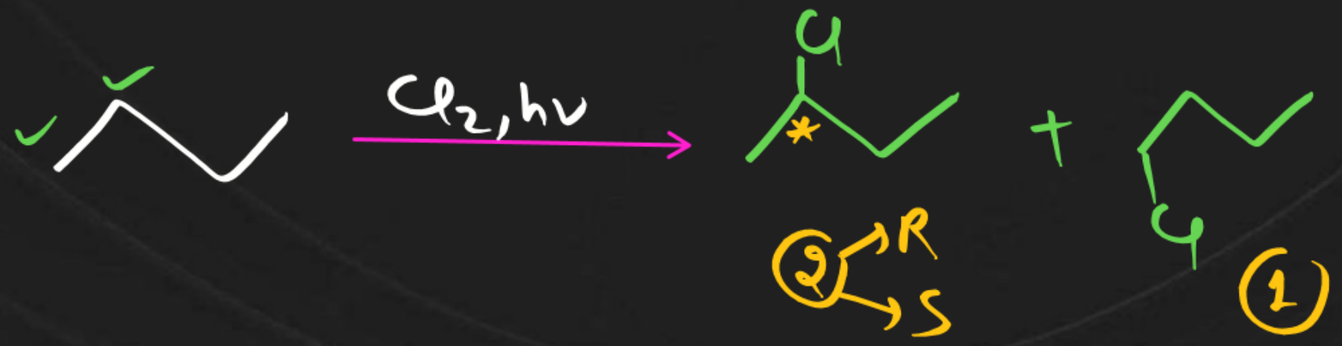
Rate of photohalogenation ∝ St. of $C^{\odot}$

∝ B.E. of H-X

Rate of photohalogenation:- $F_2 >> Cl_2 > Br_2 >> I_2$

(explosion) (Reversible) → (Add some amt of O.A. like HIO_3, HNO_3) → Irreversible

Ex :→



x = No. of monochlorinated product (excluding Stereoisomers) = 2

y = No. of monochlorinated product (including Stereoisomers) = 3

Major & Minor in photohalogenation

	Reactivity of H		
	1°H	2°H	3°H
F_2	1	1	1
Cl_2	1	3.8	5
Br_2	1	82	1600

$$\text{Reactivity} \propto \frac{1}{\text{Selectivity}}$$

Rate :→ $F_2 >> Cl_2 > Br_2 >> I_2$

F_2 → Too Reactive

Br_2 → Too selective

n_p → No. of 1°H

n_s → No. of 2°H

n_t → No. of 3°H

r_p → Rate of 1°H

r_s → Rate of 2°H

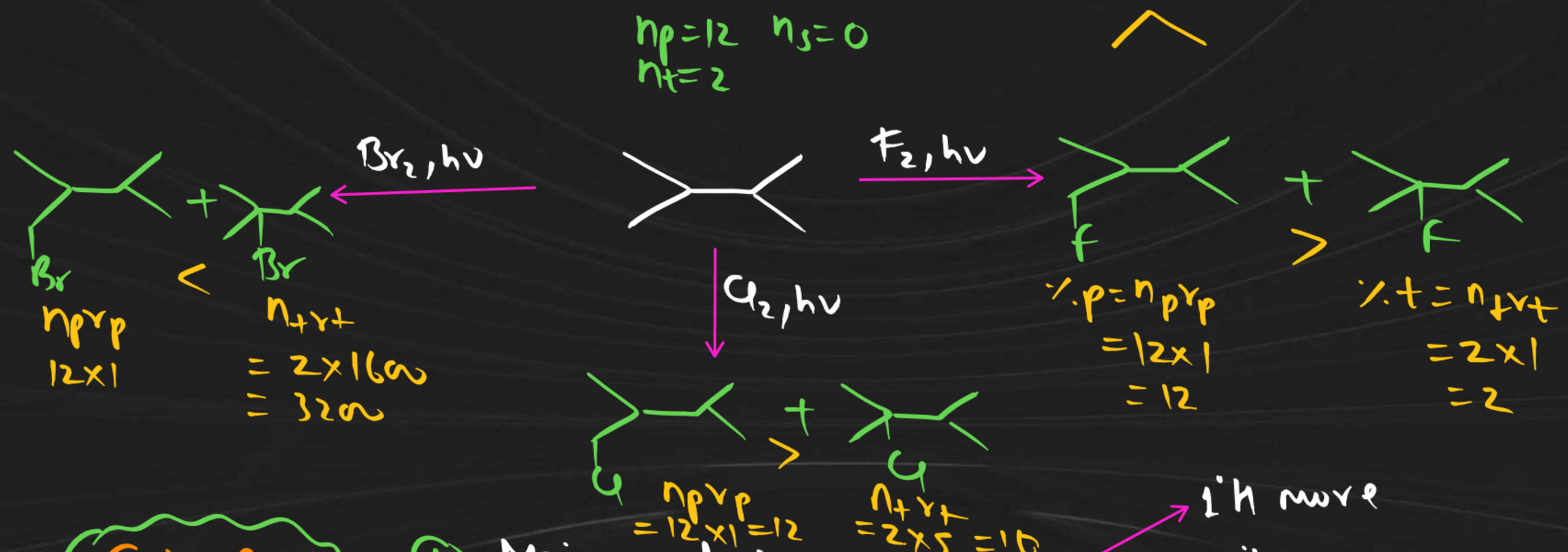
r_t → Rate of 3°H

$$\%p = \frac{n_p r_p}{n_p r_p + n_s r_s + n_t r_t}$$

$$\%s = \frac{n_s r_s}{n_p r_p + n_s r_s + n_t r_t}$$

$$\%t = \frac{n_t r_t}{n_p r_p + n_s r_s + n_t r_t}$$

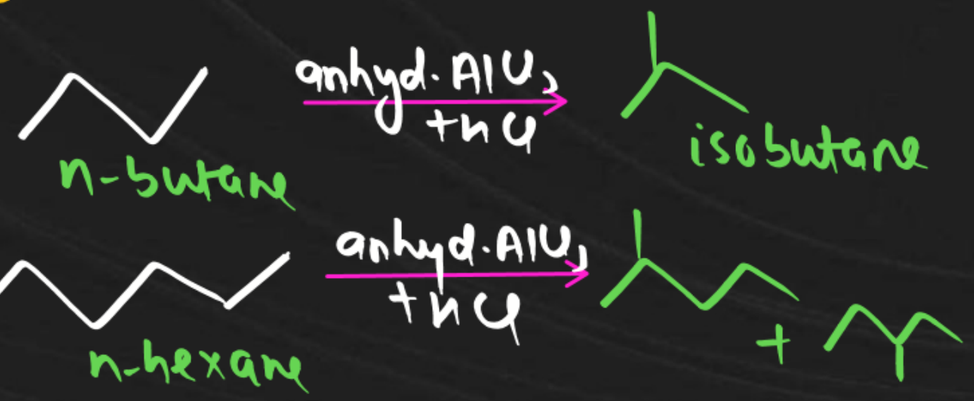
$n_p = 12 \quad n_s = 0$
$n_t = 2$



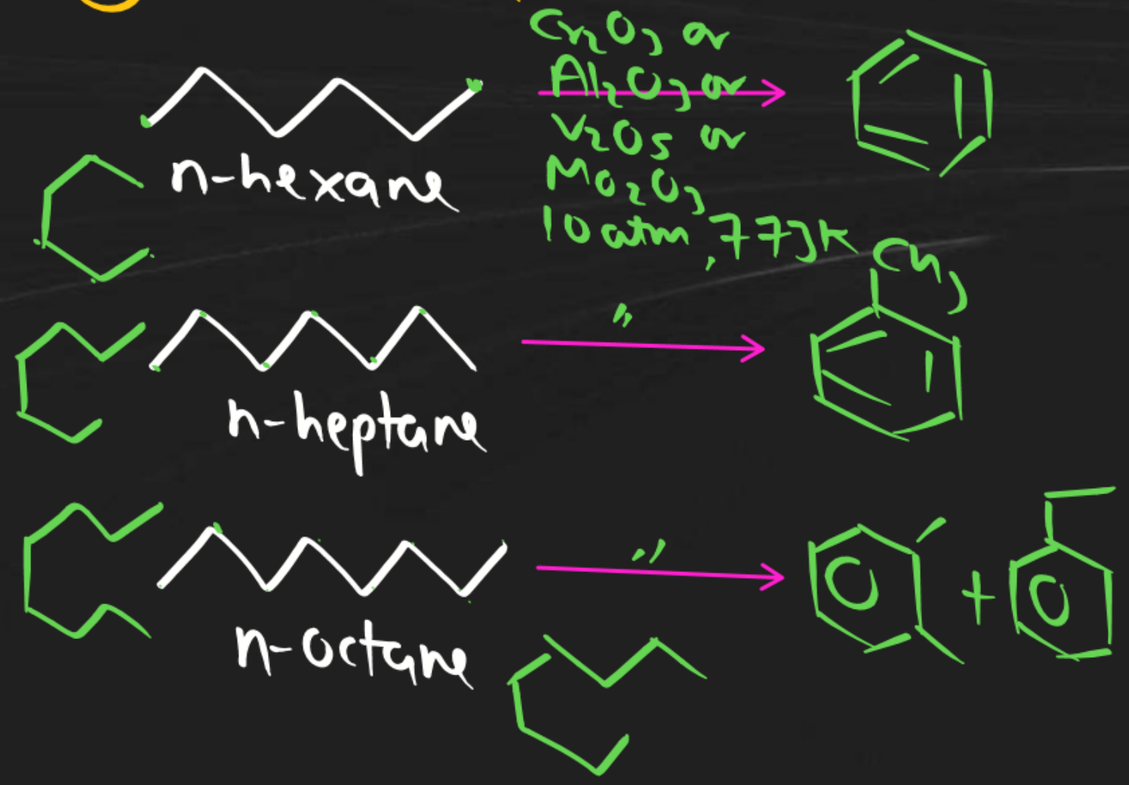
Gehri Baat :→

1. Major product in fluorination → 1°H more, 2°H more, 3°H more
2. In bromination major product will be decided by st. of free radical
3. In chlorination → Chidchidapan, Dutch, Dard, Peeda, Kasht (Find by Calculation)

② Isomerisation :-



③ Aromatisation :-



Combustion Rxn :-

$$C_xH_y + \left(x + \frac{y}{4}\right)O_2 \longrightarrow x\,CO_2 + \frac{y}{2}H_2O$$

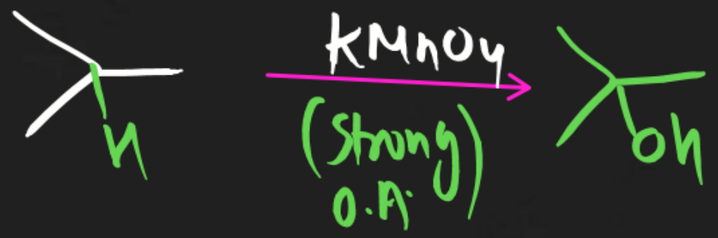
C_nH_{2n+2} $\quad x = n$, $y = 2n+2$

Controlled Oxidation :-

$$CH_4 + O_2 \xrightarrow[100\ atm.]{Cu,\ 523K} CH_3-OH$$

$$CH_4 + O_2 \xrightarrow[\Delta]{MoO_3} H-\overset{O}{\overset{\|}{C}}-H$$

$$CH_3-CH_3 + O_2 \xrightarrow[\Delta]{(CH_3COO)_2Mn} CH_3-\overset{O}{\overset{\|}{C}}-OH$$



⑥ Reaction with Steam

$$CH_4 + H_2O \xrightarrow[1273K]{Ni} CO + 3H_2$$

Water gas ← $CO + H_2$

⑦ Pyrolysis | Cracking :-

$$C_6H_{14} \xrightarrow{773K} C_6H_{12} + H_2$$

$$\xrightarrow{''} C_4H_8 + C_2H_6$$

$$\xrightarrow{''} C_3H_6 + C_2H_6 + CH_4$$

$$C_{12}H_{26} \xrightarrow[973K]{Ni|Pt|Pd} C_7H_{16} + C_5H_{10} + \text{many more}$$

⑧ Nitration of Alkane :-

$$R-H \xrightarrow[\Delta]{conc^n\ HNO_3} R-NO_2$$

Short Trick

$$R-\boxed{H + HO}-N{=}O \rightarrow O$$

⑨ Sulphonation of Alkane :-

$$R-H \xrightarrow[\Delta]{conc^n\ H_2SO_4} R-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$$

Short Trick

$$R-\boxed{H + HO}-\overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{S}}-OH$$

ALKENE

Method of Preparation of Alkene

(1) Reduction of Alkyne

$R-C\equiv C-R'$ (Non-terminal alkyne)

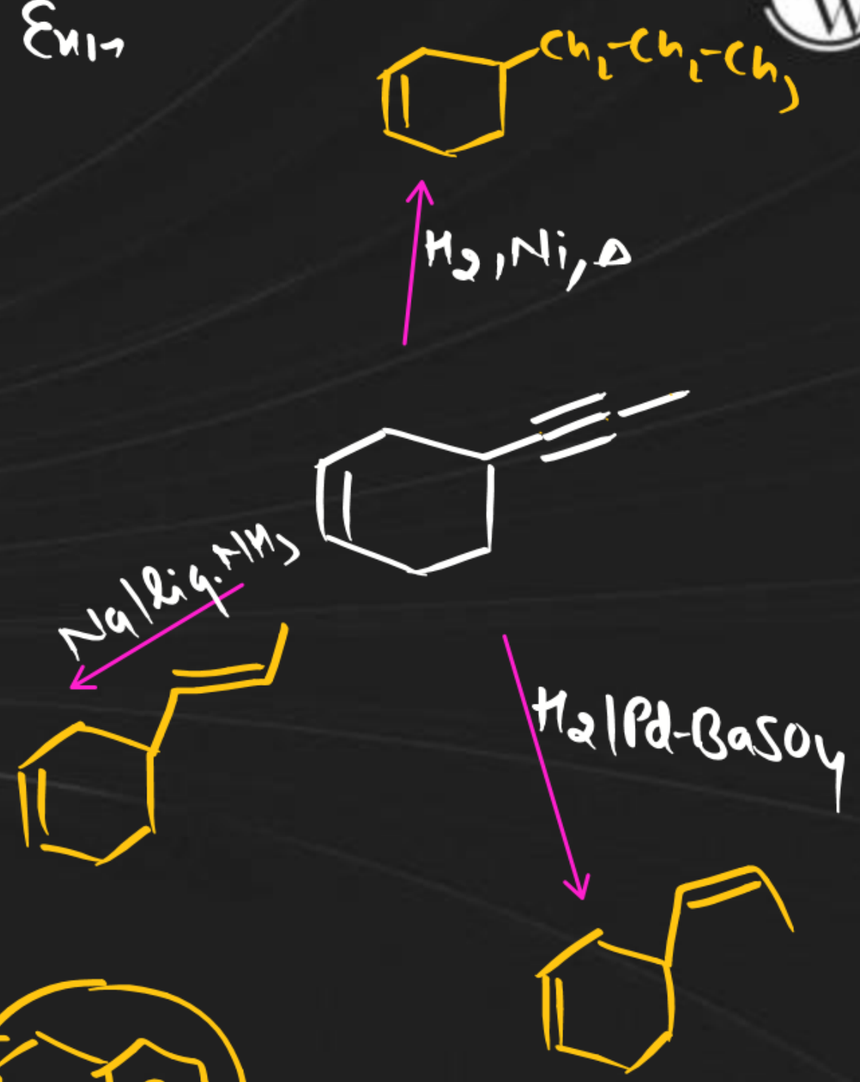
H_2/Pd-$BaSO_4$ or H_2/Pd-$CaCO_3$ or H_2/Pd-C → cis alkene (Lindlar catalyst; Rosenmund catalyst)

Na/liq. NH_3 or $NaNH_2$ (Birch Redn) → trans alkene

* Lindlar Catalyst :→ H_2/Pd-$BaSO_4$+$CaCO_3$+S+Quinoline

* $BaSO_4$ or $CaCO_3$ powder :→ poisoned to Pd-surface

Exm



(2) Dehydrohalogenation {Removal of HX} {anti elimⁿ} {E_2 rxn.}

(α,β-elimⁿ)

C—H > C—D

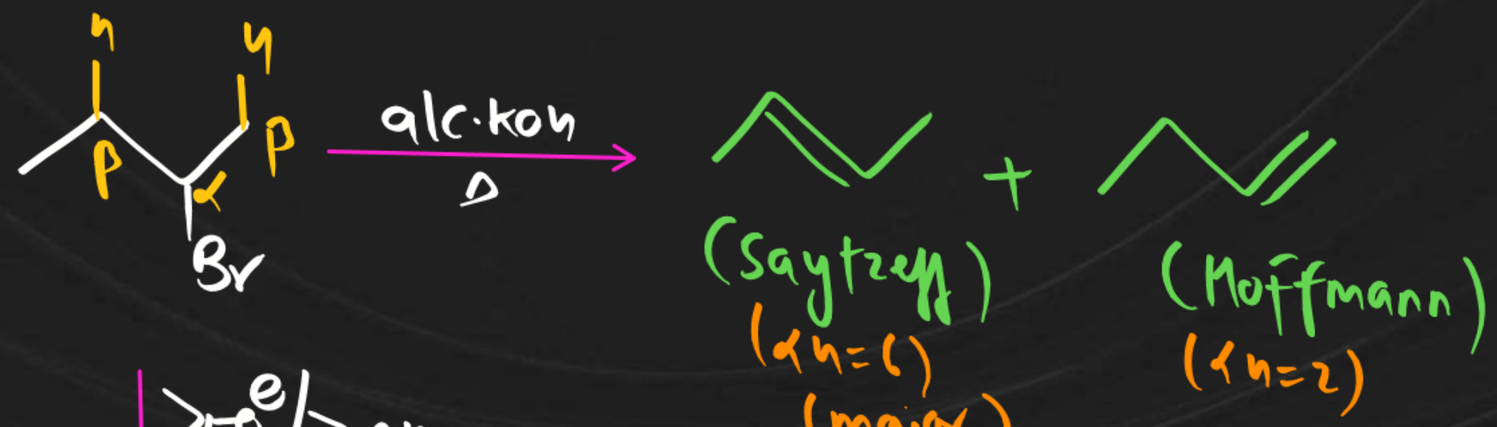
* Dehydrohalogenating Reagents

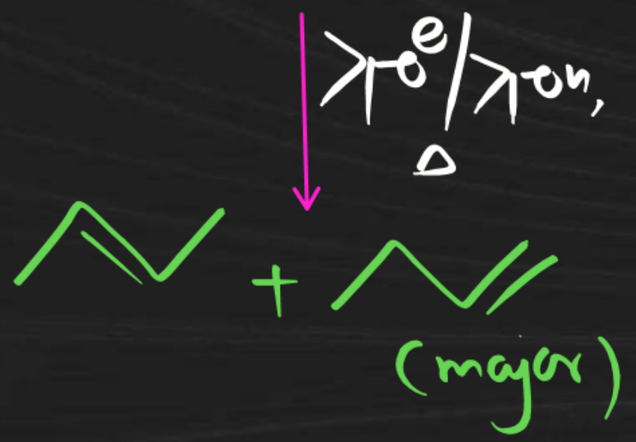
1. alc. KOH, Δ
2. $EtO^{\ominus}$ / EtOH, Δ
3. $t\text{-}BuO^{\ominus}$ / t-BuOH, Δ
4. $NaNH_2^{\ominus}$, Δ

Qw. Compare rate of E_2 :-

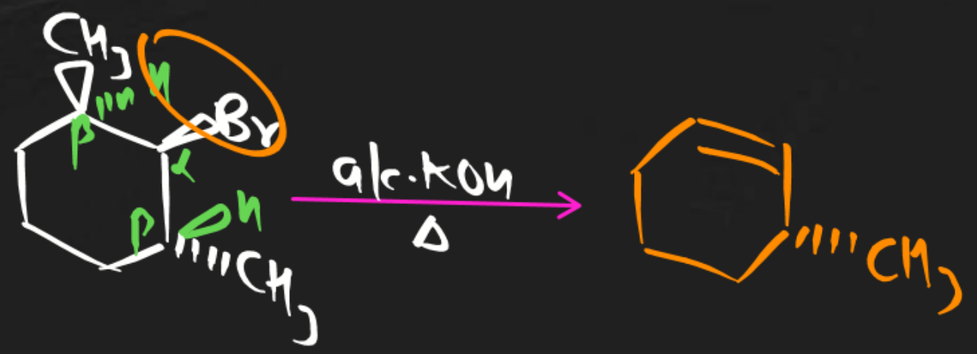
1. t-I > t-Br > t-Cl >> t-F
2. CD_3-CH_2-Cl < CH_3-CH_2-Cl
3. 

Ex:- ①


γ
γ
β
β
α
Br
alc.KOH
Δ
(Saytzeff)
(α H = 1)
(major)
+
(Hoffmann)
(α H = 2)


Δ
+
(major)

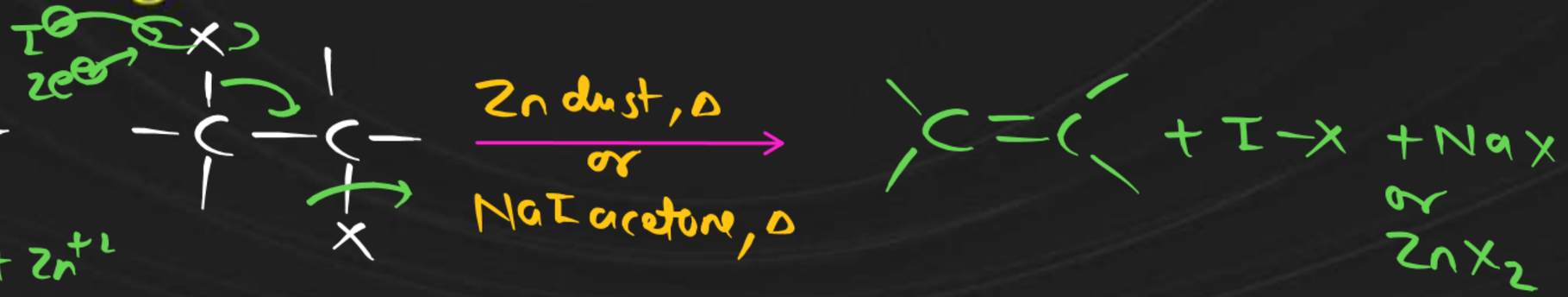
②


CH3
Br
alc.KOH
Δ
CH3

(3) Dehalogenation Reaction

{Removal of X_2} {Anti elimⁿ} {E_2 rxn.}

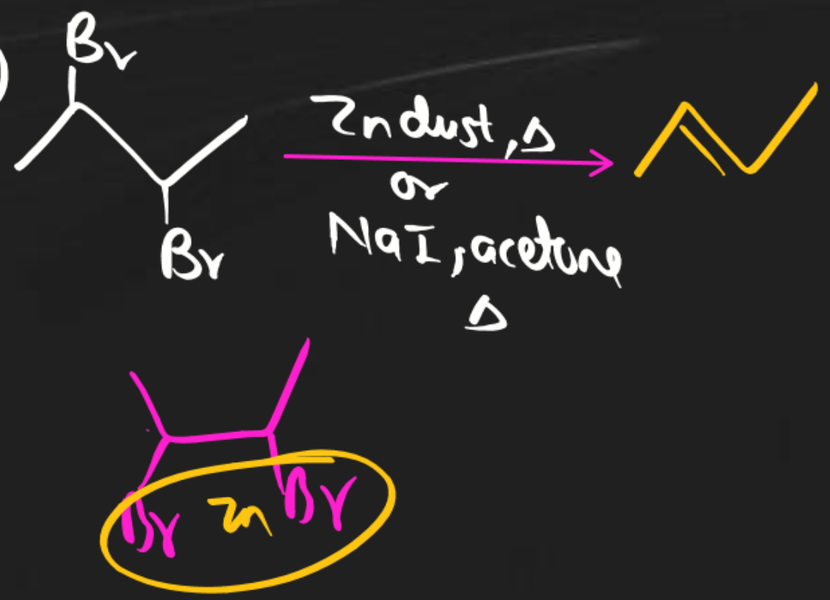
Rxn :-



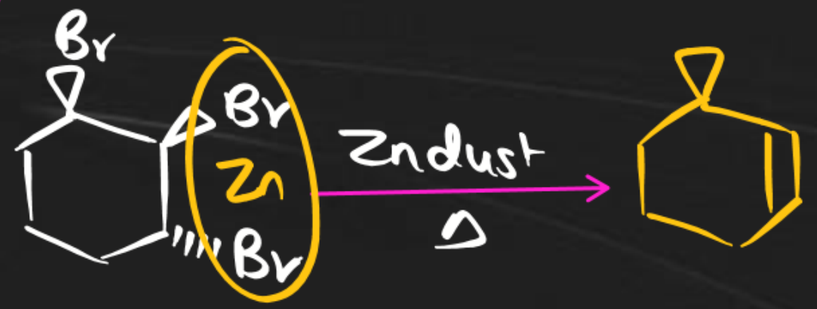
$Zn \rightarrow 2e^{\ominus} + Zn^{+2}$

Short Trick

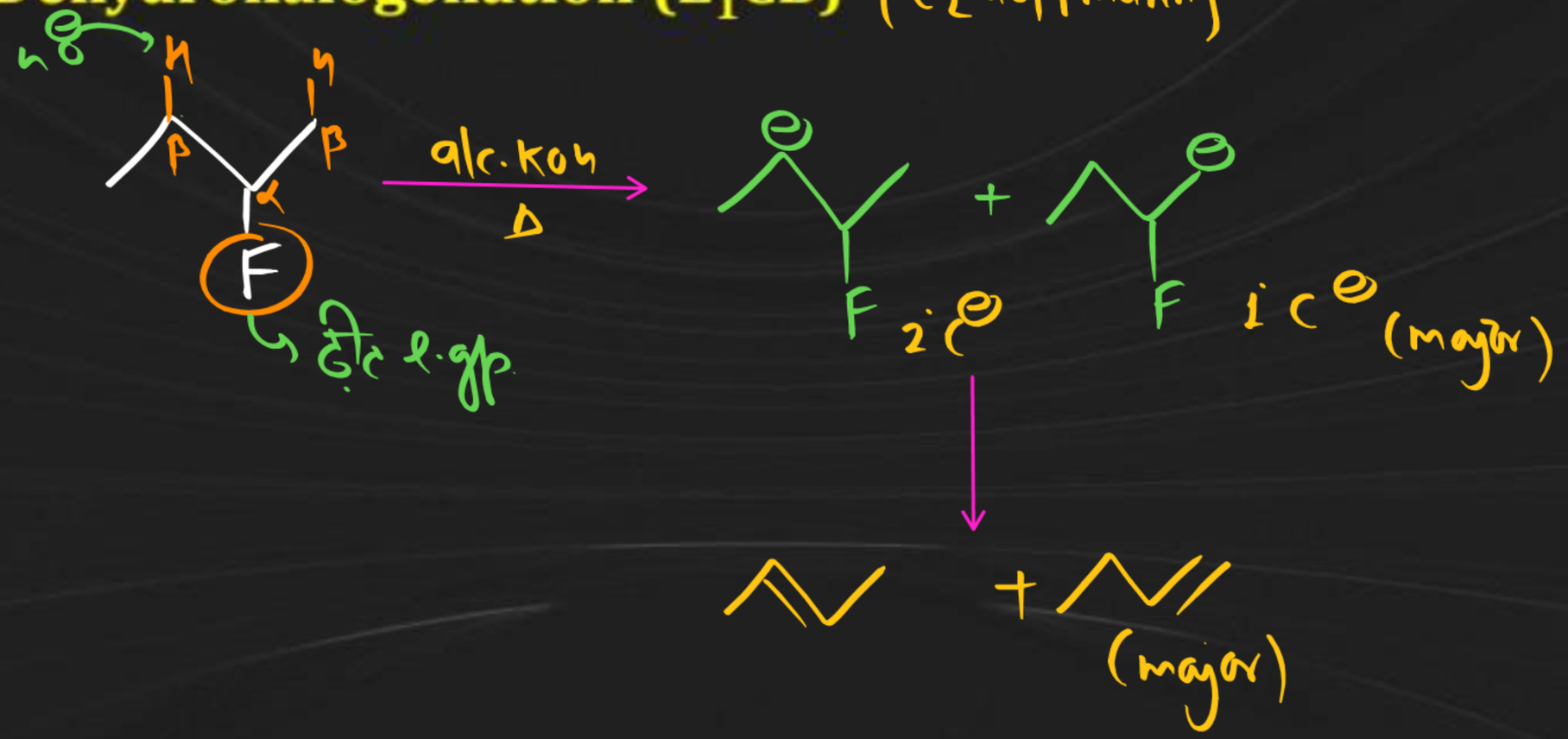
Ex:- ①



②

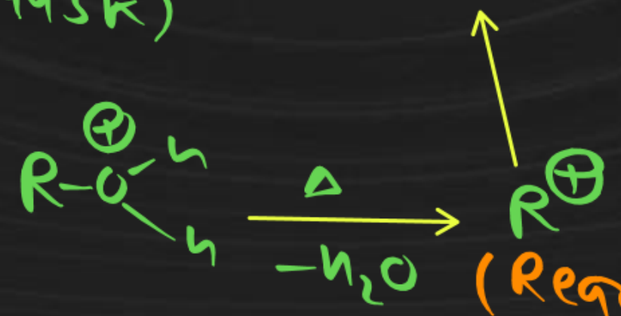


(4) Dehydrohalogenation (E_1CB) {E_2 hoffmann}



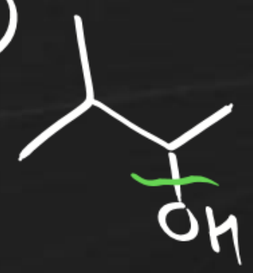
(5) Dehydration of Alcohol (E_1 rxn.) (Int → $C^{\oplus}$) (Rearr ✓)

Rxn :- R–OH $\xrightarrow[\Delta]{\text{conc}^n\ H_2SO_4}$ Alkene (443 K)

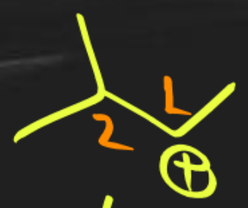


(Regr. if possible)

Ex:- ①



$\xrightarrow[\Delta]{\text{conc}^n\ H_2SO_4}$



($\alpha H = 4$)

1,2-$H^{\ominus}$ shift

($\alpha H = 8$)

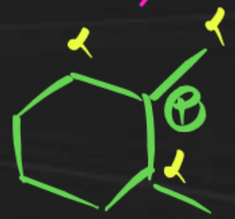
(major) ($\alpha H = 9$)

+

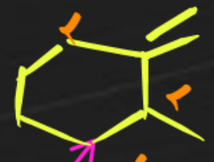
($\alpha H = 5$)

② 

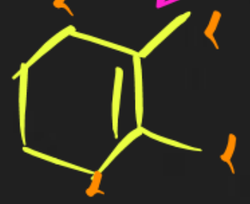
$\xrightarrow[\Delta]{\text{conc}^n\ H^{\oplus}}$



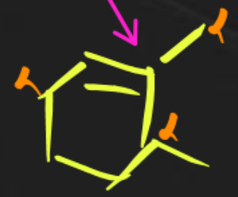
($\alpha H = 6$)



(3 αH)



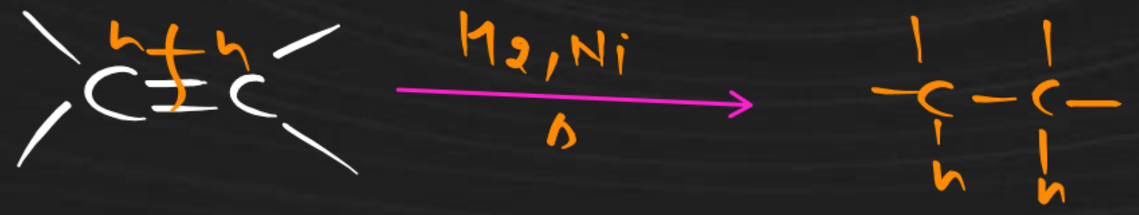
10 αH (major)



6 αH

Chemical Properties of Alkene

(1) Hydrogenation Reaction (syn addⁿ



(2) Electrophilic Addition Reaction

* Attack of $E^{\oplus}$ in slow step
* Overall addition (1 π-bond break, 2 σ-bond form)

EAR

EAR via classical $C^{\oplus}$

* l.p. not containing $E^{\oplus}$
  $H^{\oplus}$, $CH_3^{\oplus}$, $D^{\oplus}$, $NO_2^{\oplus}$ etc.
* Int :- $C^{\oplus}$
* Rearr. :- ✓

EAR via Non-classical $C^{\oplus}$

* l.p. containing $E^{\oplus}$
  $:\ddot{\underset{..}{X}}:^{\oplus}$, $:NO^{\oplus}$, $:OH^{\oplus}$, $Mg^{2\oplus}$ etc.
* Int: $NCC^{\oplus}$ 
* Rearr: ✗

Examples of EAR

	$E^{\oplus}$	$Nu^{\ominus}$
(1) $H-OH$	H^+	OH
(2) $H-OR$	H^+	OR
(3) $H-O-C(=O)-R$	H^+	$O-C(=O)-R$
(4) $H-O-S(=O)_2-OH$	$H^{\oplus}$	SO_3H
(5) $H-X$	$H^{\oplus}$	$X^{\ominus}$
(6) $X-X$	$:X^{\oplus}:$	$:X^{\ominus}:$
(7) HOX	$:X^{\oplus}:$	$H_2O:$
(8) NOH	$:NO^{\oplus}$	$H^{\ominus}$
(9) ICl	$:I^{\oplus}:$	$:Cl^{\ominus}:$

→ EAR via classical $C^{\oplus}$
In → $C^{\oplus}$
Rearr → ✓

→ EAR via $NCC^{\oplus}$
Rearr ✗

$X_2 + H_2\ddot{O}:$

$CH_2=CH_2 \xrightarrow{E^{\oplus}} CH_2-\overset{\oplus}{C}H_2$ (E) or $\overset{\oplus}{C}H_2-CH_2$ (E)

$CH_3-CH=CH_2 \xrightarrow{E^{\oplus}} CH_3-\overset{\oplus}{C}H-CH_2$ (E) (4n=5) ✓ or ~~$CH_3-CH-\overset{\oplus}{C}H_2$ (E) (4n=2)~~

Markonikov Rule

$E^{\oplus}$ adds where more H on alkene.
$Nu^{\ominus}$ adds where less H on alkene.
} Bakwaas

Modern Markonikov Rule

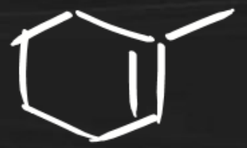
$E^{\oplus}$ attacks such that stable $C^{\oplus}$ forms.

Que. Where Markonikove Rule is applicable:

(1) ✗ 

(2) ✓ 

(3) ✗ 

(4) ✓ 

(5) ✗ 

(6) ✓ $CH_3-C\equiv CH$

(3) Hydrohalogenation (Addition of HX) {MWR}

$$R-CH=CH_2 \xrightarrow{HX} R-\underset{X}{CH}-\underset{H}{CH_2}$$

Mech^n:-

$$R-CH=CH_2 \xrightarrow[\text{slow step (rds)}]{\overset{\oplus}{H}\overset{\ominus}{X}} R-\overset{\oplus}{C}H-CH_2 \xrightarrow[\text{fast}]{X^{\ominus}} R-\overset{*}{C}H-CH_3$$

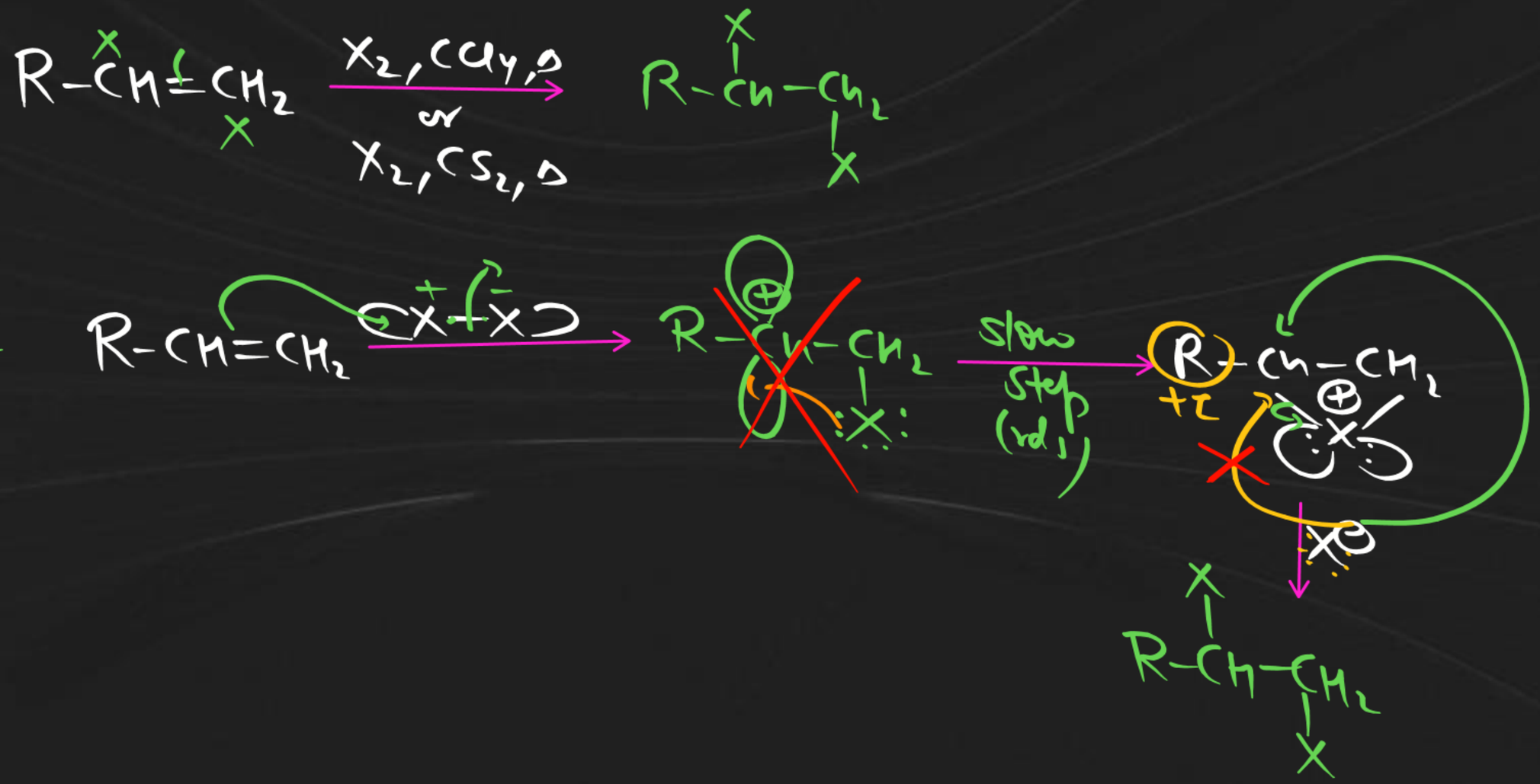
$$\begin{matrix} & & \\ & H & \\ & & \end{matrix} \qquad \begin{matrix} & & \\ & X & \\ & & \end{matrix} \qquad \begin{matrix} & & \\ & H & \\ & & \end{matrix} \qquad \begin{matrix} & & \\ & X & \\ & & \end{matrix}$$

(Rearrange if possible)

② → R, S

Rate of EAR ∝ St. of 1st $C^{\oplus}$

(4) Halogenation (Addition of X_2) {anti addⁿ} {M w/o R} {Int → NCC⊕}



(5) Addition of H–Br in Presence of Peroxide (Peroxide effect / Kharasch Effect)

{AMR w/o R}

H–F, HCl → Step-2 End o

HI → Step-3 End o

$$R-CH=CH_2 \xrightarrow[R_2O_2,\,h\nu]{HBr} R-\underset{H}{CH}-\underset{Br}{CH_2}$$

① $R-O-O-R \xrightarrow{h\nu} 2RO^{\odot}$ {Chain Initiation Step}

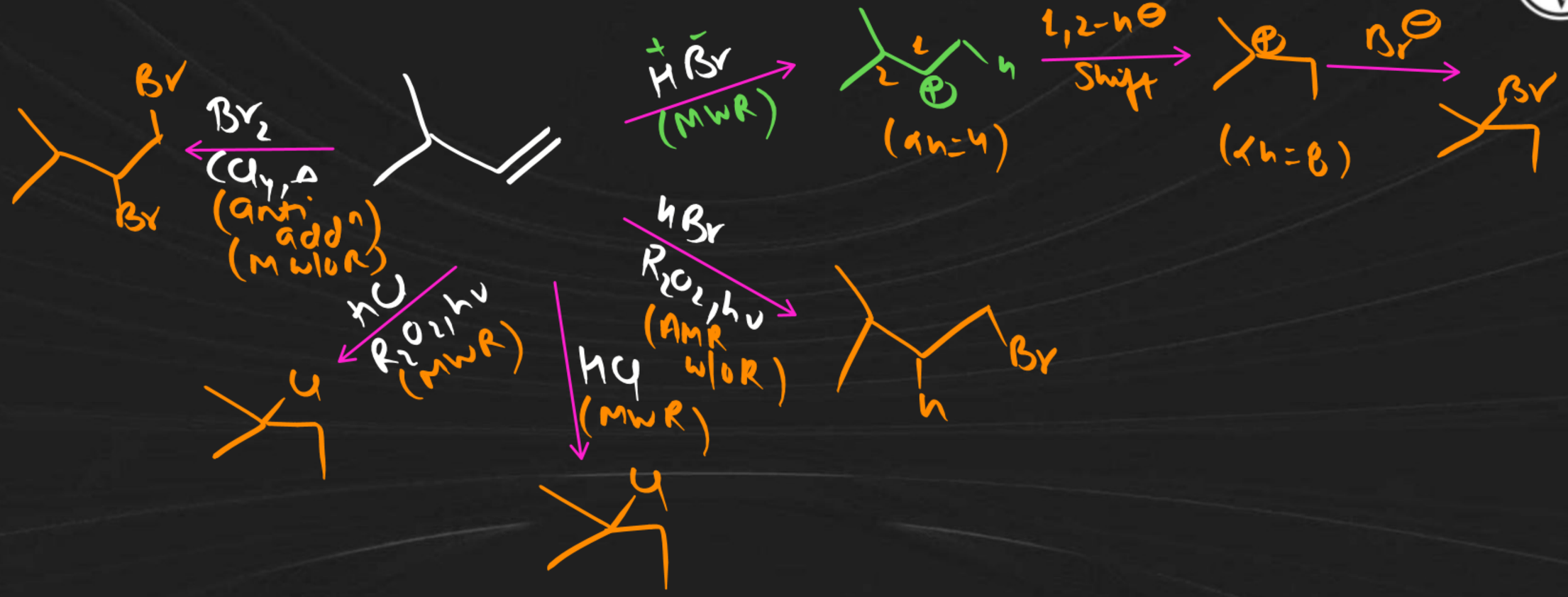
② $RO^{\odot} + H-Br \longrightarrow R-O-H + Br^{\odot}$

③ $R-CH=CH_2 + Br^{\odot} \longrightarrow R-\overset{\odot}{C}H-\underset{Br}{CH_2}$ or $\cancel{R-\underset{Br}{CH}-\overset{\odot}{C}H_2}$

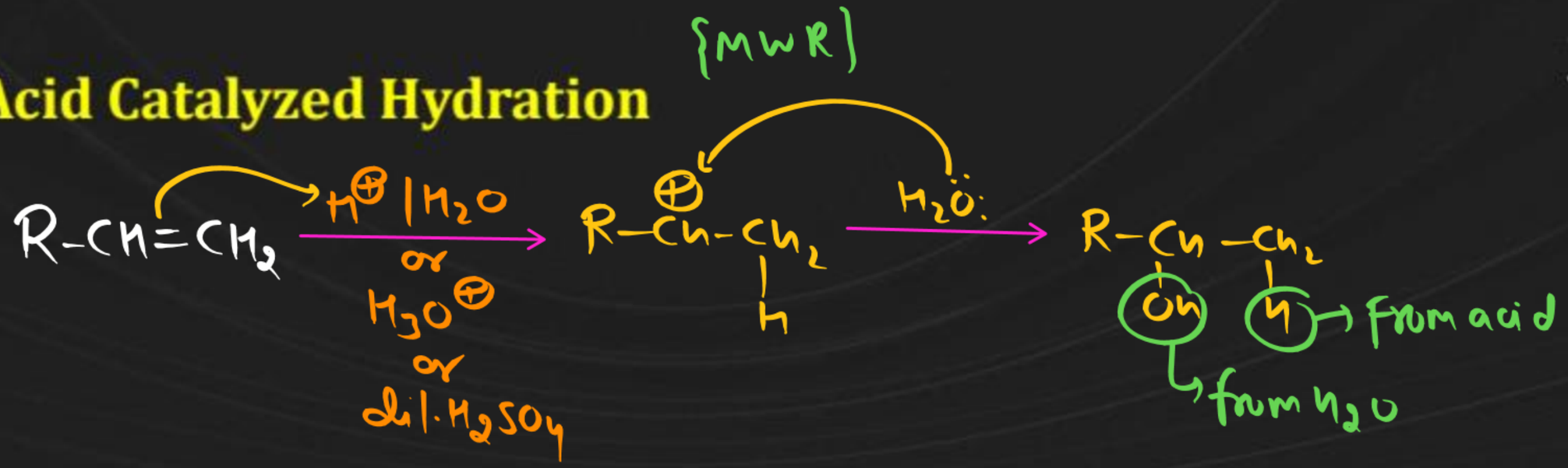
④ $R-\overset{\odot}{C}H-\underset{Br}{CH_2} + H-Br \longrightarrow R-CH_2-CH_2-Br + Br^{\odot}$

{Chain propogation Step}

⑤ $Br^{\odot} + Br^{\odot} \longrightarrow Br-Br$ {Chain Termination Step}

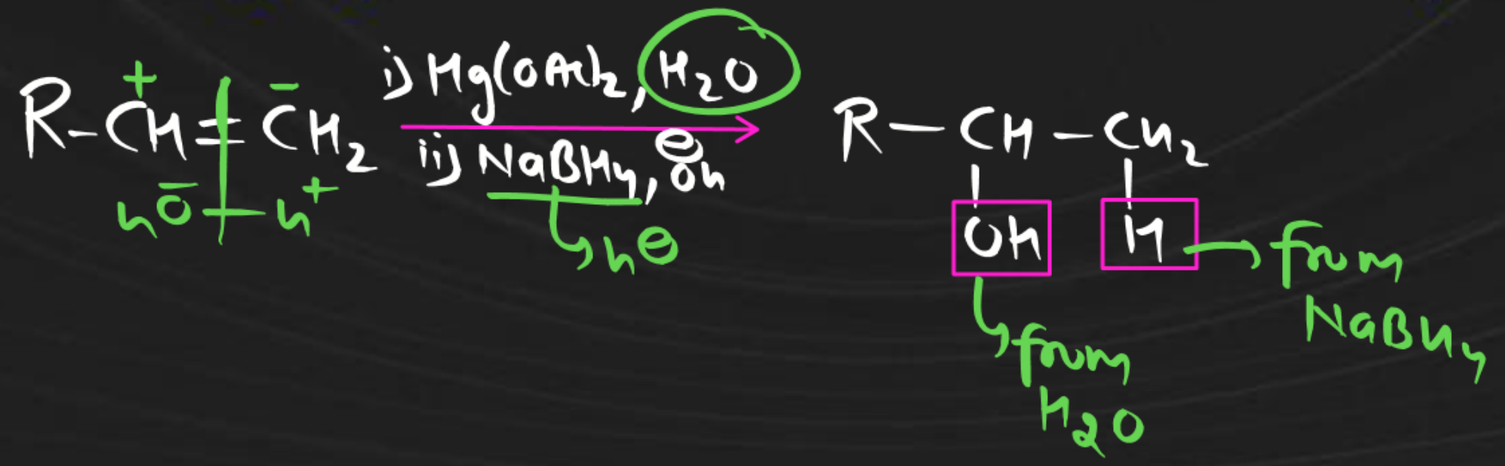

Br
Br
Br_2
CCl_4, Δ
(anti add^n)
(MWOR)
$\overset{+}{H}\overset{-}{Br}$
(MWR)
(α n=4)
1,2-n⊖ Shift
(α n=β)
$Br^{\ominus}$
Br
HCl
R_2O_2, hν
(MWR)
Cl
HCl
(MWR)
Cl
HBr
R_2O_2, hν
(AMR WOR)
Br

(6) Acid Catalyzed Hydration

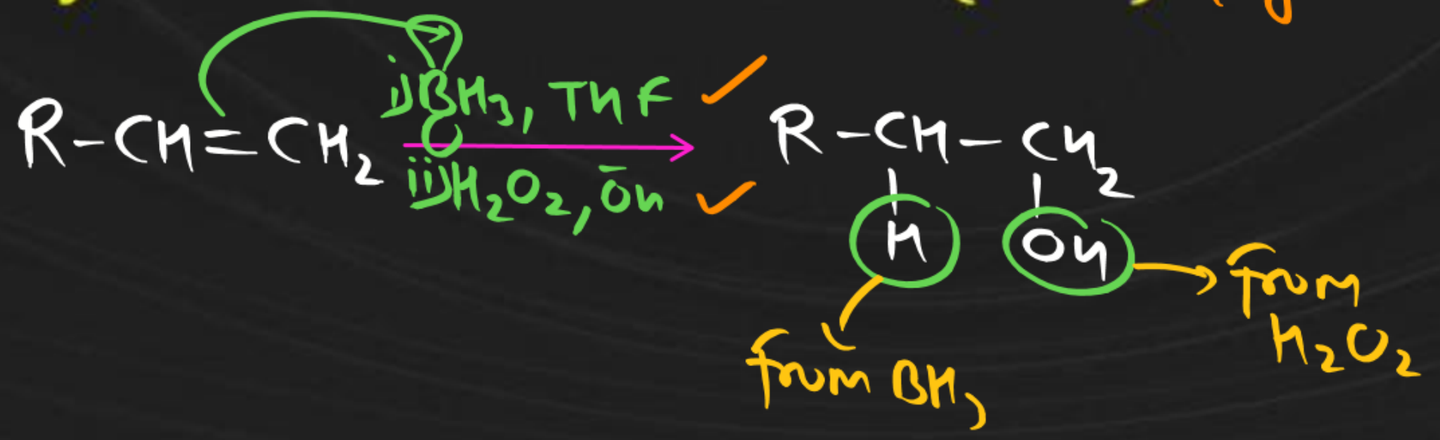


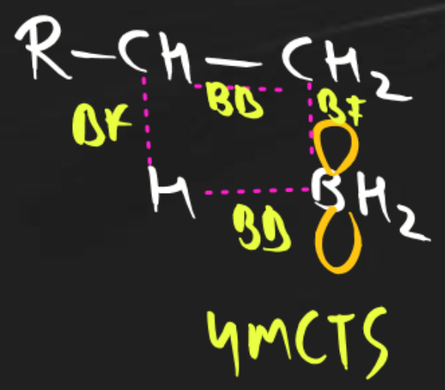
$$H_2SO_4 \longrightarrow H^{\oplus} + HSO_4^{\ominus}$$

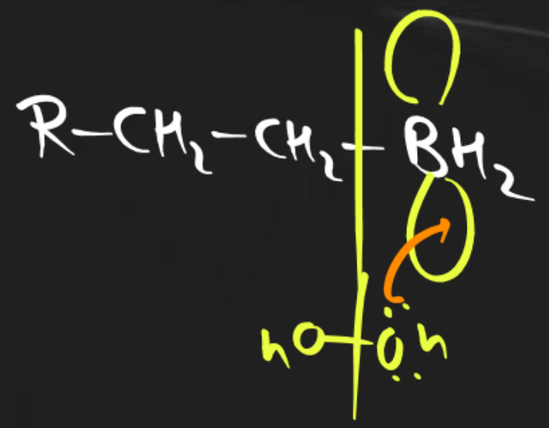
(7) OMDM (Oxymercuration – Demercuration) {MWO R}

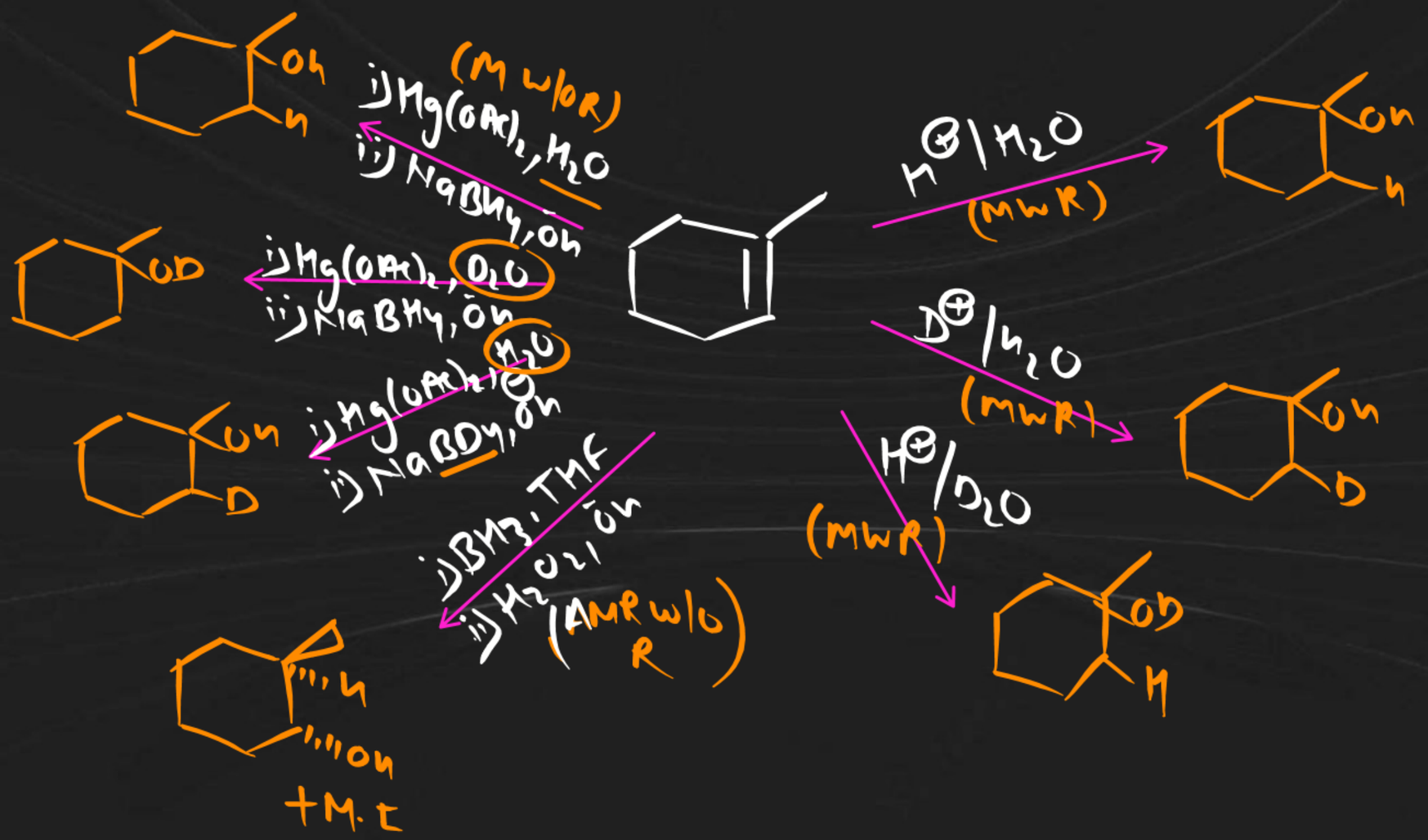


(8) Hydroboration – Oxidation (HBO) {syn addⁿ} {AMR w/o R}

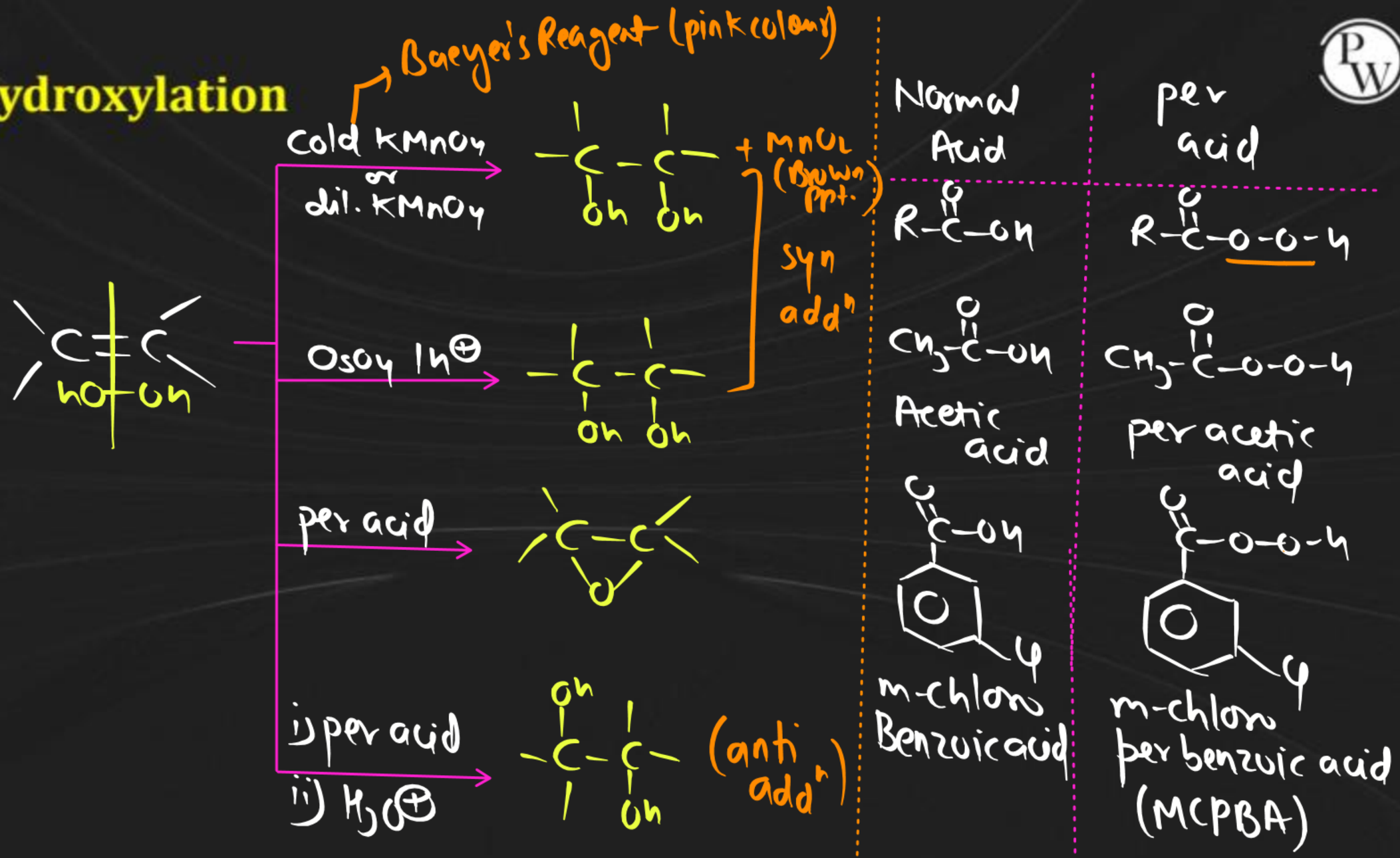




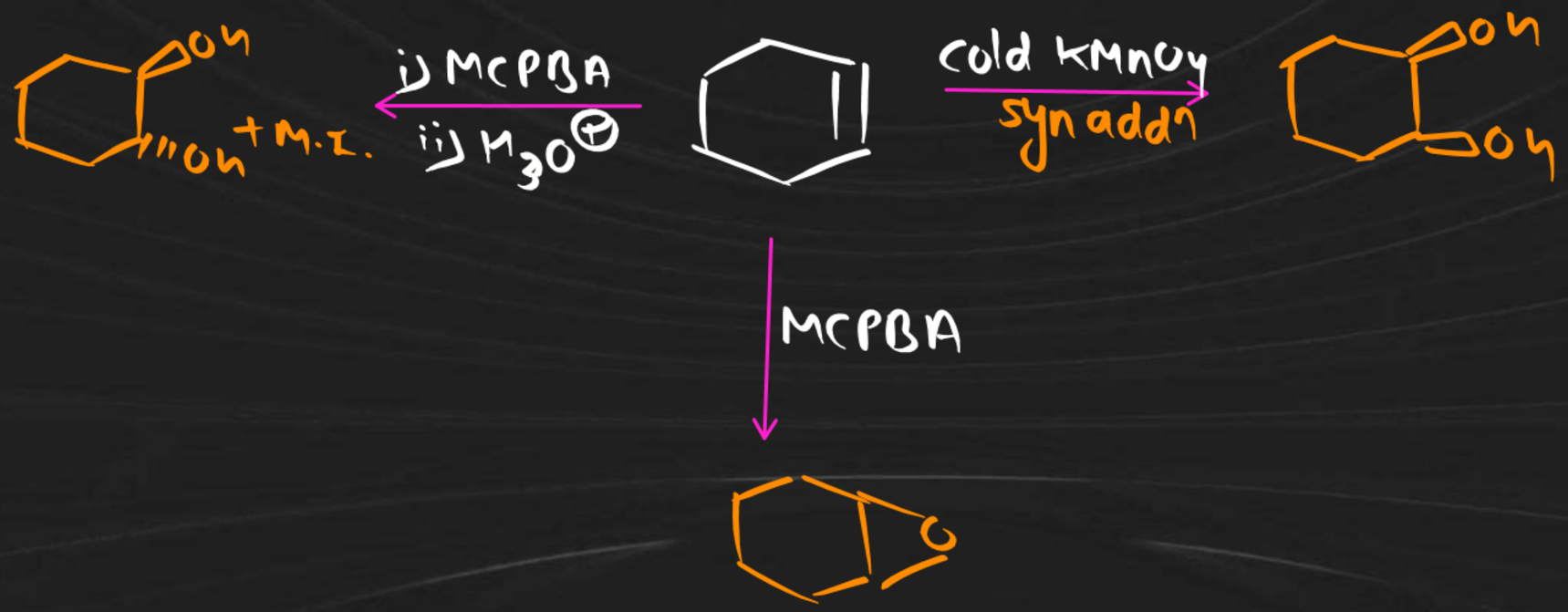



(M w/o R)
i) Mg(OAc)2, H2O
ii) NaBH4, ΔH
i) Mg(OAc)2, D2O
ii) NaBH4, ΔH
i) Hg(OAc)2, H2O
ii) NaBD4, ΔH
i) BH3, THF
ii) H2O2, ΔH
(AMR w/o R)
+M.E
H⊕/H2O
(MWR)
D⊕/H2O
(MWR)
H⊕/D2O
(MWR)

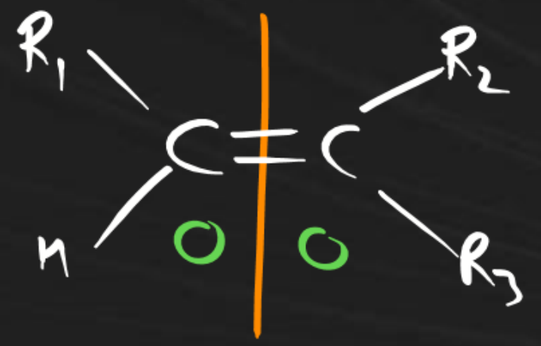
(9) Hydroxylation



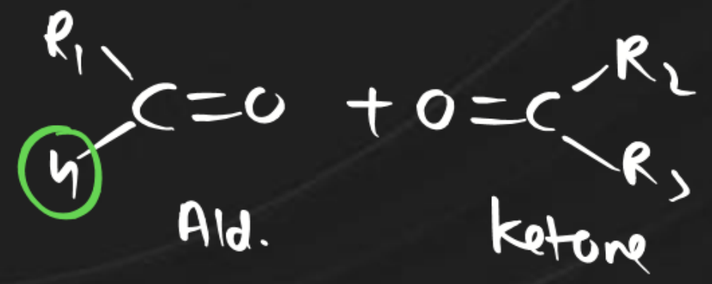
Ex:-



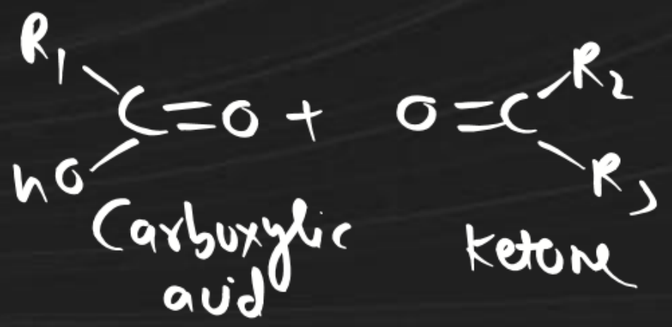
(10) Ozonolysis

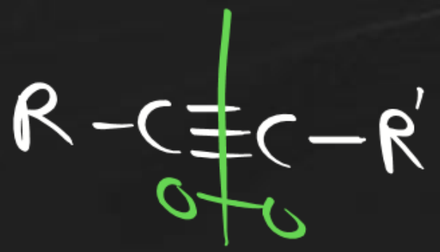


O_3, Zn, H_2O (Reductive) or O_3, Me_2S



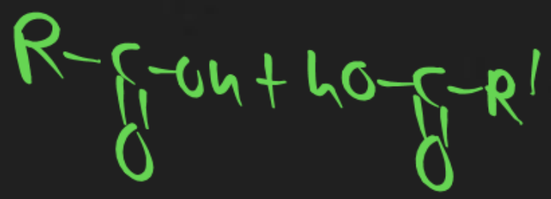
O_3, H_2O or O_3, H_2O_2 or hot $KMnO_4$ or Conc^n $KMnO_4$ (Oxidative)



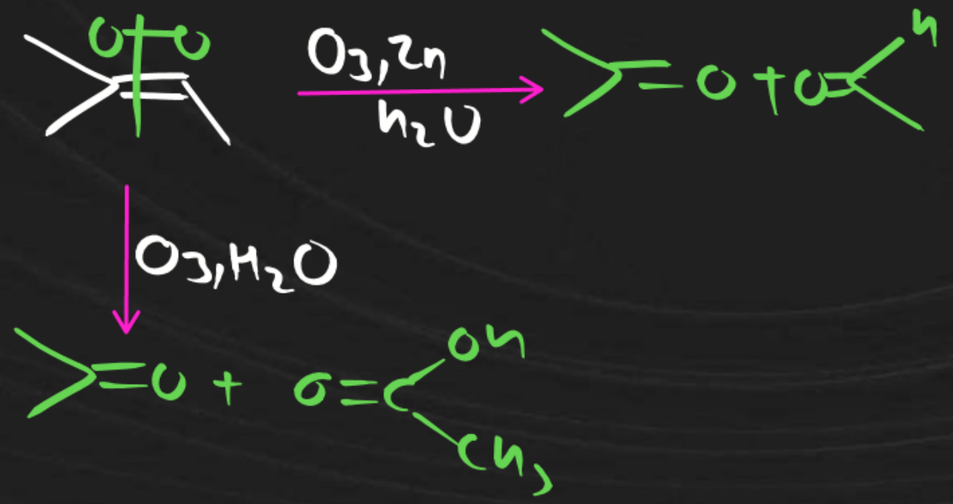


Reductive ozo.

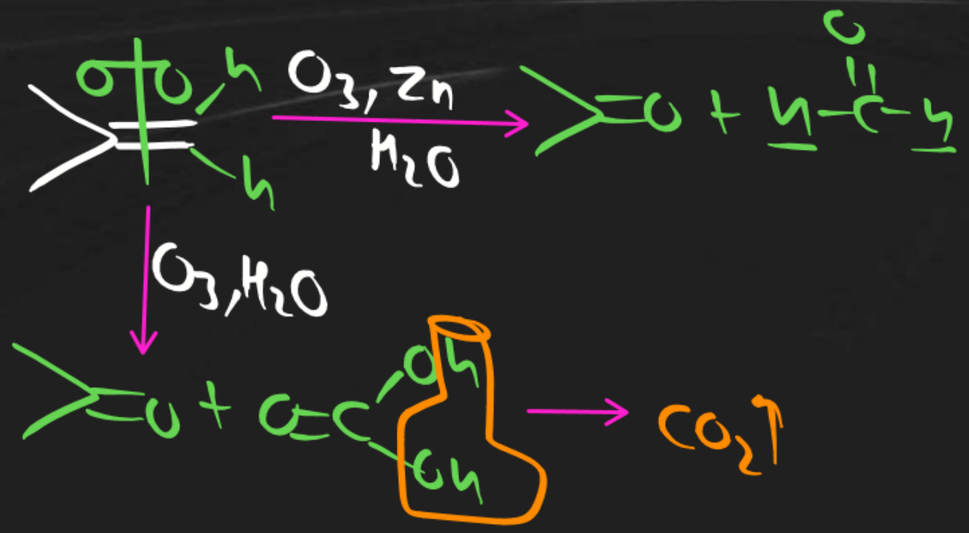
Oxidative ozo.



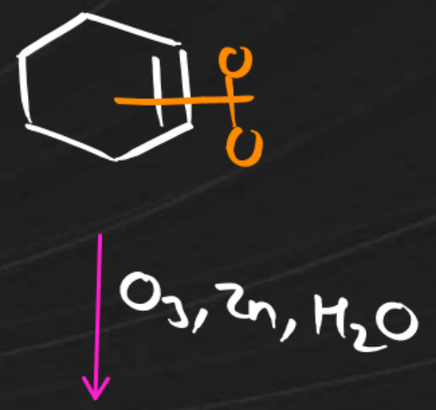
Exm ①

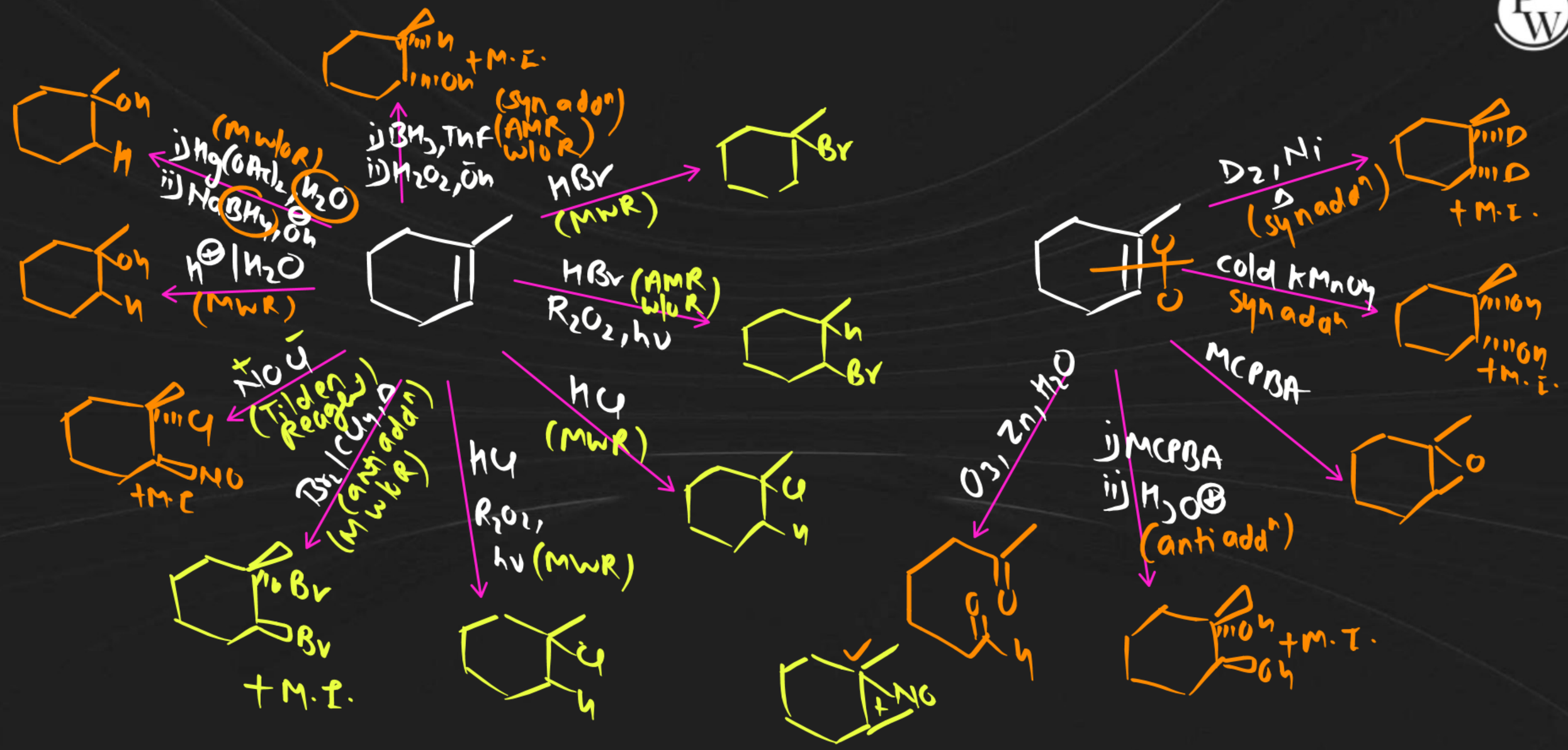


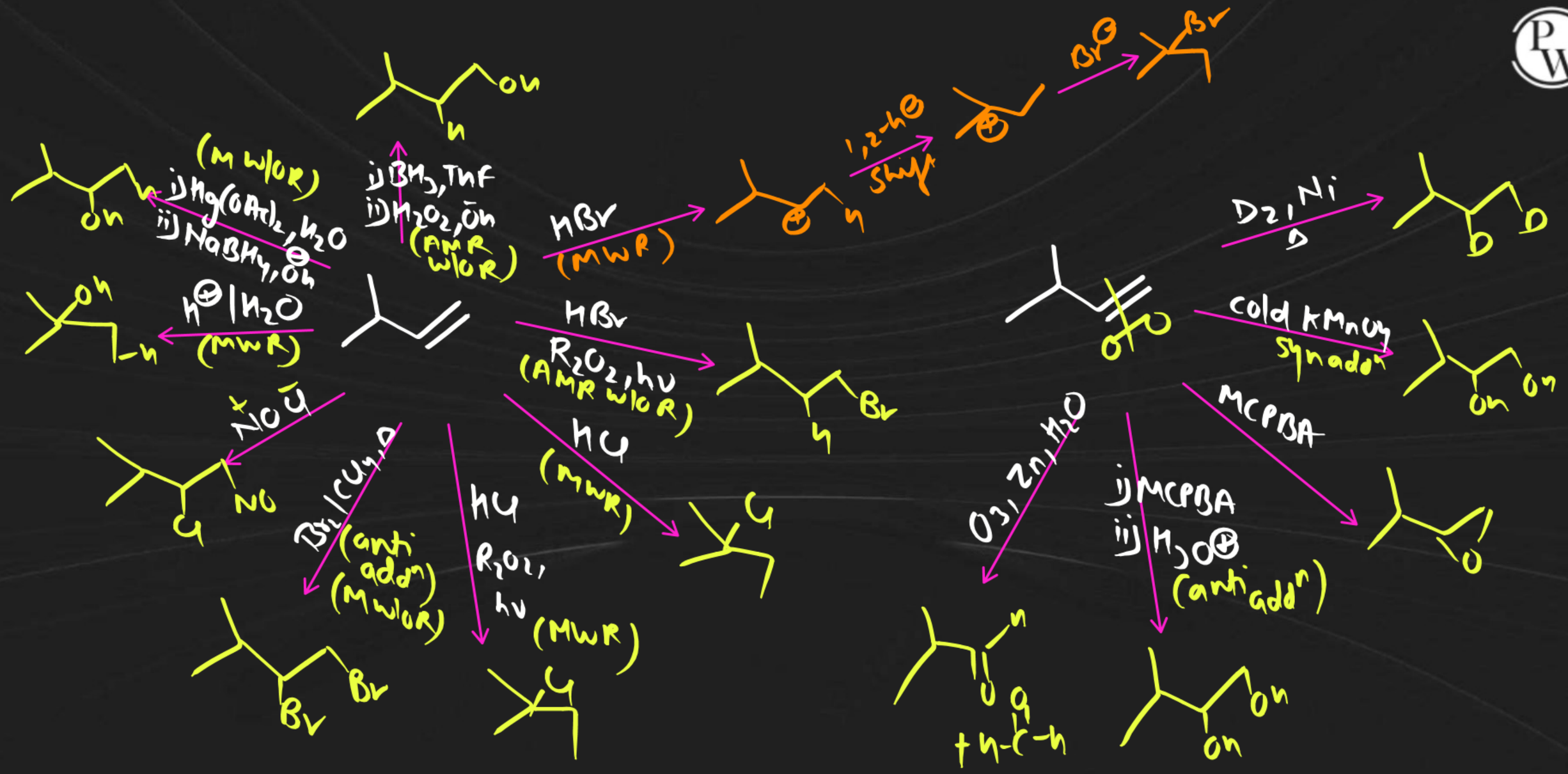
②



③




i) Hg(OAc)2, H2O
ii) NaBH4, OH⊖
(MWOR)
i) BH3, THF
ii) H2O2, OH⊖
(syn addn)
(AMR w/o R)
+M.I.
H⊕ | H2O
(MWR)
HBr
(MWR)
HBr (AMR w/o R)
R2O2, hν
NOCl
(Tilden Reagent)
+M.C
Br2 | CCl4, Δ
(anti addn)
(MWOR)
+M.I.
HCl
(MWR)
HCl
R2O2, hν (MWR)
D2, Ni
Δ
(syn addn)
+M.I.
cold KMnO4
syn addn
+M.I.
MCPBA
O3, Zn, H2O
i) MCPBA
ii) H3O⊕
(anti addn)
+M.I.


(M w/o R)
i) Hg(OAc)2, H2O
ii) NaBH4, OH
i) BH3, THF
ii) H2O2, OH
(AMR w/o R)
HBr
(MWR)
1,2-H⊖ shift
Br⊖
D2, Ni
Δ
H⊕ | H2O
(MWR)
HBr
R2O2, hν
(AMR w/o R)
cold KMnO4
syn addn
NO
Br2 | CCl4, Δ
(anti addn)
(M w/o R)
HCl
(MWR)
HCl
R2O2, hν
(MWR)
O3, Zn, H2O
i) MCPBA
ii) H3O⊕
(anti addn)
MCPBA

ALKYNE

Method of Preparation of Alkyne

(1) From Carbide

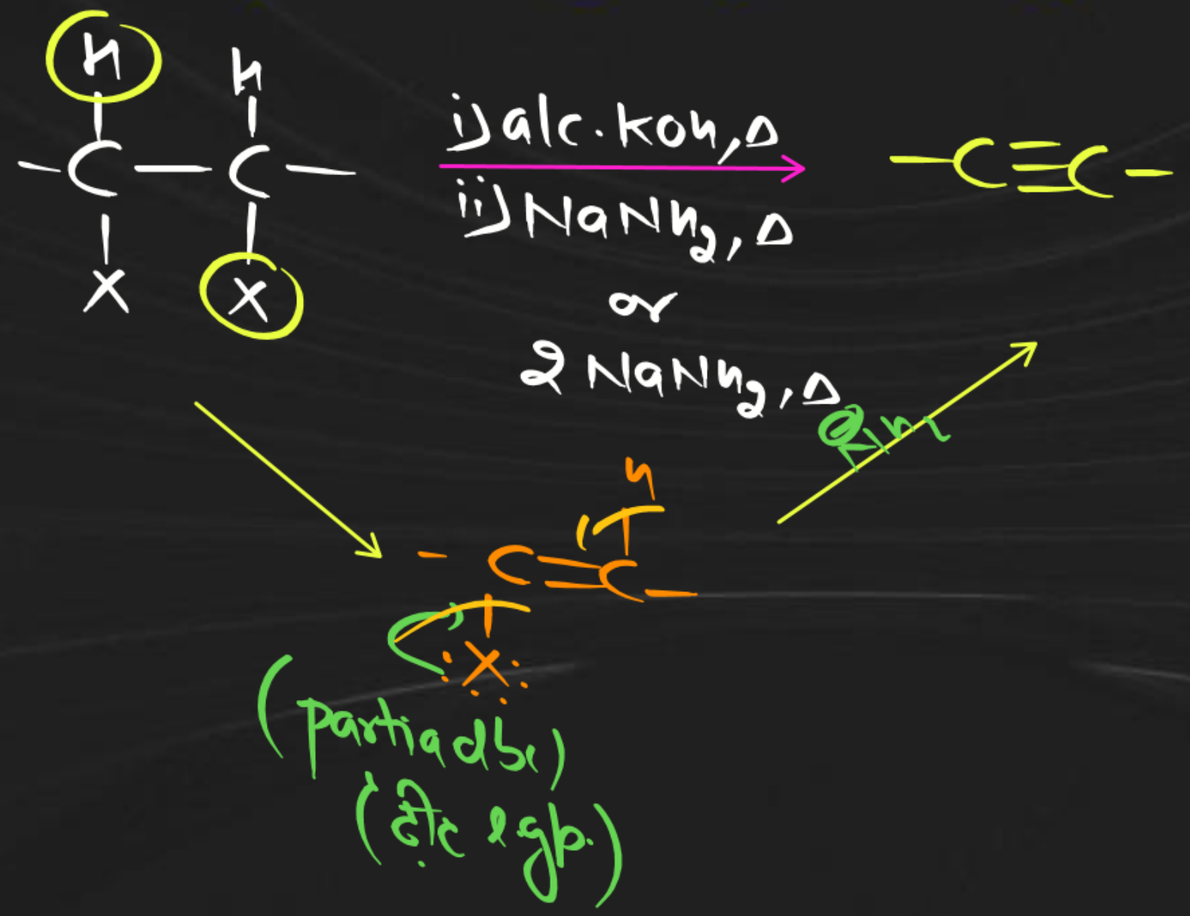
$$CaC_2 \xrightarrow{2H_2O} HC\equiv CH + Ca(OH)_2$$

$$Mg_2C_3 \xrightarrow{4H_2O} CH_3-C\equiv CH + 2Mg(OH)_2$$

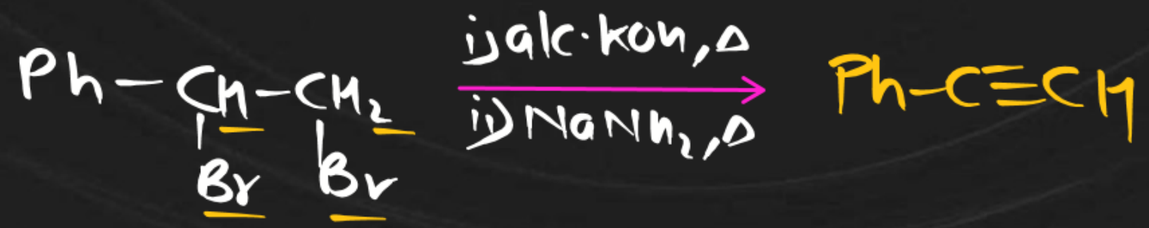
Ca^{+2} C_2^{-2} $\overset{+}{H}-\overset{-}{O}H$

$2Mg^{+2}$ C_3^{-4} C_3H_4

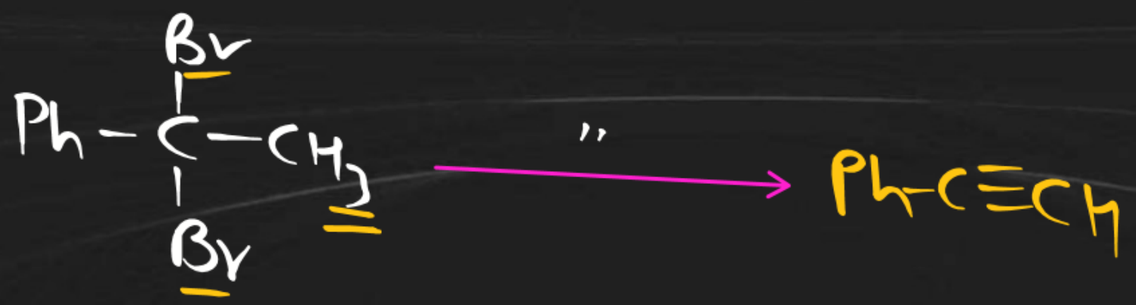
(2) From Alkyl Halide (Dehydrohalogenation) (anti elimⁿ) (E2 rxn.)



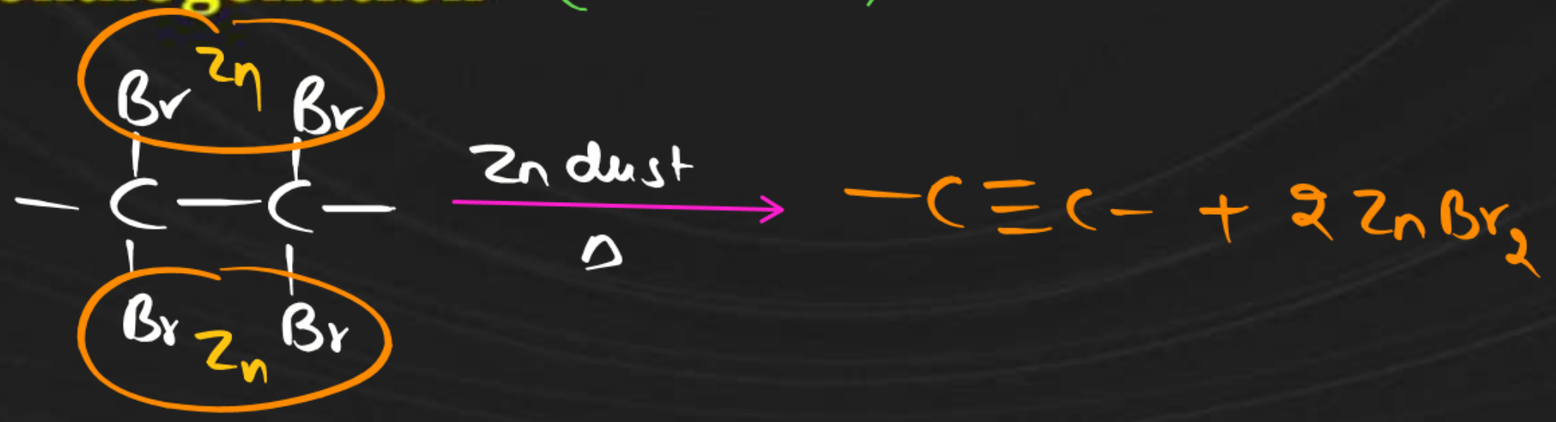
Ex:→ ①



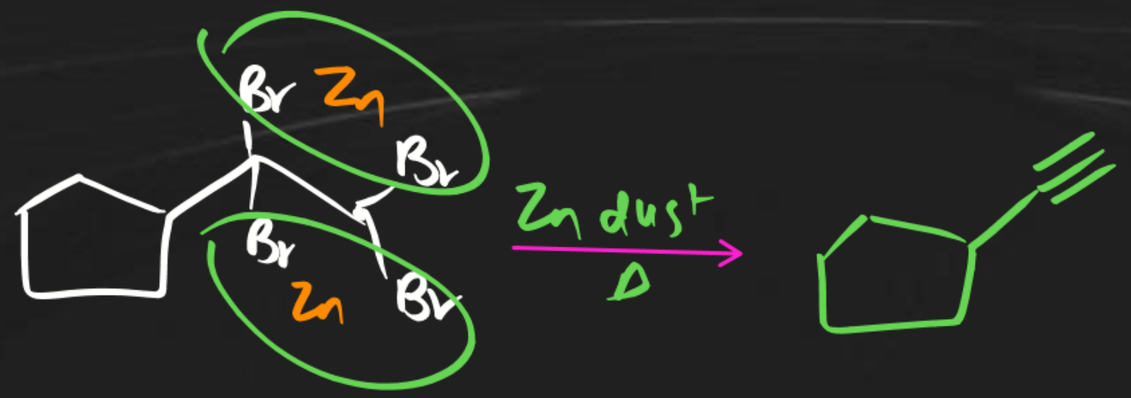
②



(3) Dehalogenation (anti elimⁿ)

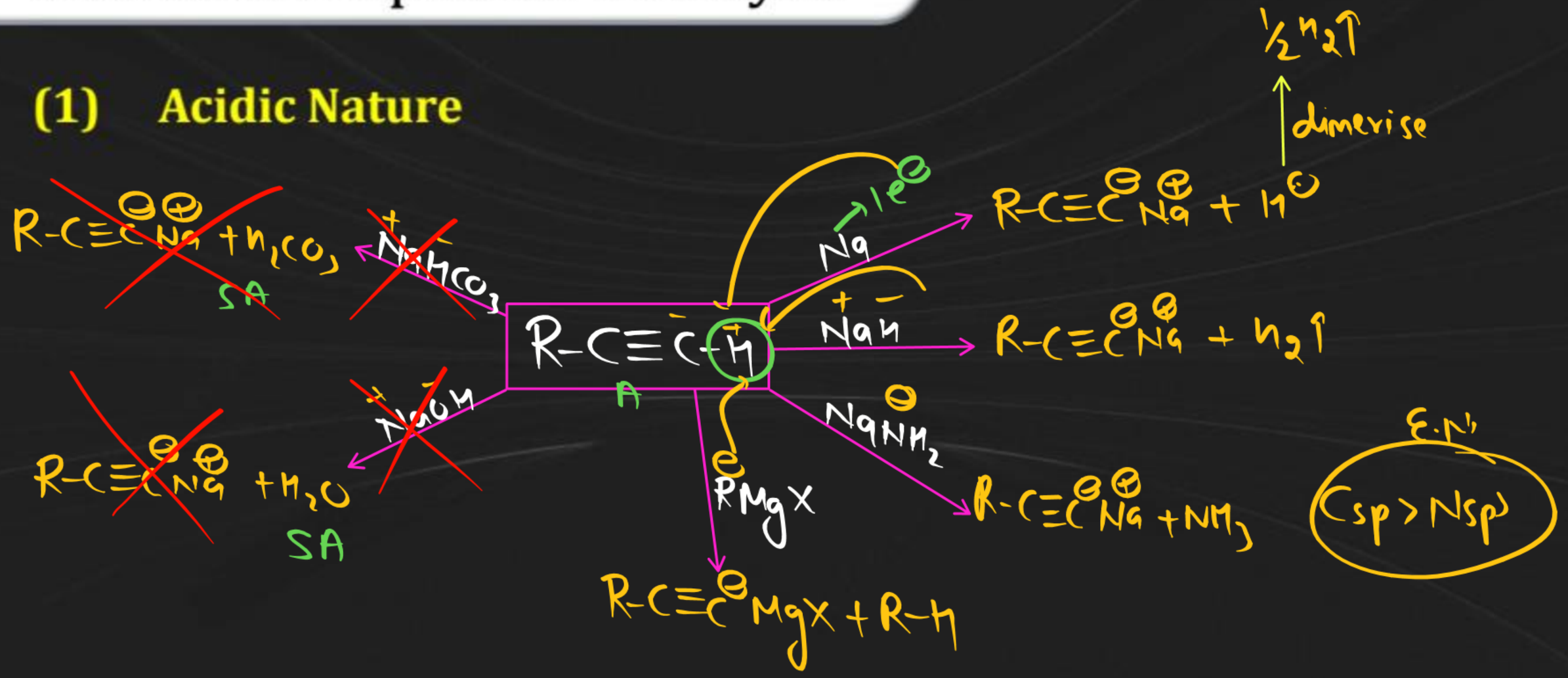


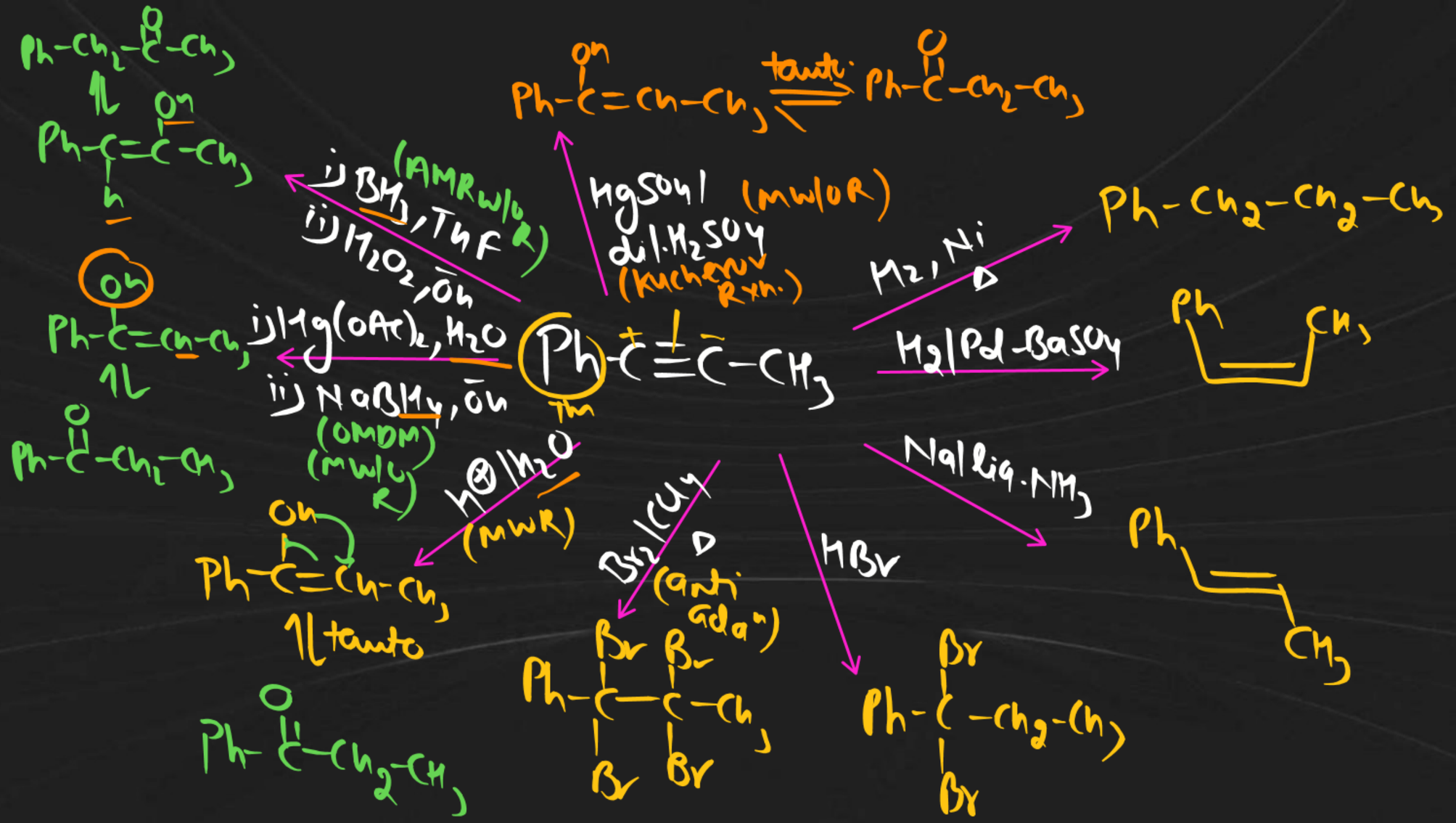
Ex:-



Chemical Properties of Alkyne

(1) Acidic Nature




Ph-CH2-C(=O)-CH3
Ph-C(OH)=C-CH3
Ph-C(OH)=CH-CH3
Ph-C(=O)-CH2-CH3
i) BH3, THF (AMR w/o R)
ii) H2O2, OH⁻
i) Hg(OAc)2, H2O
ii) NaBH4, OH⁻ (OMDM) (MW/O R)
Ph-C(OH)=CH-CH3
tauto
Ph-C(=O)-CH2-CH3
HgSO4/ dil. H2SO4 (MW/OR) (Kucherov Rxn.)
Ph-C(OH)=CH-CH3
tauto
Ph-C(=O)-CH2-CH3
Ph-C≡C-CH3
H2, Ni
Δ
Ph-CH2-CH2-CH3
H2/Pd-BaSO4
Ph
CH3
Na/liq. NH3
Ph
CH3
HBr
Ph-C(Br)2-CH2-CH3
Br2/CCl4
Δ
(anti add^n)
Ph-C(Br)2-C(Br)2-CH3
H⊕/H2O (MWR)
Ph-C(OH)=CH-CH3
tauto
Ph-C(=O)-CH2-CH3

(6) Test of Alkyne

$R-C\equiv C\underline{H}$ (Terminal alkyne)

$\xrightarrow{AgNO_3 + NH_4OH}$ $R-C\equiv C^{\ominus}Ag^{\oplus}$ (white crystalline)

Tollen's reagent

$\xrightarrow{Cu_2Cl_2 + NH_4OH}$ $R-C\equiv C^{\ominus}Cu^{\oplus}$ (Brick Red)

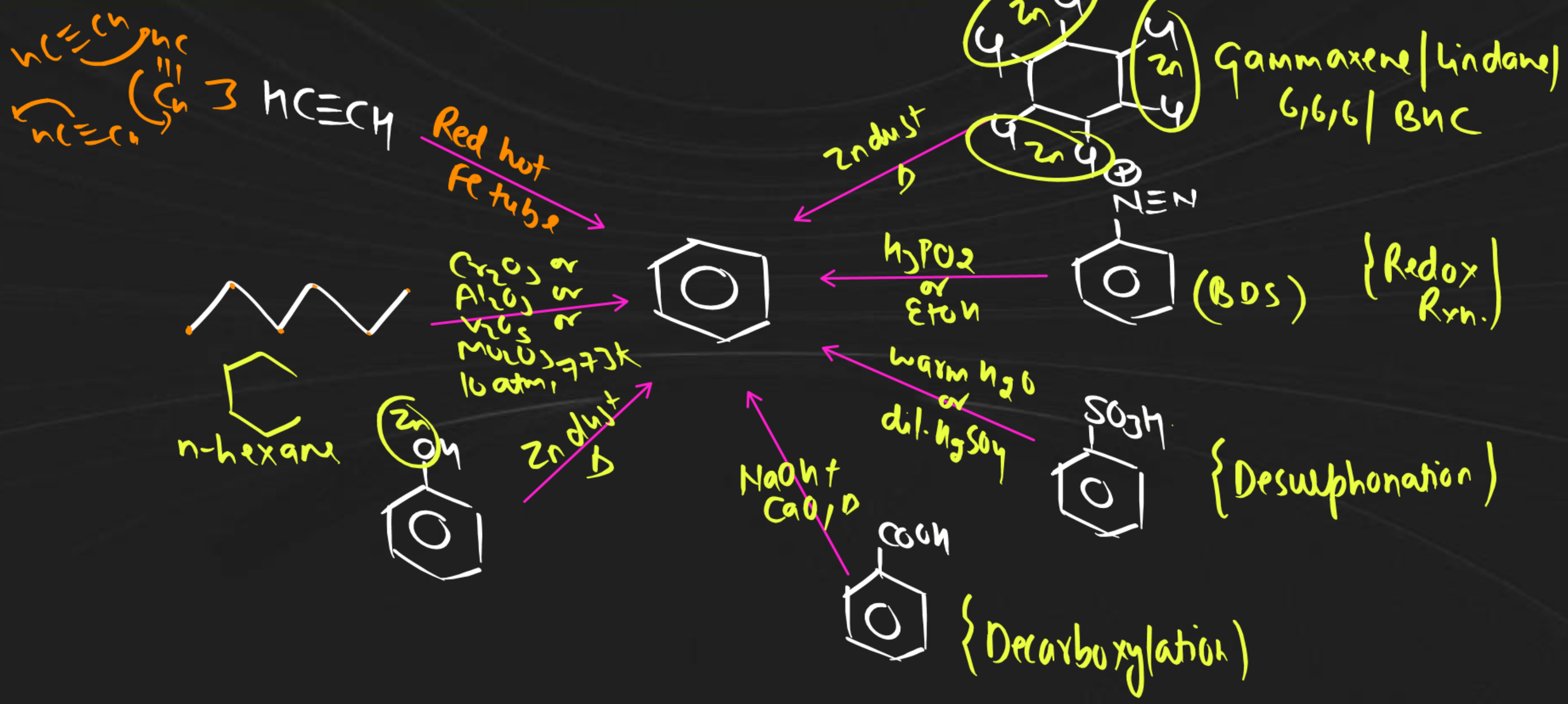
$R-C\equiv C-R'$ (Non-terminal alkyne)

$\xrightarrow{''}$ No rxn

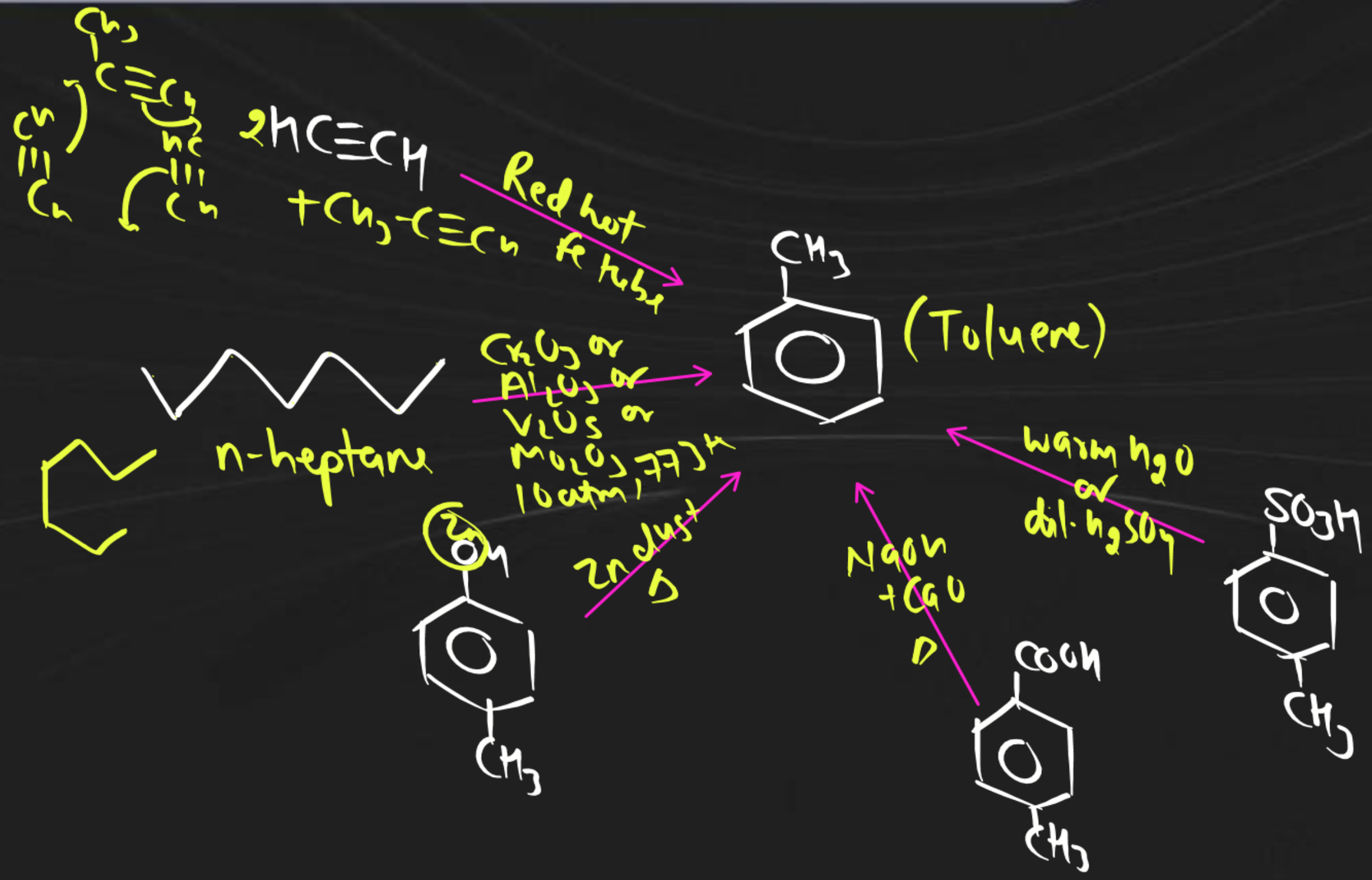
$\xrightarrow{''}$ no rxn

AROMATIC HYDROCARBON

Method of Aromatic Hydrocarbon



Method of Aromatic Hydrocarbon



Chemical Properties of Aromatic Hydrocarbon

(Aromaticity loss)

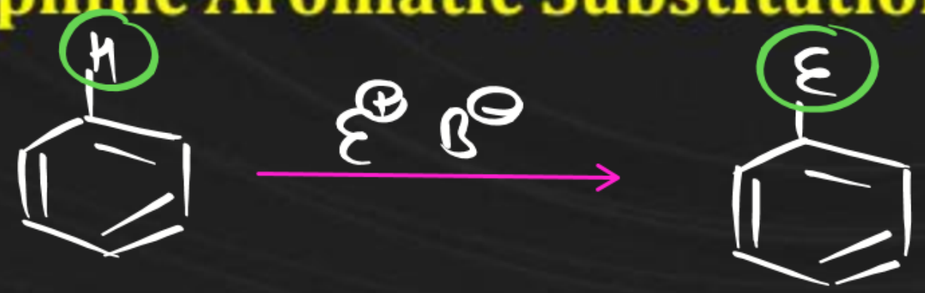
Gehri Baat :-

Aromatic Hydrocarbon $E^{\oplus}$ add^n rxn. nhi dete.

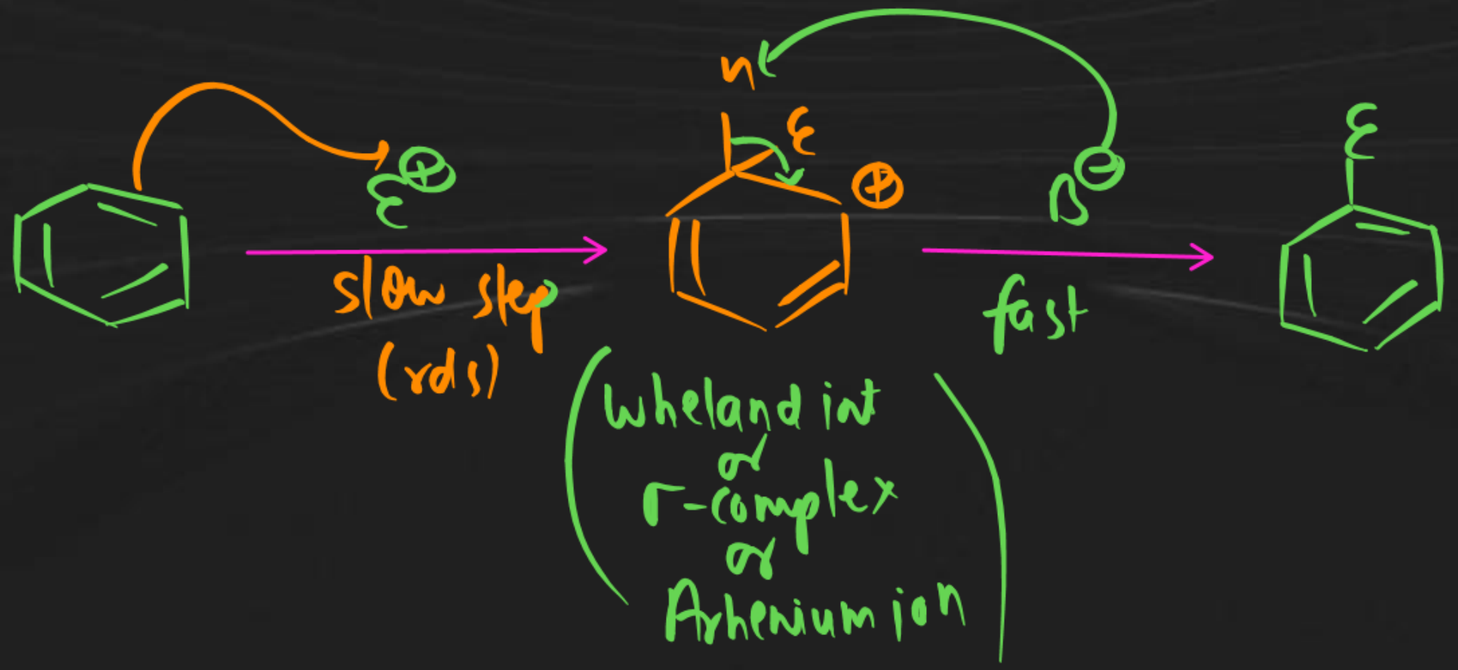
kynki aromaticity chali jati h.

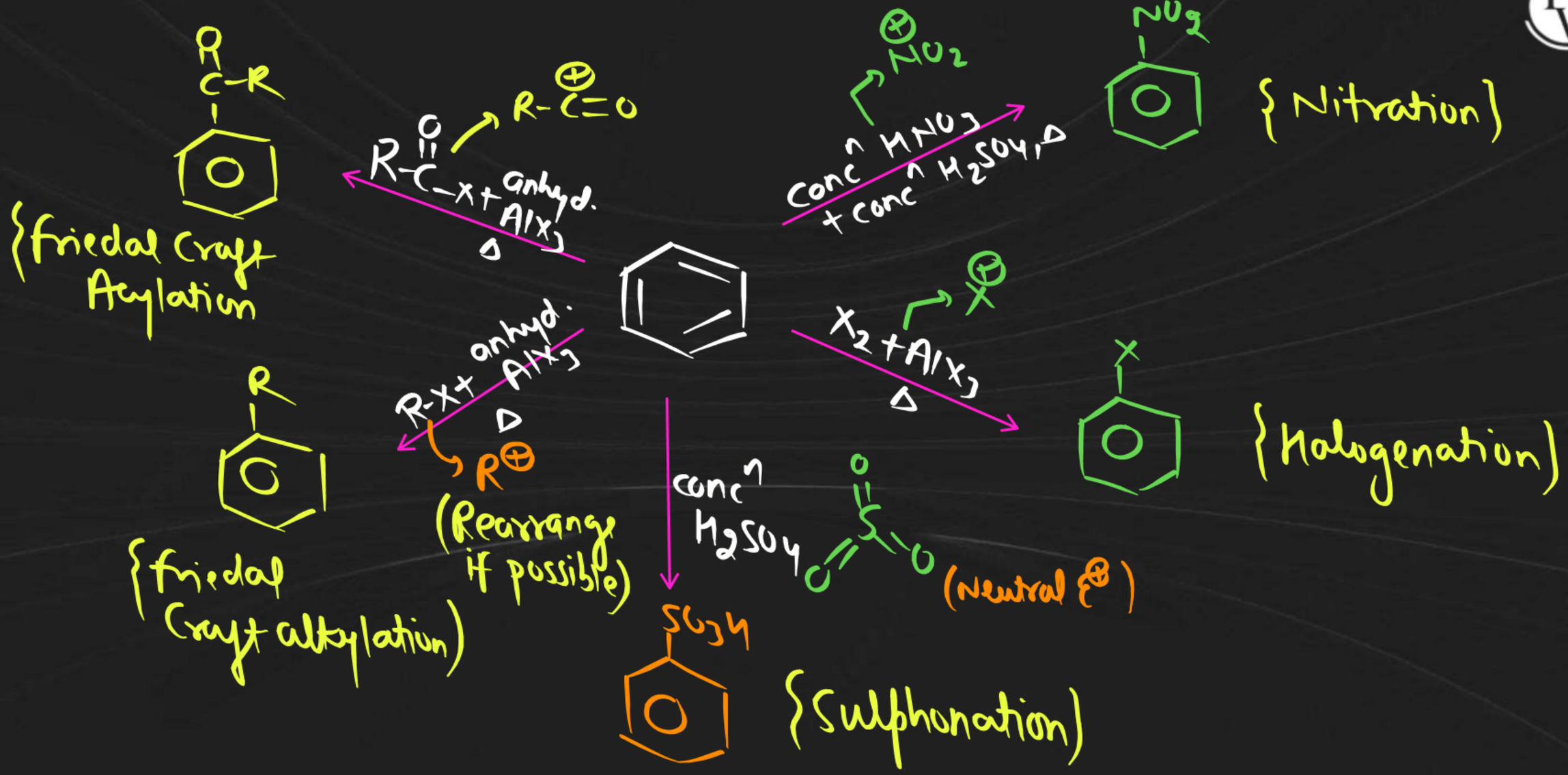
Electrophilic Substitution Reaction or Electrophilic Aromatic Substitution Reaction

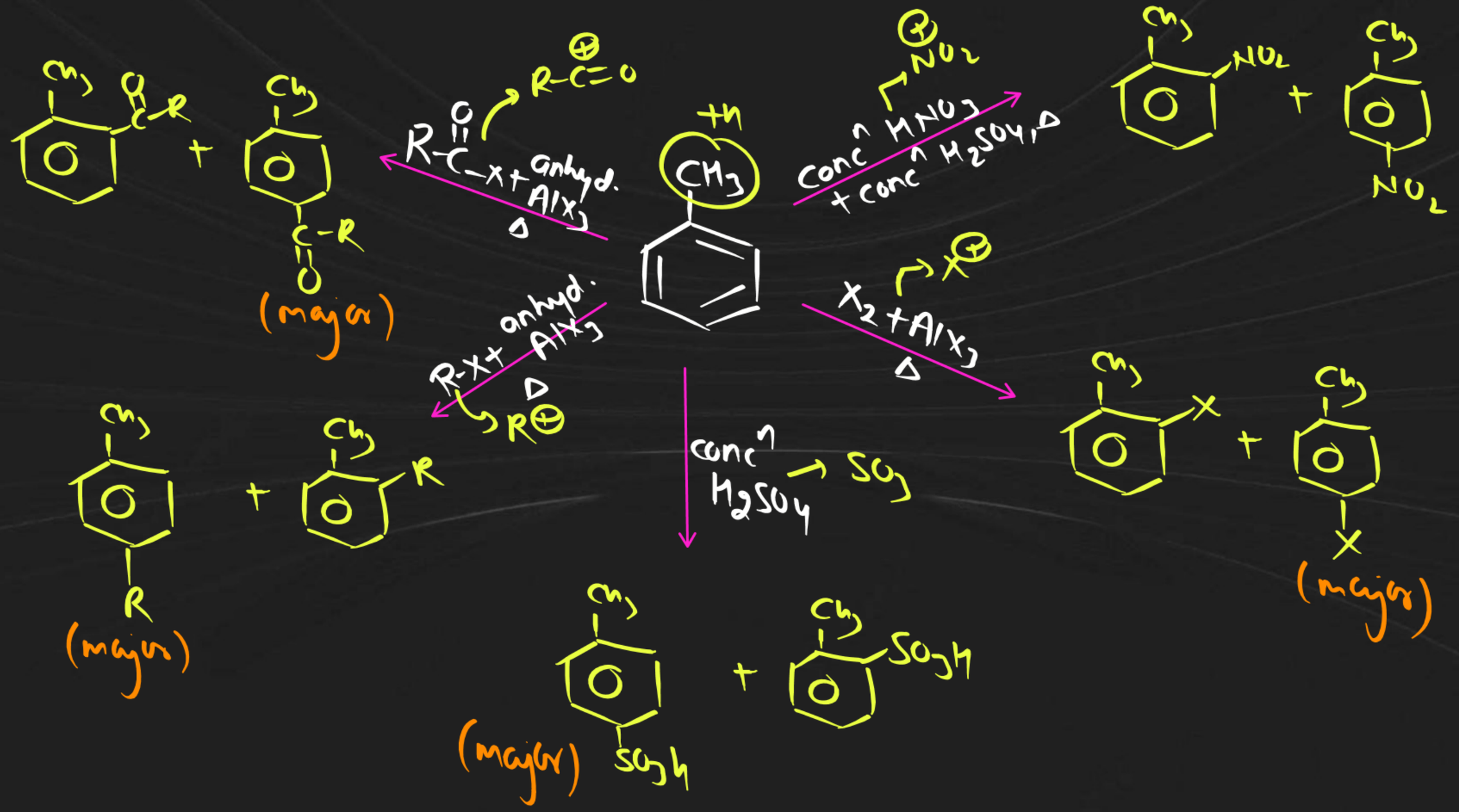
Rxn:-

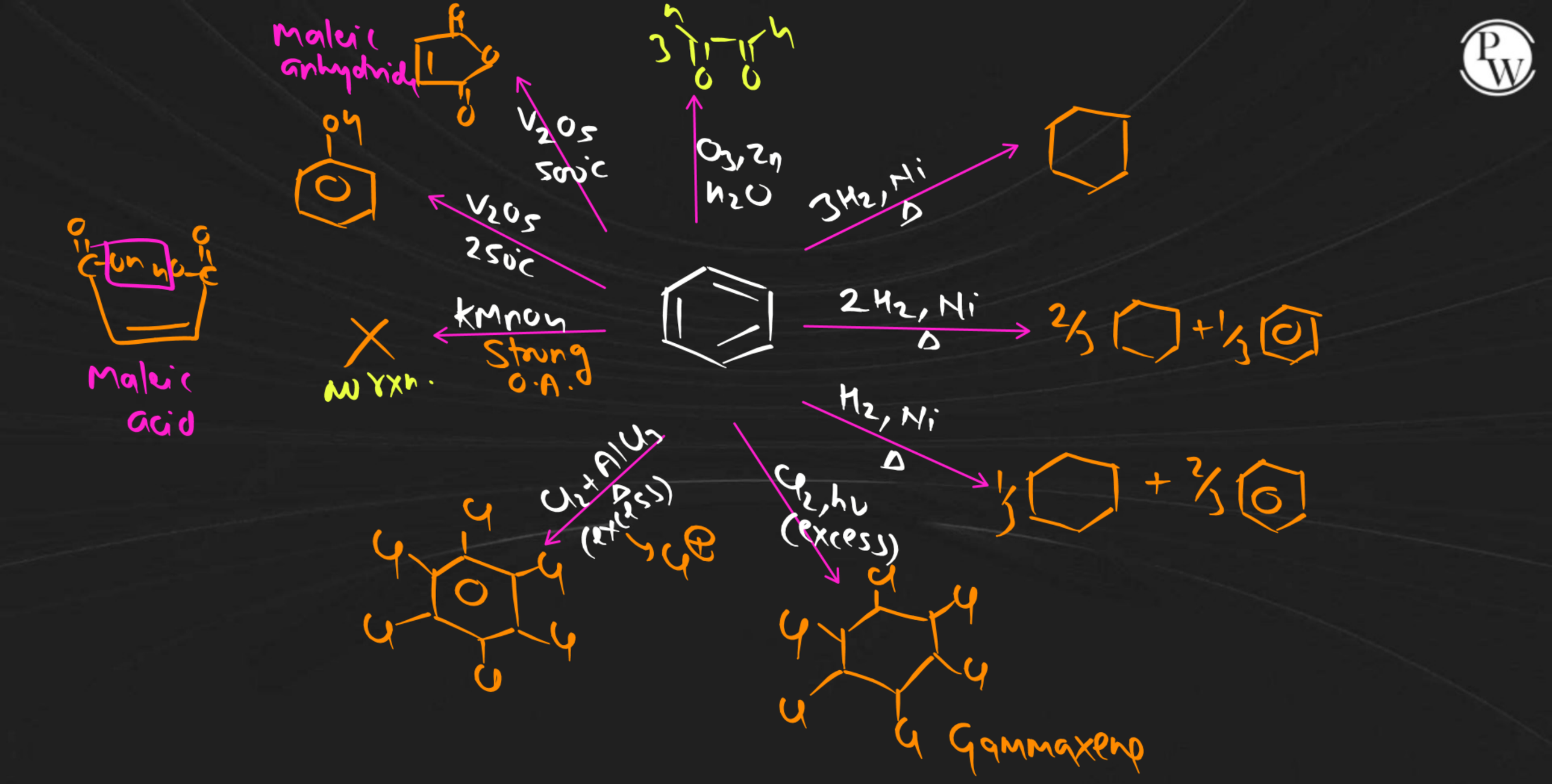


Mechⁿ:-




{Friedal Crafts Acylation
R-C(=O)-X + anhyd. AlX3
Δ
R-C≡O
conc^n HNO3 + conc^n H2SO4, Δ
NO2
{Nitration}
X2 + AlX3
Δ
X
{Halogenation}
R-X + anhyd. AlX3
Δ
R
(Rearrange if possible)
{Friedal Crafts alkylation}
conc^n H2SO4
(Neutral E⊕)
SO3H
{Sulphonation}


CH3
+n
R-C(=O)-X + anhyd. AlX3
Δ
R-C≡O
(major)
conc^n HNO3 + conc^n H2SO4, Δ
NO2
R-X + anhyd. AlX3
Δ
R⊕
X2 + AlX3
Δ
X⊕
conc^n H2SO4
SO3
(major)
SO3H


Maleic anhydride
V_2O_5
500°C
O_3, Zn
H_2O
V_2O_5
250°C
$3H_2, Ni$
Δ
$KMnO_4$
Strong O.A.
No rxn.
$2H_2, Ni$
Δ
2/3 + 1/3
H_2, Ni
Δ
1/3 + 2/3
$Cl_2 + AlCl_3$
(excess)
$Cl_2, h\nu$
(excess)
Gammaxene
Maleic acid

THANK *You*