# Reducing agents:

| R-MgX |
| R$_2$CuCl |

| Na |
| Sn/HCl |
| Fe/HCl |
| Mg/Et$_2$O |
| Zn-Hg/HCl |
| Na-C$_2$H$_5$OH |
| Na in liq NH$_3$ |

| LiAlH$_4$ |
| NaBH$_4$ |
| DIBAL |
| B$_2$H$_6$ |

| H$_2$/Cat |
| N$_2$H$_4$/H$_2$O$_2$ |
| H$_2$-Pd/BaSO$_4$ |
| (i) N$_2$H$_4$/$\overset{\ominus}{O}H$, $\Delta$ |
| Red P/HI |

Reactant $\xleftarrow{e^-\text{donor}}$ gets Reduced.

$$R-X \xrightarrow[Et_2O]{Mg} \overset{\delta-}{R}-\overset{\delta+}{MgX}$$

**Acid-Base Rxn**

$$\overset{\delta-}{R}-MgX \xrightarrow{\text{Acid-Base Rxn}} R-H + M\overset{+}{g}X\overset{-}{En}$$

$$\underset{\substack{\delta+ \quad \delta- \\ H-En}}{} $$

$$H-OH \mid H-OR \mid H_2N-R \mid H-C\equiv C-R \quad ''$$

**Nucleophilic** $add^n / add^n$ **Ellimin.**

(i) $R'-\overset{O \,\, sp^2}{\underset{lg}{C}}$

(ii) $NH_4Cl$

$$R-\overset{OH}{\underset{R'}{\overset{|}{\underset{|}{C}}}}{}^{R}$$

**Nucleophilic Subs. $Rx^n$**

$$\underset{sp^3}{R'-X} \; (SN^2) \longrightarrow R-R'$$

(1) $R-MgX + \overset{\overset{O}{\|}}{\underset{\underset{O}{\|}}{C}} \xrightarrow[\text{(ii) } H^+]{} R-C\overset{\nearrow O}{\underset{\searrow OH}{}}$  (Carboxylic Acid)

(2) $R-MgX + R'-C\equiv N \xrightarrow[\text{(ii) } H_2O]{} R-\overset{\overset{O}{\|}}{C}-R'$  (Ketone)

Order of rate of GR (Nu) with following

(3) (i) $H-\overset{\overset{O}{\|}}{C}\diagdown H > R-\overset{\overset{O}{\|}}{C}\diagdown H > R-\overset{\overset{O}{\|}}{C}\diagdown R$

(ii) $R-\overset{\overset{O}{\|}}{\underset{\delta+}{C}}\diagdown X > R-\overset{\overset{O}{\|}}{\underset{\delta+}{C}}\diagdown H > R-\overset{\overset{O}{\|}}{\underset{\delta+}{C}}\diagdown R > R-\overset{\overset{O}{\|}}{\underset{\delta'''+}{C}}\diagdown O \overset{\overset{O}{\|}}{C}\diagdown R > R-\overset{\overset{O}{\|}}{\underset{\delta'''+}{C}}\diagdown OR' > R-\overset{\overset{O}{\|}}{\underset{\delta'''+}{C}}\diagdown NR_2$

(4) $R-mgX + H-\overset{\overset{\displaystyle O}{\|}}{C}-H \longrightarrow R-\underset{1°}{CH_2}-OH$

$+ R_1-\overset{\overset{\displaystyle O}{\|}}{C}-H \longrightarrow R_1-\underset{2°}{\overset{\overset{\displaystyle OH}{|}}{CH}}-R$

$+ R_1-\overset{\overset{\displaystyle O}{\|}}{C}-R_2 \longrightarrow \underset{R_1}{\overset{OH}{\underset{\overset{|}{R}}{\overset{|}{\underset{\displaystyle C}{}}}}}R_2 \quad 3°$

$mgX\overset{+}{O}^{-}$ ... $O^{-}mgX$ ... $\overset{-}{O}\overset{+}{mgX}$

$m\overset{+}{g}X\overset{-}{O}$ ... $\langle O \rangle$ ... $\overset{-}{O}\overset{+}{mgX}$ $+$ $\underset{R}{\overset{R}{\underset{|}{\overset{|}{R}}}}R$

$+ 2RH$

(5) "$P$" $R-mgX$ $+$



$P_{min} = "5"$

$\xrightarrow{NH_4Cl}$

$$R-\overset{O}{\overset{\|}{C}}-X$$

$$R-\overset{O}{\overset{\|}{C}}-OR'$$ → $R-CH_2-OH$

$$R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R$$ → $R-CH_2-OH$

$$R-\overset{O}{\overset{\|}{C}}-OH$$ → $R-CH_2-OH$

$$R-CH=O$$ → $R-CH_2-OH$

$$R-\overset{O}{\overset{\|}{C}}-R$$ → $R-\overset{OH}{\overset{|}{C}H}-R$

**LiAlH₄**

⇒ Strg Reducing agent

⇒ Not Chemeosclectne

$R-CH=NH$ → $R-CH_2-NH_2$

$R-C\equiv N$ → $R-CH_2-NH_2$

$R-CH_2-N_3$ → $R-CH_2-NH_2$

$R-CH_2-NO_2$ → $R-CH_2-NH_2$

$R-CONH_2$ → $R-CH_2-NH_2$

$R-CONHR$ → $R-CH_2-NHR$

$R-CONR_2$ → $R-CH_2NR_2$

**Q :**



?
most appropriate for
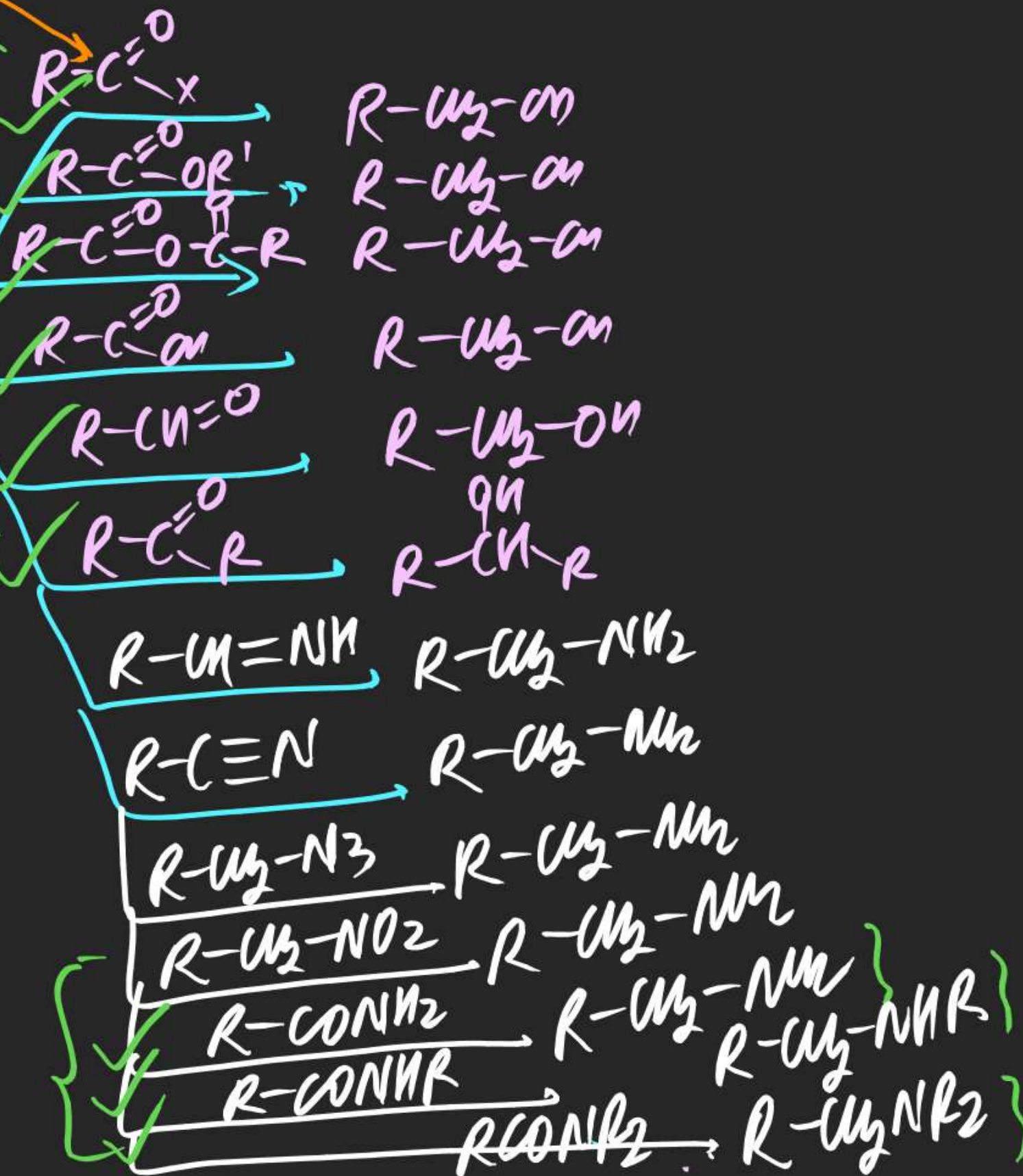
(A) $LiAlH_4$

(B) $NaBH_4$ ✓

(C) $B_2H_6$

(D) $R-MgX$

**Q :** [xx]

$$Ph-CH=CH-COOH \xrightarrow{LiAlH_4} Ph-CH_2-CH_2-CH_2-OH$$

$\Rightarrow$ NaBH₄ — Acid Halide ✓  Ester  Amide  Acid anhydride  Acid
$\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad\quad$ X $\quad$ X $\quad\quad$ X $\quad\quad\quad$ X

$\quad\quad\quad\quad\quad\quad\quad\quad$ Aldehyde ✓

$\quad\quad\quad\quad\quad\quad\quad\quad$ Ketone ✓

$\quad\quad\quad\quad\quad\quad\quad\quad$ Imine ✓

$$\left( \overset{N}{\underset{C}{\|}} \right)$$

$\Rightarrow$ B₂H₆ — RCOOH $>$ R-COOR' $\quad$ Acid halide
$\quad\quad\quad\quad\quad\quad\quad$ ✓ $\quad\quad$ ✓ $\quad\quad\quad\quad$ X

$\quad\quad\quad\quad\quad\quad$ R-CHO , R-$\overset{O}{\underset{\|}{C}}$-R $\quad$ Alkene ✓

(#)
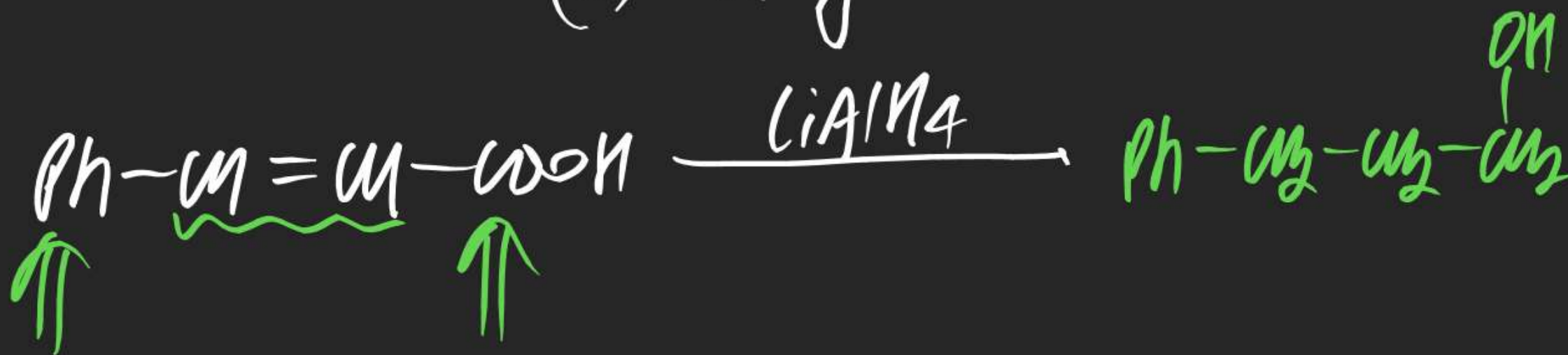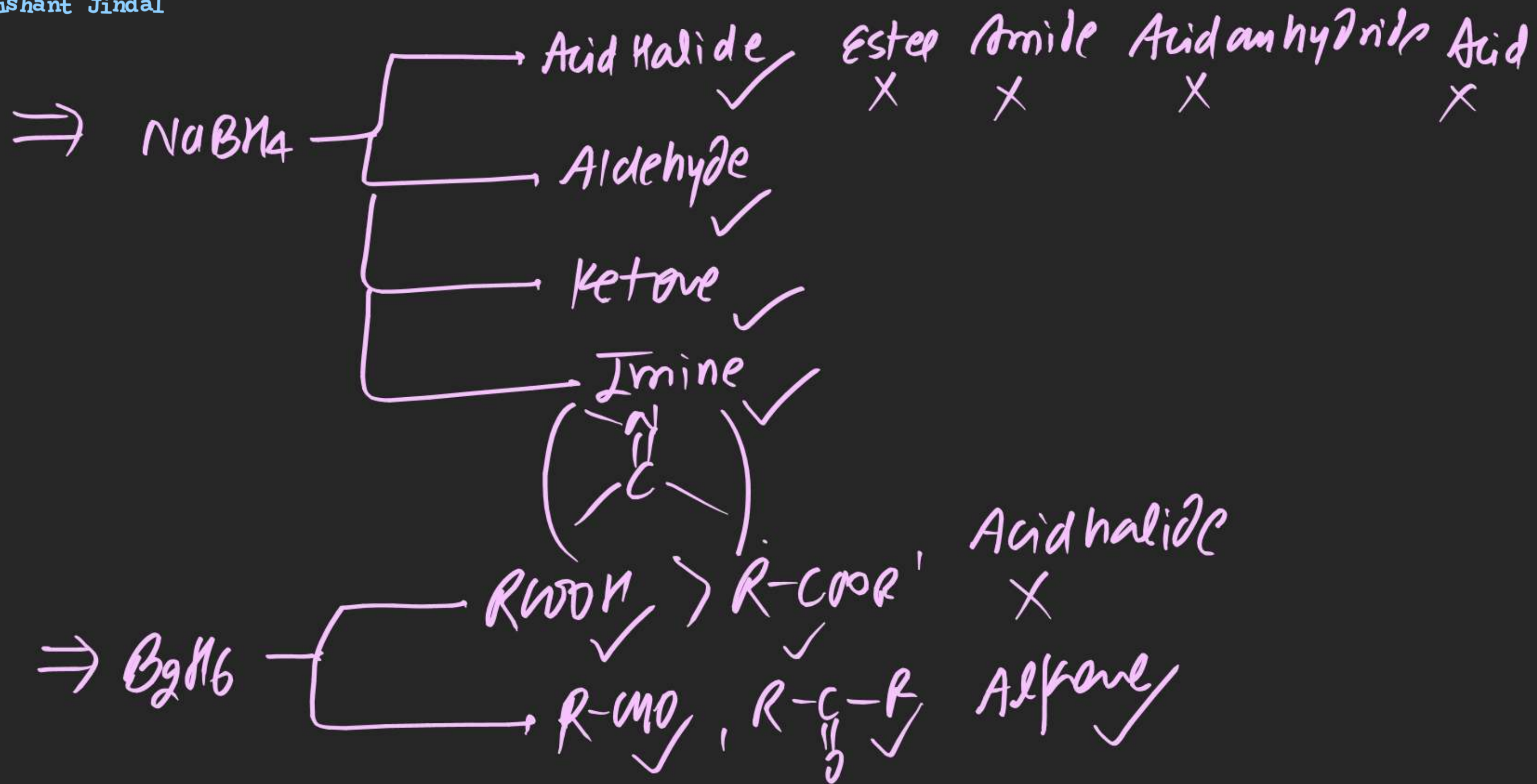
DIBAL-H

⇒ One step. Reducing agent
⇒ −78°C

$R-C\equiv N$

$R-C\overset{O}{\underset{H}{\lessgtr}}$

$R-C\overset{O}{\underset{O-R'}{\lessgtr}}$  $R-C\overset{O}{\underset{H}{\lessgtr}} + R'-OH$

(#)
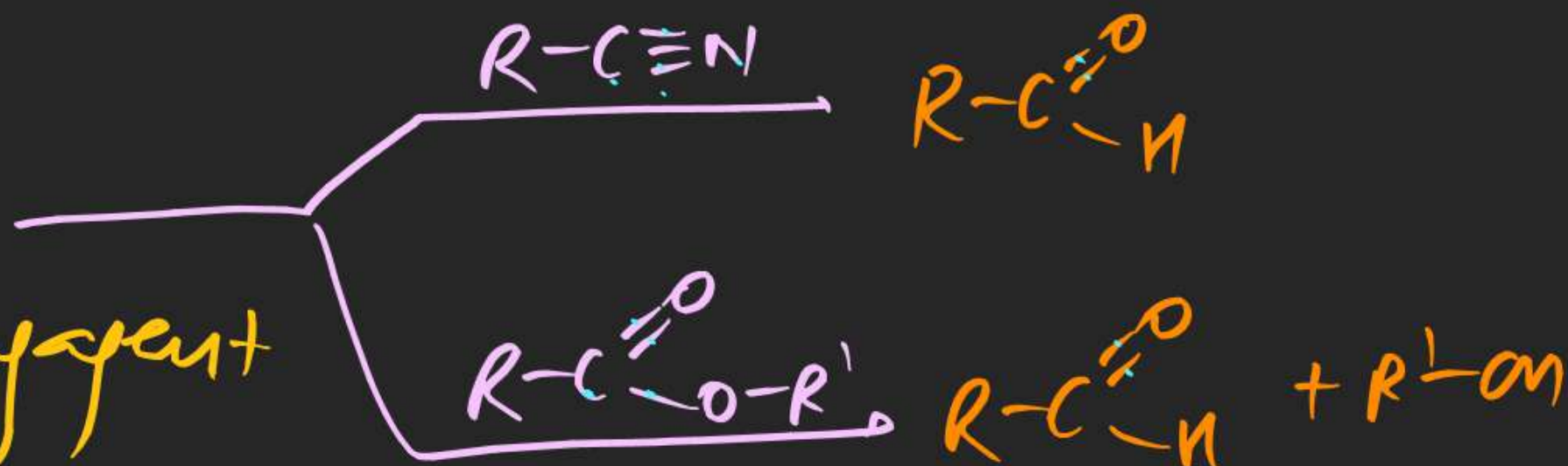
Both Reduces only
Aldehyde/ketone

① 

Ketone

OH

Acid

$Zn-Hg/HCl$ (Acidic condn)
Clemensen Reduction

(i) $N_2H_4$ (ii) $\overset{\ominus}{O}H/\Delta$ (Basic condn)
Wolf Kishner Reduction

OH

②

Cl

Cl

OH

Cl

OH

# (#) Red P/HI

$$R - OH \xrightarrow{\text{Red P/HI}} R \sim H$$

$$R - CH = O \xrightarrow{\quad '' \quad} R - CH_3$$

$$\underset{R}{\overset{R}{>}} C = O \xrightarrow{\quad '' \quad} \underset{R}{\overset{R}{>}} CH_2$$

(1)

$$\begin{array}{c} CH = O \\ H - | - OH \\ HO - | - H \\ H - | - OH \\ H - | - OH \\ CH_2OH \end{array} \xrightarrow[HI]{Red P}$$

(2)

$$\begin{array}{c} CH_2 - OH \\ C = O \\ HO - | - H \\ H - | - OH \\ H - | - OH \\ CH_2OH \end{array} \xrightarrow[\Delta]{HI}$$

(3)

$$\begin{array}{c} CH = O \\ H - | - OH \\ CH_2OH \end{array} \xrightarrow{\quad '' \quad}$$

# (#) Hydryation:-

(1) Rosenmund Reduction:

$$R-C{\overset{\displaystyle =O}{\underset{\displaystyle Cl}{}}} + H_2 \xrightarrow[BaSO_4]{Pd} R-C{\overset{\displaystyle =O}{\underset{\displaystyle H}{}}}$$

(2) $R-C\equiv C-R + H_2 \xrightarrow[BaSO_4]{Pd}$ $\underset{H}{\overset{R}{}}C=C\underset{H}{\overset{R}{}}$ 100% Cis
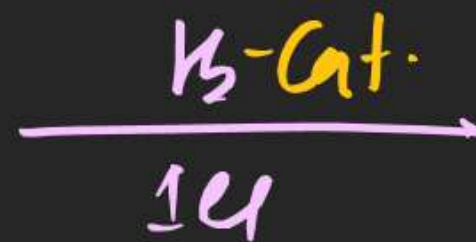
(3)
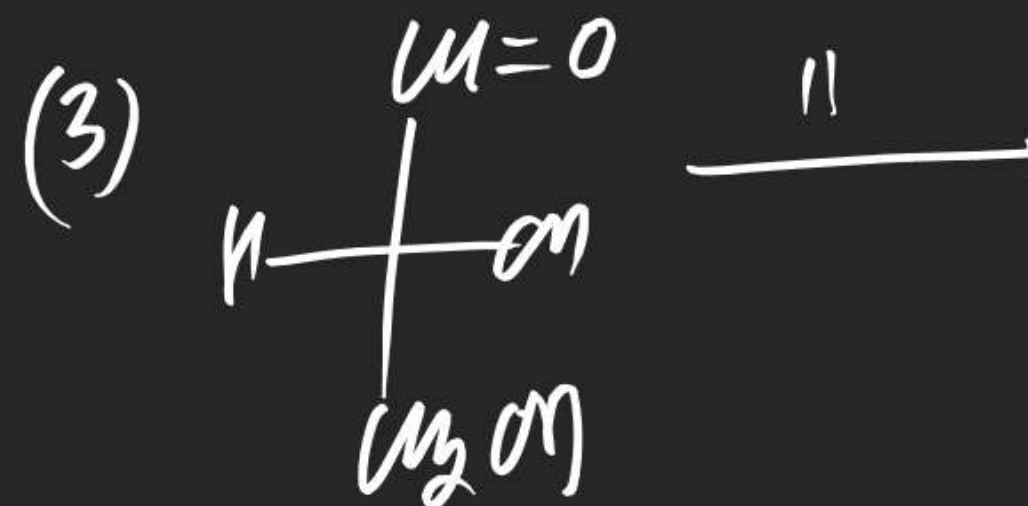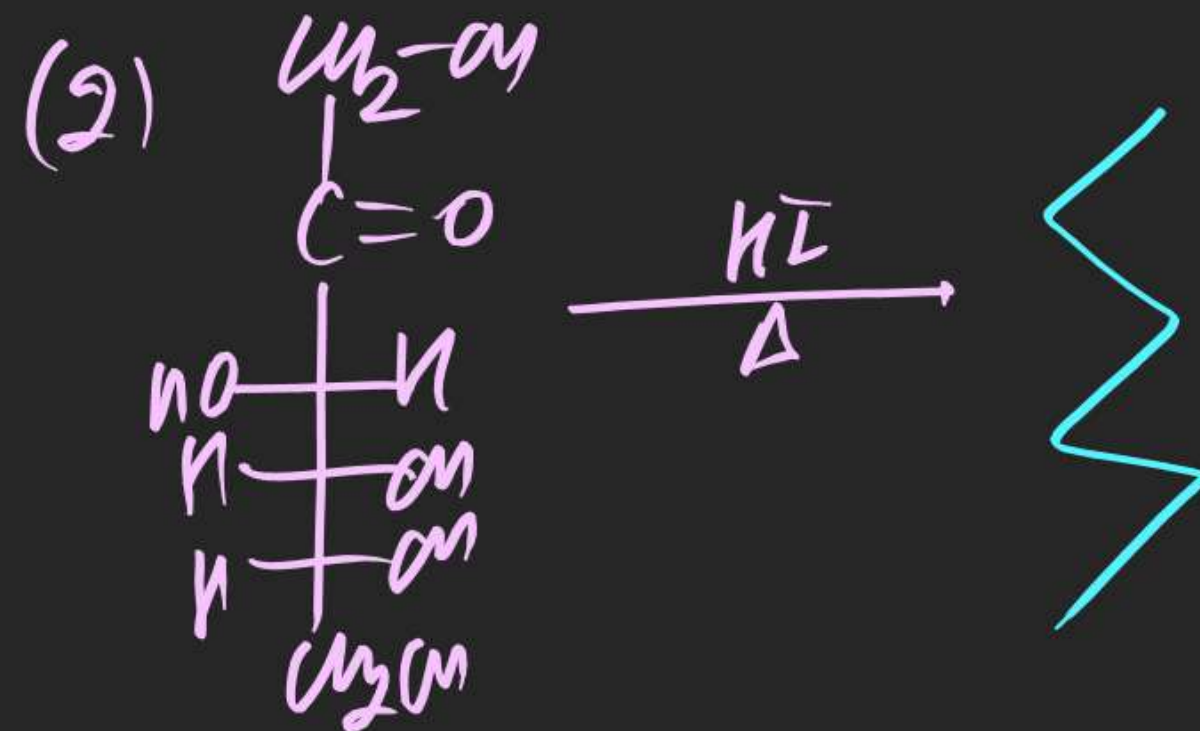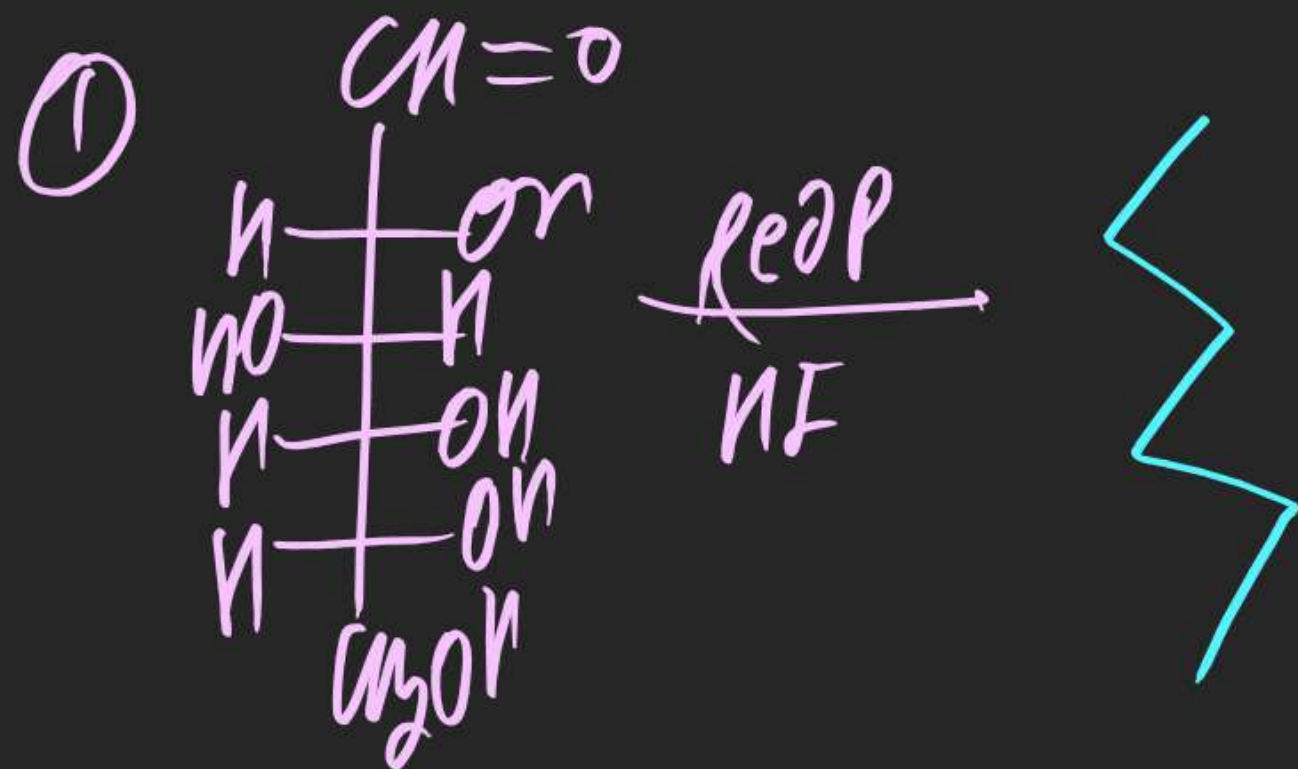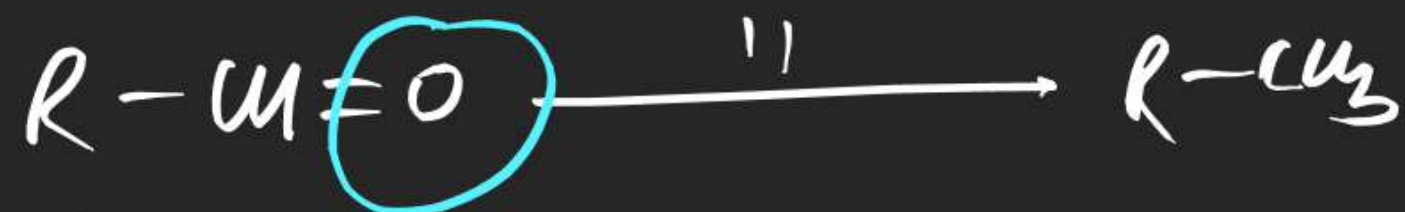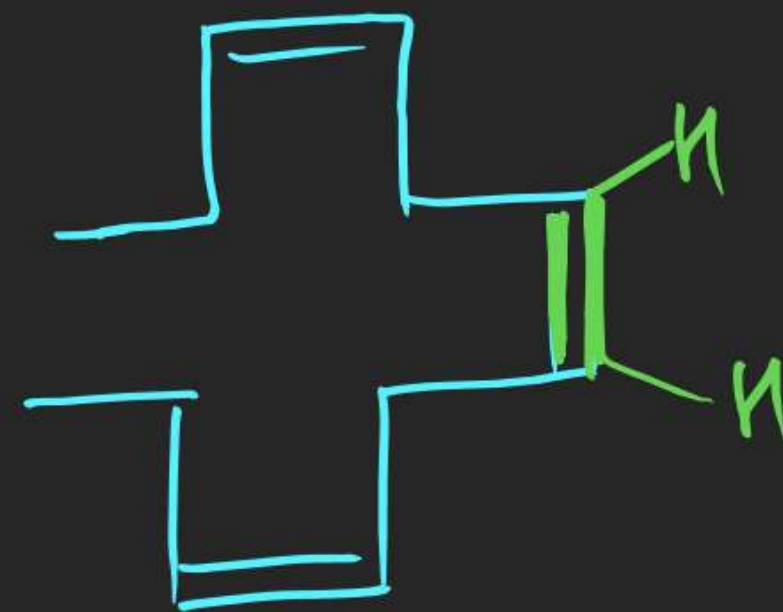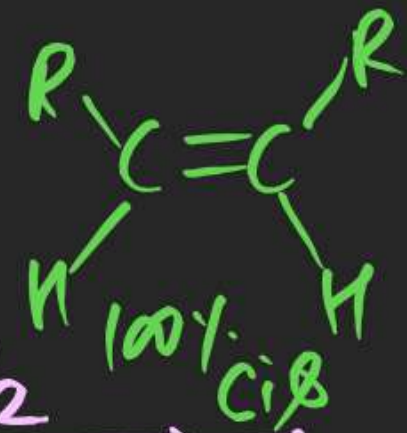
$$\xrightarrow[Pd-BaSO_4]{H_2}$$

(4) Lindlar Catalyst Pd-BaSO_4 or Pd-C
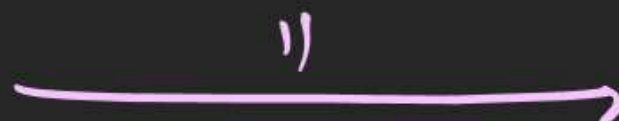(poisond Catalyst)

(5)



Trans

$\dfrac{H_2}{Pd-BaSO_4}$

"P"

Trans

$ci\phi$
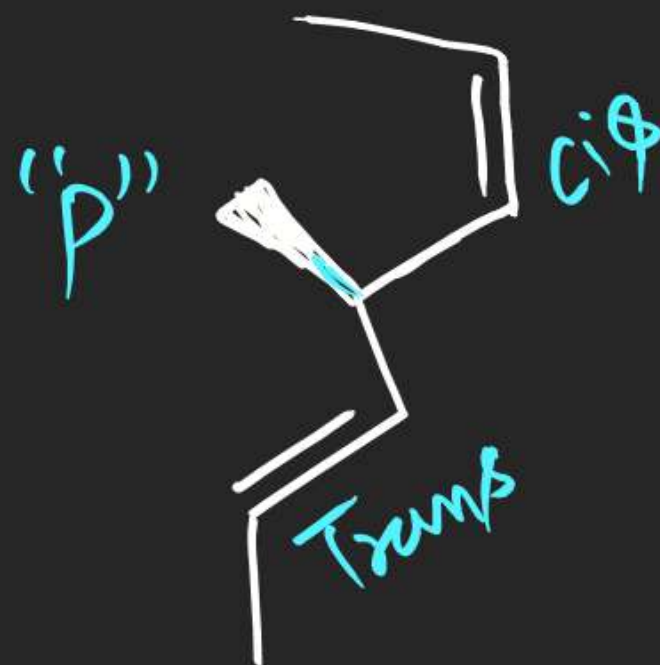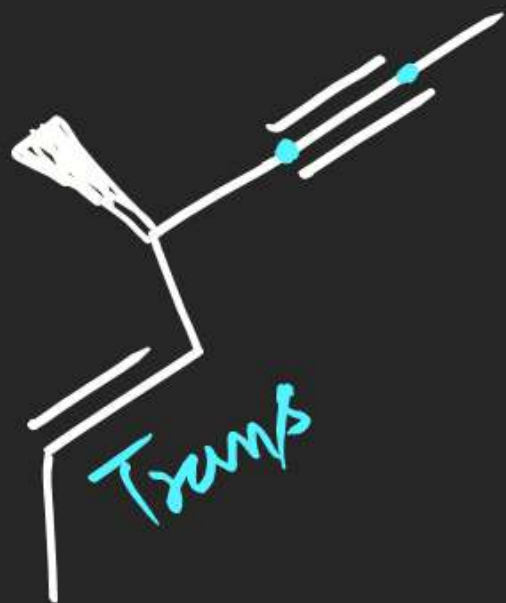
Sn absent

POS, COS, Absent

optically Active

(6) $HC \equiv C - CH_2 - CH_2 - CH = CH_2 \xrightarrow[1\,eq]{B-Cat.} H_2C = CH - CH_2 - CH_2 - CH = CH_2$

(7)



$\xrightarrow{\;\;''\;\;}$

(8)

$R-C \equiv C-R \xrightarrow[\text{Liq } NH_3]{Na}$

$\underset{H}{\overset{R}{\diagdown}} C = C \overset{H}{\underset{R}{\diagup}}$

$\longrightarrow \quad \underset{}{\overset{R}{\diagdown}} \overset{\cdot\cdot}{C} = C \overset{\cdot}{\underset{R}{\diagdown}}^{\ominus}$

(with Anion Radical

(Intermidiate)

(9)

EWG

$\underset{O}{\bigcirc} \xrightarrow[\text{Liq nn}]{Na} \bigcirc$ EWG

(10)

EDG

$\underset{O}{\bigcirc} \xrightarrow[\quad]{''} \bigcirc$ EDG

(11)



NO$_2$

Sn/HCl

Fe/HCl

NH$_2$

O

(12)



NO$_2$

O

NO$_2$

NH$_3 \cdot$H$_2$S

NH$_2$

O
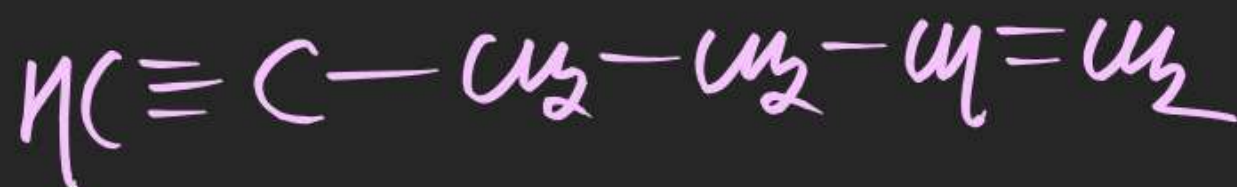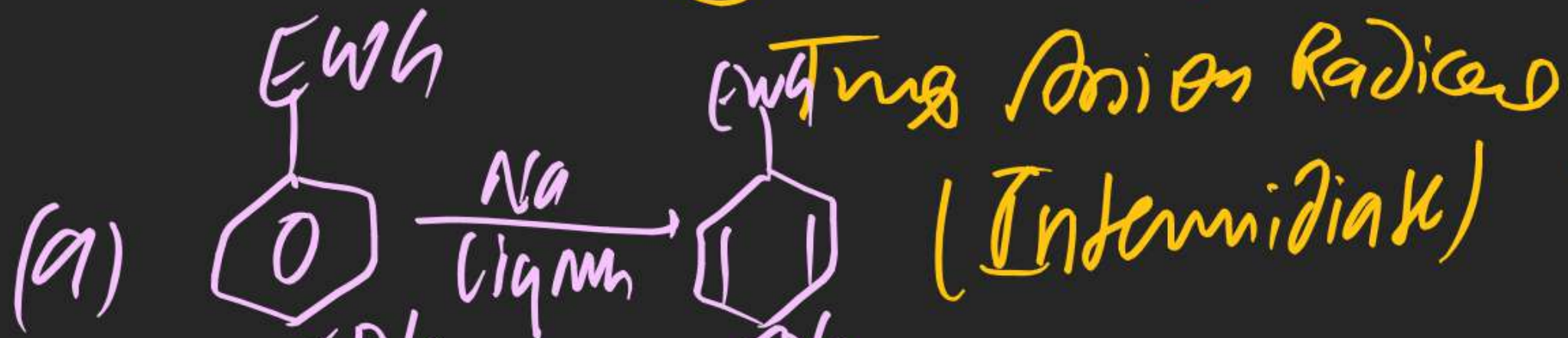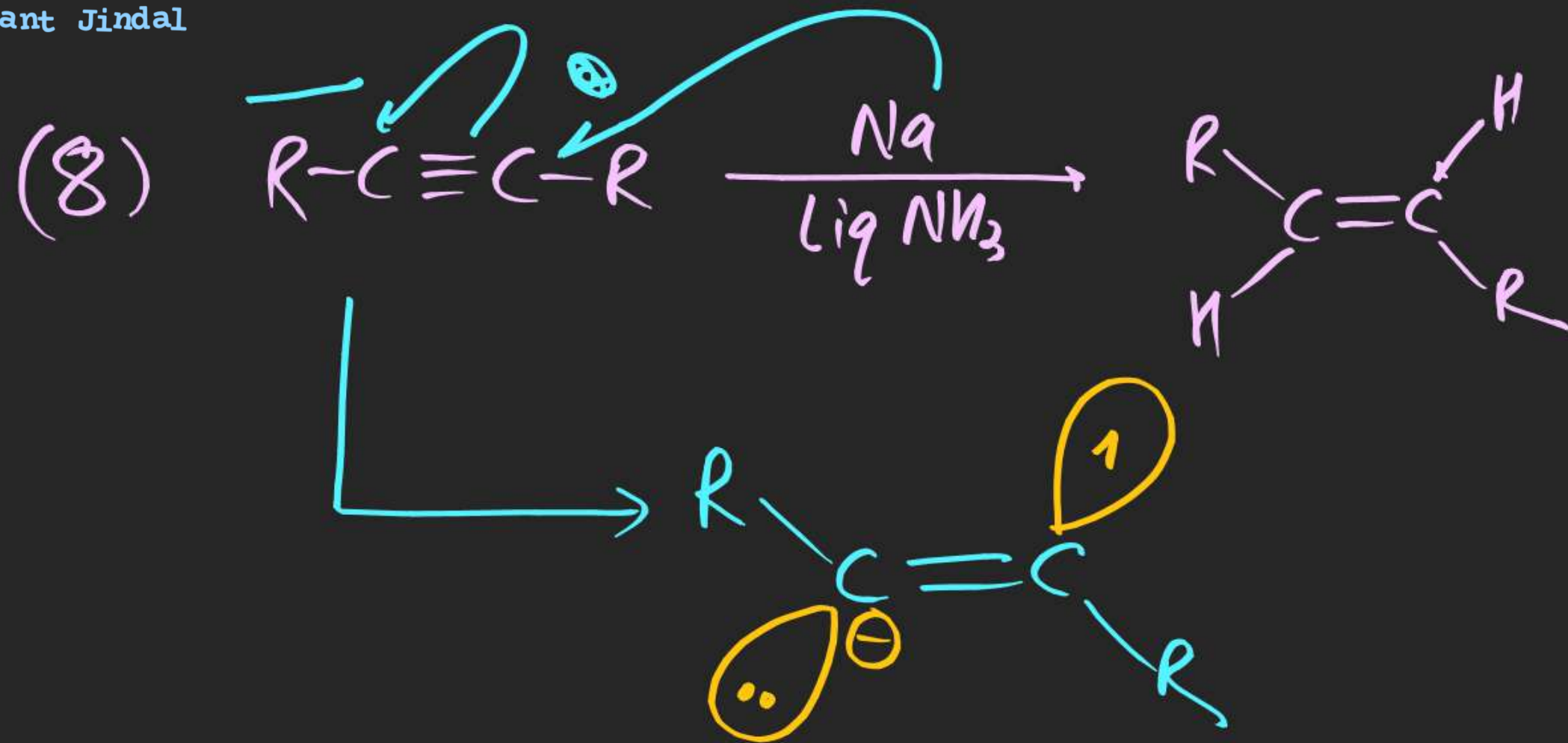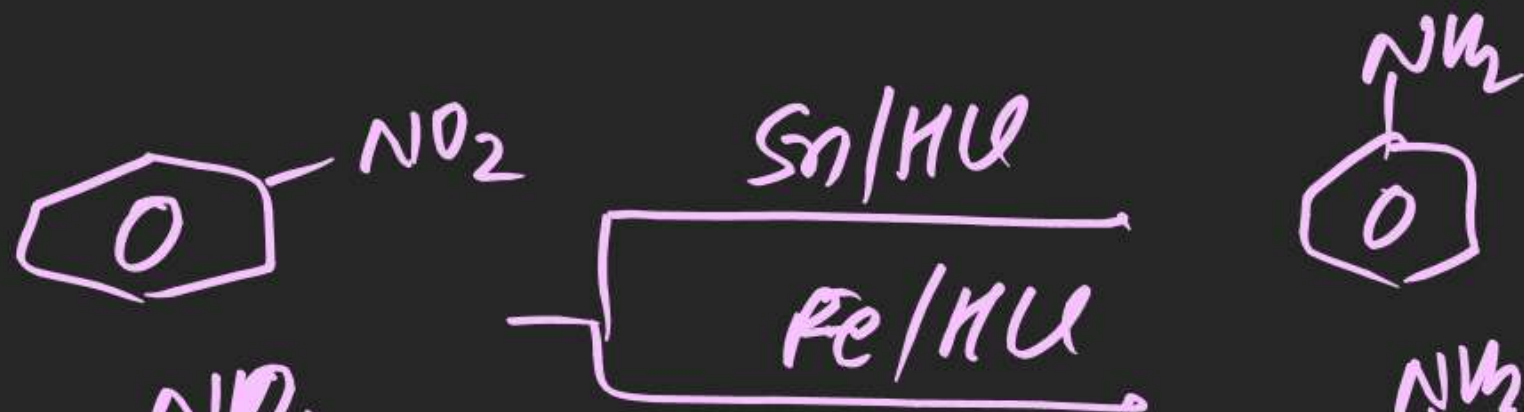
NO$_2$
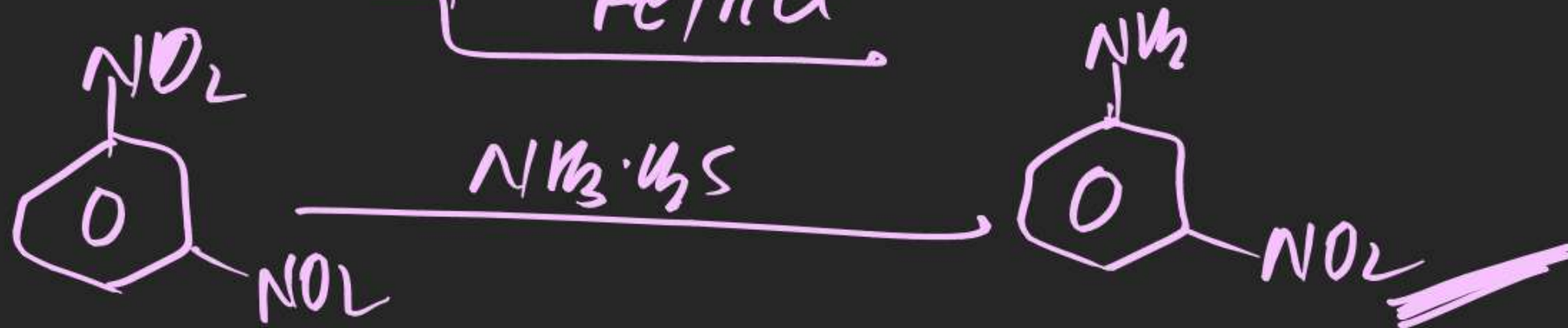
# Oxidation Reaction

## (#) Alkene oxidation:

(1) $\ce{>C=C<} + Br_2 \xrightarrow{CCl_4}$ 

[structure: C—C with Br, Br]
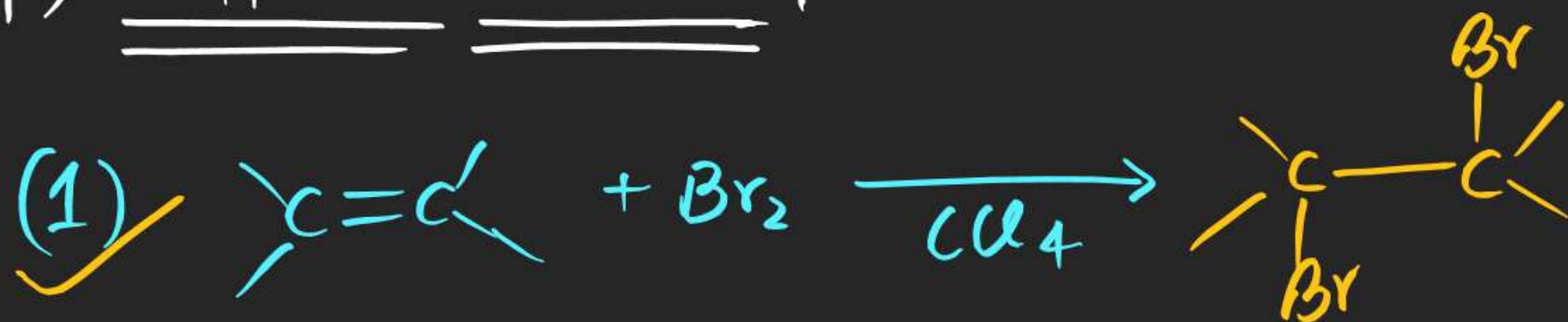
Anti add$^n$
unsaturation Test
Reddish Brown colour of
$Br_2$ gets disappear.

(2) $\ce{>C=C<} + KMnO_4 \xrightarrow{0°C}$  Baeyer's Reagent

$\ce{>C-C<}$ on on
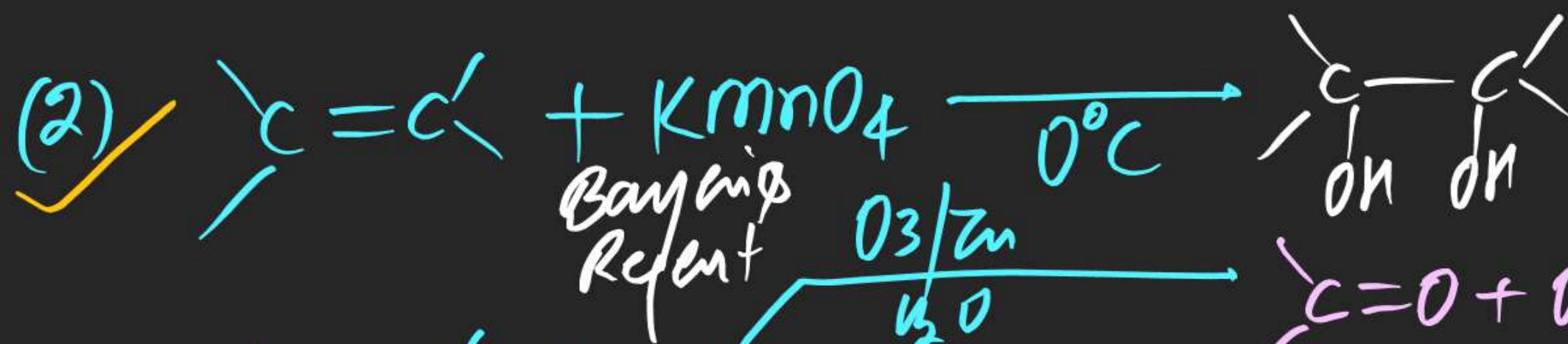
unsaturation Test
Syn Glycolisation
purple colour of $KMnO_4$
changes into Brown

(3) $\ce{>C=C<} +$ 

$\xrightarrow[H_2O]{O_3/Zn}$ $\ce{>C=O + O=C<}$ H

$\xrightarrow[H_2O]{O_3}$ $\ce{>C=O + O=C<}$ OH

**Q:**

$$\text{Reactant} \xrightarrow[Zn, H_2O]{O_3} \text{methanal + Ethanal + Butandial.}$$

[IVPAC Name]

$$\underset{O}{\overset{}{CH_2}} + \underset{O}{\overset{}{CH}}-CH_2-CH_2-\underset{O}{\overset{}{CH}} \quad \underset{O}{\overset{}{CH}}-CH_3$$

$$\overset{1}{H_2C}=\overset{2}{CH}-\overset{3}{CH_2}-\overset{4}{CH_2}-\overset{5}{CH}=\overset{6}{CH}-\overset{7}{CH_3}$$

$$\boxed{1,5-\text{heptadiene}}$$

**Q:**



$$\text{benzene} \xrightarrow[\substack{CH_3-C \overset{O}{\diagdown} \\ O-O-H \\ \text{or} \\ \text{m-CIBA}}]{\text{Per Acid}} \text{epoxide} \xrightarrow[-H]{H_2O} \left( \text{diol} \overset{OH}{\underset{'''OH}{}} + MI \right)$$

(Anti Glycolisation)

# (#) Alcohol oxid$^n$:-

(a) $R-CH_2-OH$

mild O.A $\longrightarrow R-C{\displaystyle{{}^{\nwarrow O}_{\searrow H}}}$

strg. O.A $\longrightarrow R-C{\displaystyle{{}^{\nwarrow O}_{\searrow OH}}}$

(b) $R{\displaystyle{\searrow}} CH-OH \atop R{\displaystyle{\nearrow}}$

mild O.A
or
strg O.A

$\longrightarrow$

$R{\displaystyle{\searrow}} C=O \atop R{\displaystyle{\nearrow}}$

(c) $R{\displaystyle{\searrow}} \atop R-C-OH \atop R{\displaystyle{\nearrow}}$

mild oxidising
or
strng oxidising

$\longrightarrow$ X
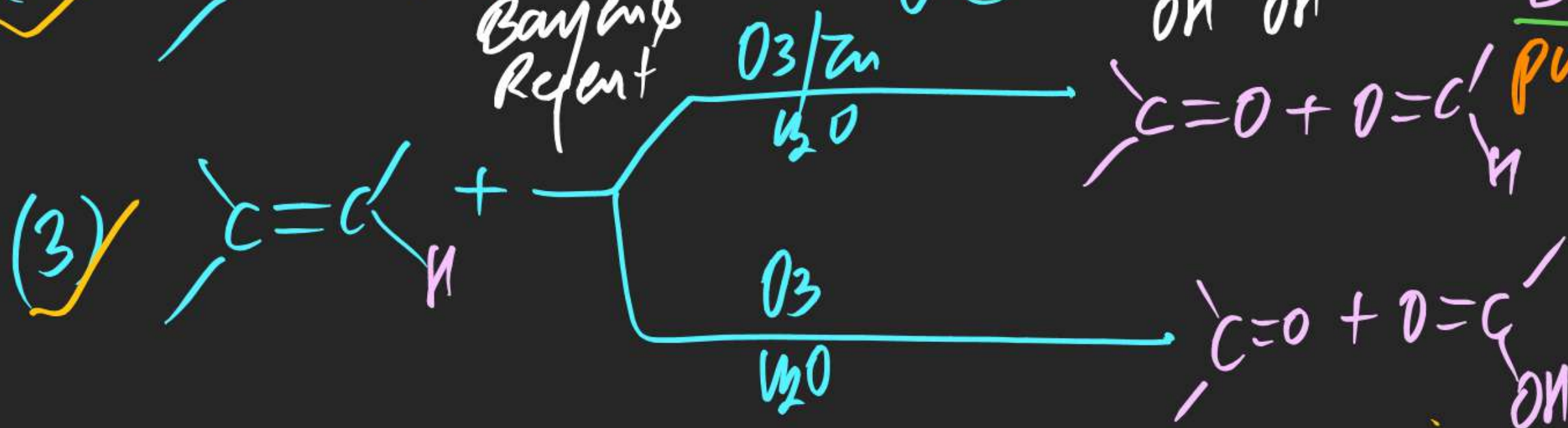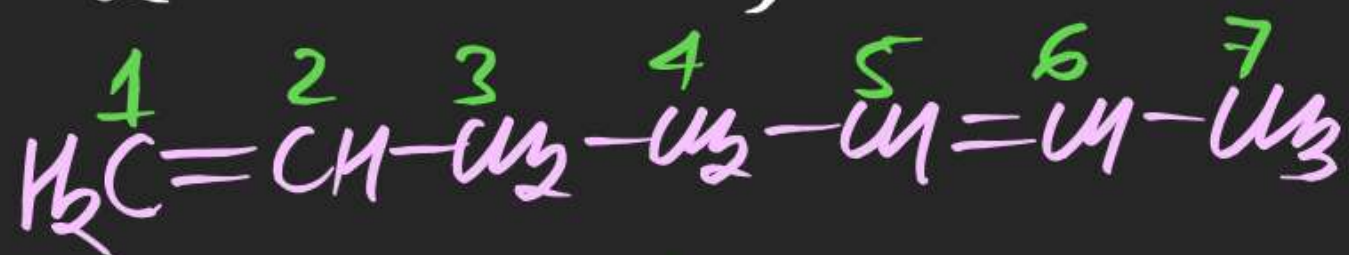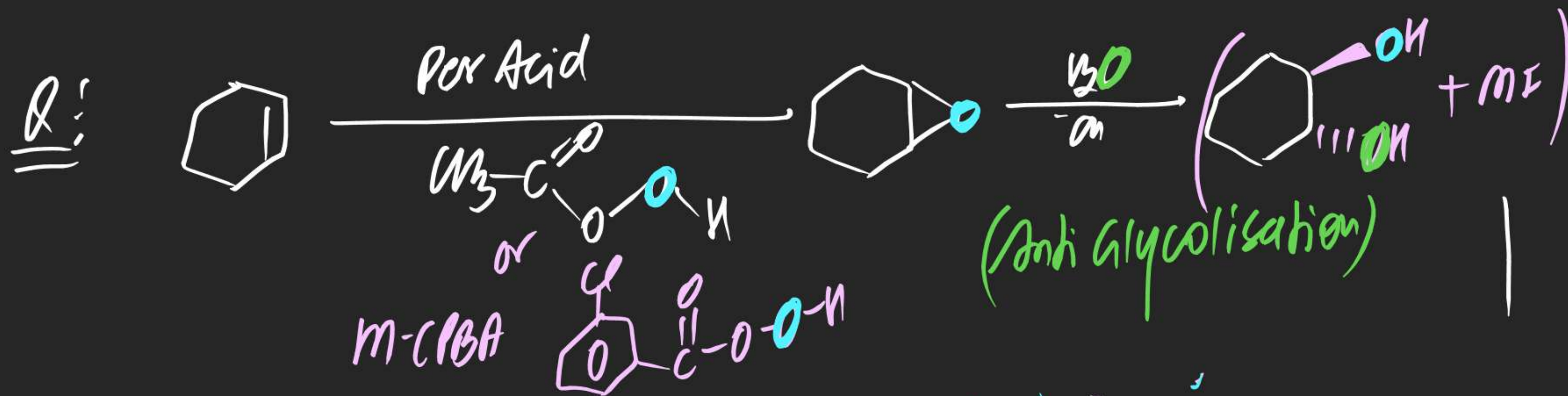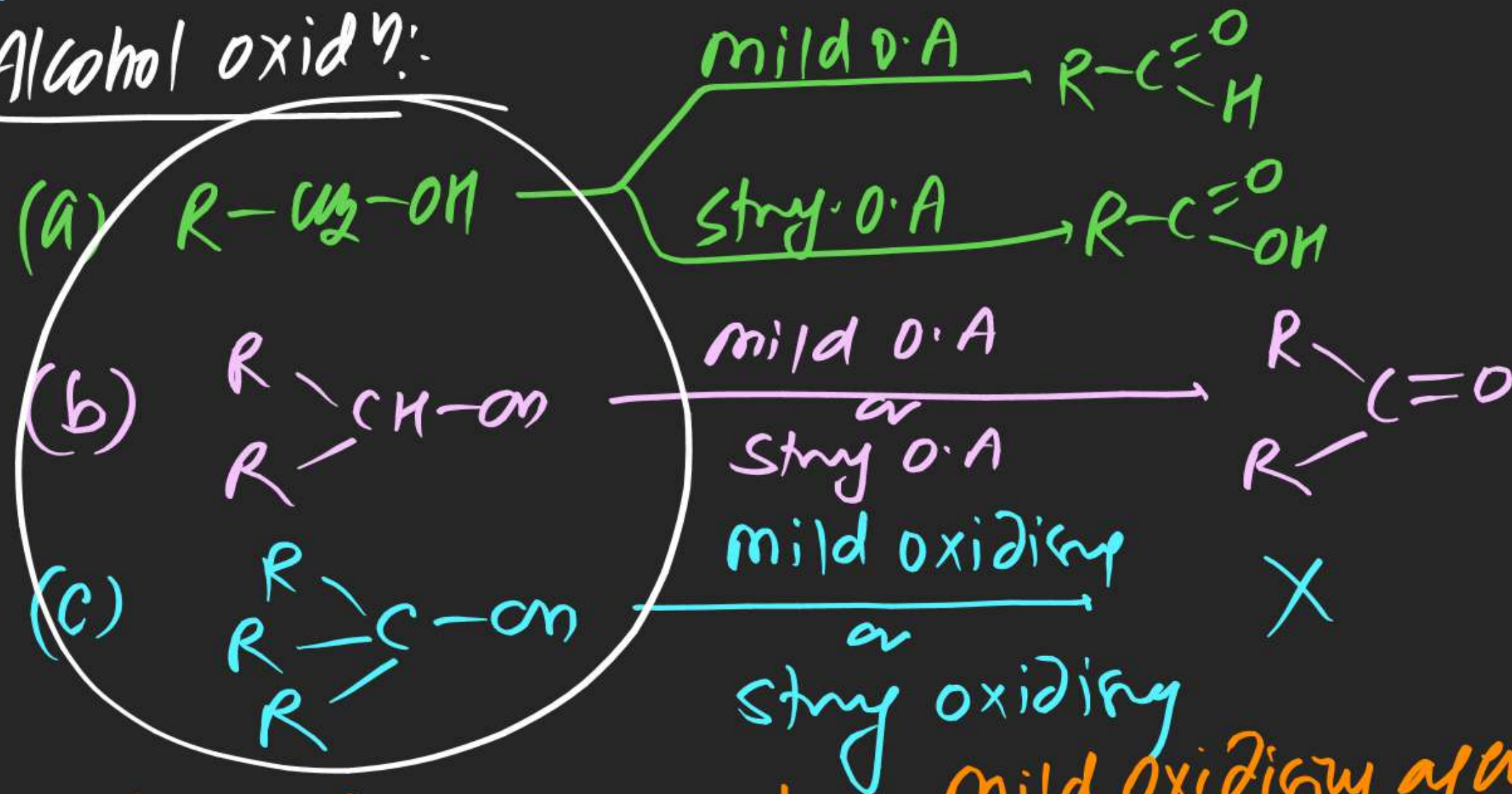
**Strng O. Agent**

* Acidic $K_2Cr_2O_7$ $\begin{bmatrix} Orange \rightarrow Green \\ Cr(VI) \rightarrow Cr(III) \end{bmatrix}$

* $CrO_3 + H_2SO_4$ $\begin{bmatrix} ----- \end{bmatrix}$
Jones
Reag^t

$KMnO_4$

**mild oxidising agent**

PCC (Pyridium Chlorochromate)

PDC

Cu/Δ

$MnO_2$ [Allylic/Benzylic 1°/2° Alcohol]

(#) $HIO_4$ oxid$^n$:

① 


$$\xrightarrow{HIO_4}$$

$CH_2=O$

$CH_2=O$ $+ HIO_3$

(2)


$$\xrightarrow{2 \, "HIO"_4}$$

$CH_2=O$
$+$
$H-C\begin{smallmatrix}=O\\OH\end{smallmatrix}$ $+HIO_3$
$+$
$CH_2=O$

(3) 
$$\xrightarrow{"5" \, HIO_4}$$ $5 HCOOH + CH_2$

(#) Aldehyde oxid$^n$

$$R-CH \overset{O}{=} \quad \begin{array}{l} \xrightarrow[\text{H}_2\text{SO}_4]{\text{K}_2\text{Cr}_2\text{O}_7} \quad R-C \overset{O}{\underset{OH}{\diagdown}} \quad \left( \begin{array}{c} 6 \longrightarrow 3 \\ 0 \longrightarrow 4 \end{array} \right) \\ \\ \xrightarrow{\text{CrO}_3/\text{H}_2\text{SO}_4} \quad \text{''} \quad \left( \begin{array}{c} 6 \longrightarrow 3 \\ 0 \longrightarrow 4 \end{array} \right) \\ \\ \xrightarrow[\Delta]{\text{KMnO}_4} \quad \text{''} \\ \\ \xrightarrow[\text{cold.}]{\text{KMnO}_4} \quad \text{''} \end{array}$$

(*)

$$R-C \overset{=O}{\underset{H}{}}$$

$\xrightarrow{[Ag(NH_3)_2] \text{ aq}}$ $R-C \overset{=O}{\underset{aq}{}} + 2Ag$ $\left[ Ag^+ \longrightarrow Ag \right]$

$\xrightarrow{\text{Fehling soln}}$ '' $+ Cu_2O$ $\left[ Cu^{+2} \underset{Blue}{\longrightarrow} Cu^{+1}_{Red.} \right]$

$\xrightarrow{\text{Benedict soln}}$ '' $+ Cu_2O$ $\left[ Cu^{+2} \underset{Blue}{\longrightarrow} Cu^{+1}_{Red} \right]$

$\xrightarrow{\text{Schiff's Regent}}$ ''
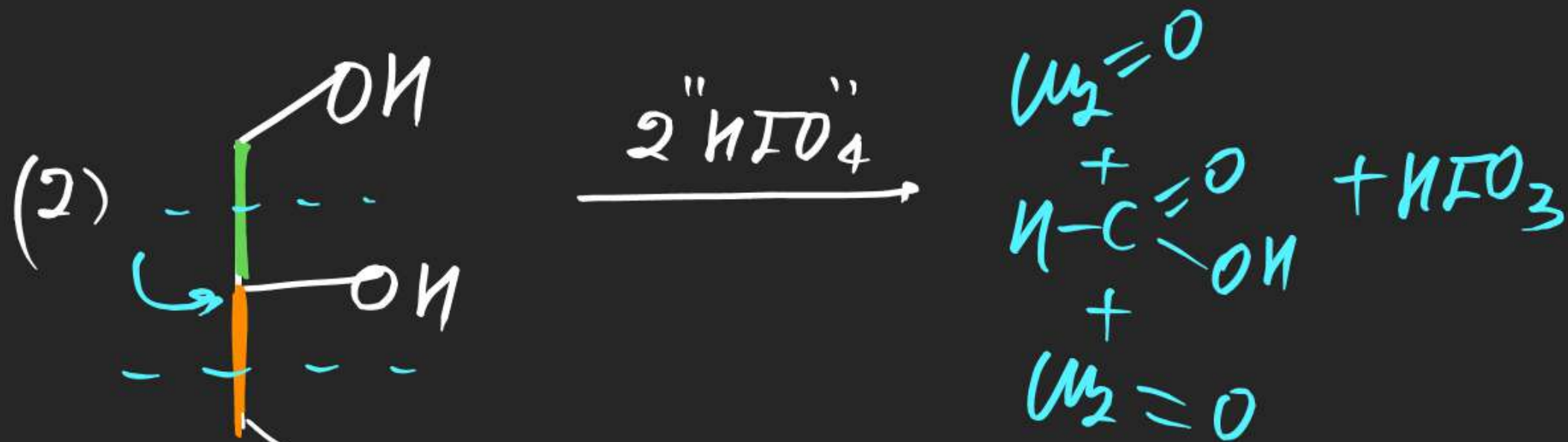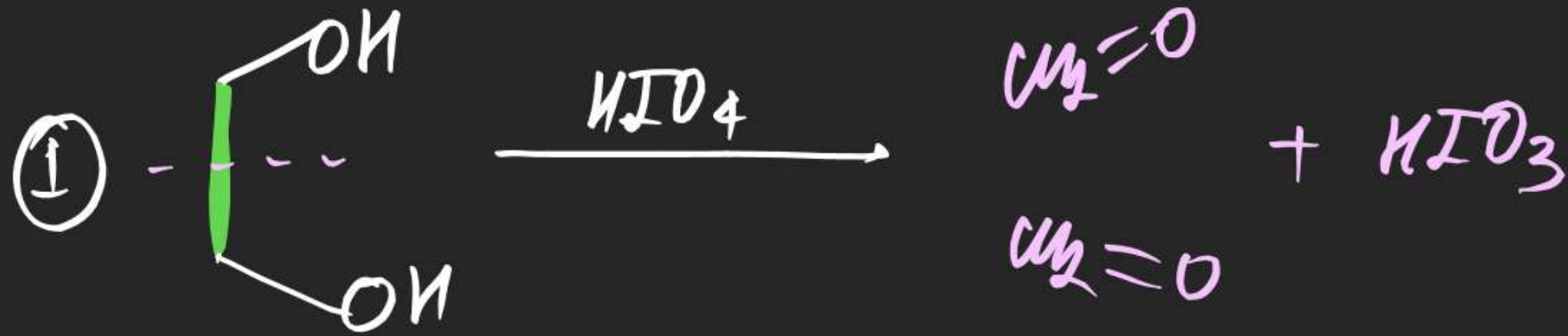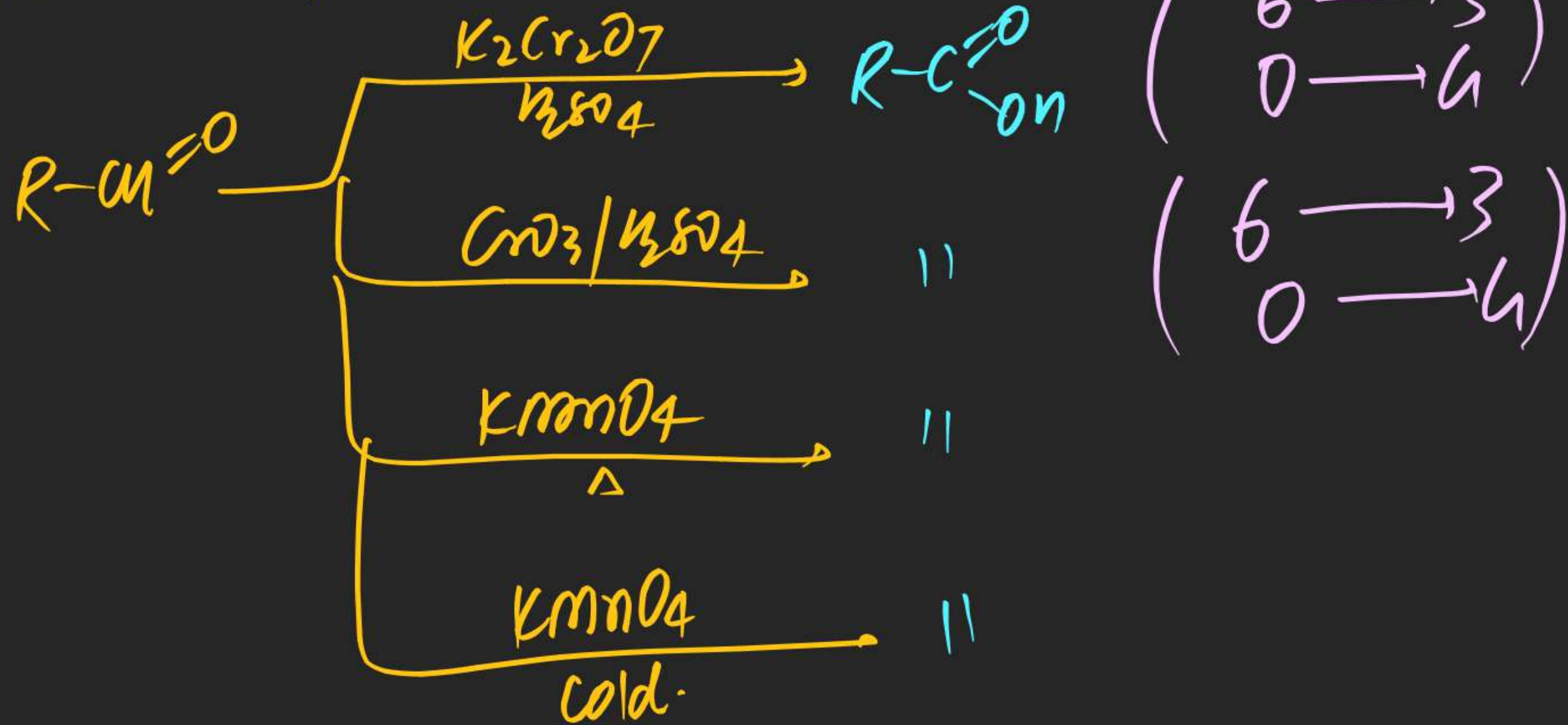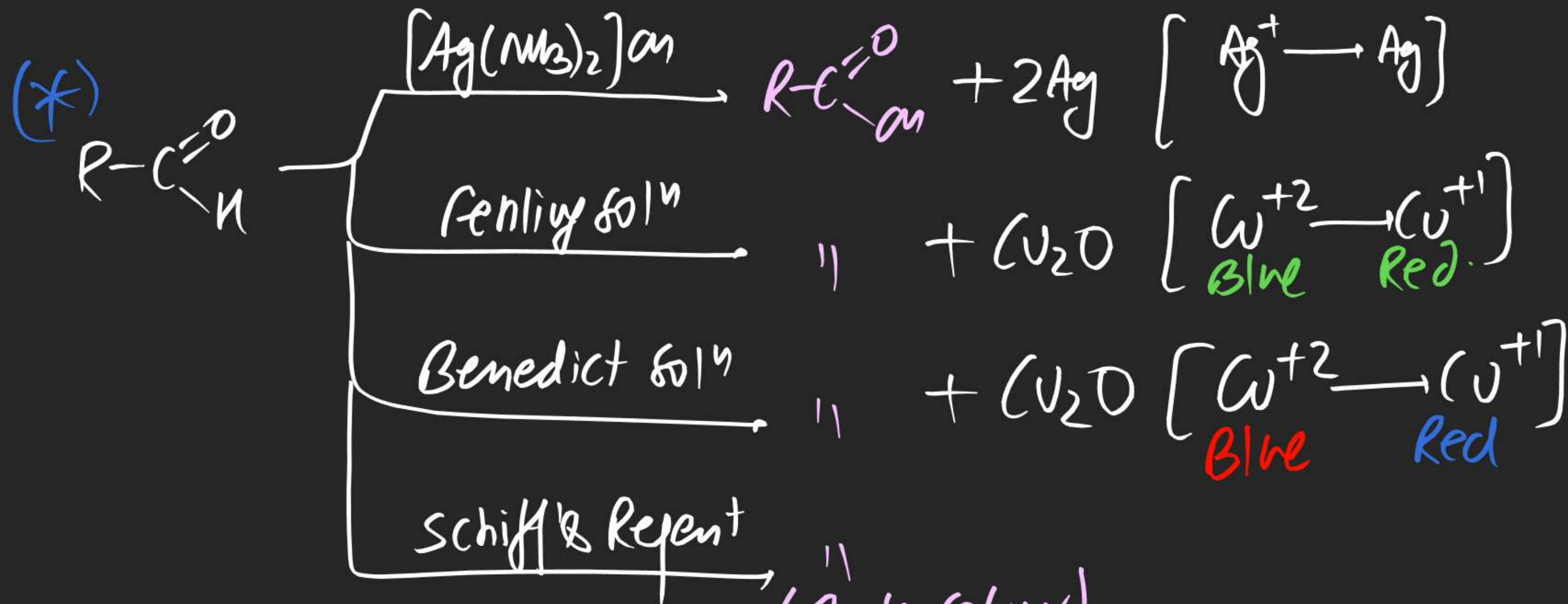
(Pink colour)
Restore,

Tollen's stmy D.A then Fehling soln.

(✗) <u>H-COOH</u> only <u>Acid</u> to Reduce Tollens & Fehling

(✗) Tollens, Fehling sol$^n$ can be used to distinguish <u>Aldehyde & Ketone</u>

(✗) Fehling sol$^n$ ———————————— Aliphatic & Aromatic Aldehyde

(#) <u>Haloform Rx$^n$</u>

⇒ <u>Iodoform Test</u>

$$R-\overset{O}{\overset{||}{C}}-CH_3 \;/\; R-\overset{OH}{\overset{|}{CH}}-CH_3 \quad \xrightarrow[\underset{NaOI}{\alpha}]{NaOH+I_2} \quad R-\overset{O}{\overset{||}{C}}-ONa + CHI_3$$

$1°/2°$

(yellow crystal)

CHO    CH$_3$-CHO

(phenyl ring with O)  (phenyl ring with O)

CH$_3$

(1)

$$H - \overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle CH_3}{}}{C}} + I_2 \xrightarrow{\text{NaOH}} H - \overset{\overset{\displaystyle O}{\|}}{C} - ONa + CHI_3$$

$$R - \overset{\overset{\displaystyle O}{\|}}{C} - CH_3 + 3X_2 + 4NaOH \longrightarrow R - \overset{\overset{\displaystyle O}{\|}}{C} - ONa + CHX_3 + 3NaX + 3H_2O$$

(2)

$$R - \overset{\overset{\displaystyle O}{\|}}{C} - R \xrightarrow[\displaystyle R - \overset{\overset{}{}}{\underset{\underset{\displaystyle O}{\|}}{C}} - O - O - H]{\text{Per Acid}} R - \overset{\overset{\displaystyle O}{\|}}{C} - O - R$$