Organic Synthesis

"Series of RXN used to create a compound"

Adding Carbon atom:-

$R-Br + KCN \xrightarrow{\text{Ethanoic}} R-CN + KBr$

1-Carbon → 2-carbon

Alkane + halogenation → R-X + KCN → R-CN (2° carb)

Hydrolysis

$R-CN \xrightarrow[HCl]{2H_2O} R-COOH + NH_4^+$

Nitrile → Carboxylic acid

$R-CN + 4[H] \xrightarrow{LiAlH_4} R-CH_2-NH_2$

Nitrile → Amine

Benzene → alkyl benzene

$C_6H_6 + CH_3CH_2Cl \xrightarrow{AlCl_3} C_6H_5-CH_2CH_3-HCl$

Friedal craft alkylation

Benzene → Ethyl benzene

(i) Alkane —halogenation→ alkyl halide

(ii) R–X —KCN/NaOH→ Nitrile

(iii) Nitrile —hydrolysis→ carboxylic acid

(iv) Nitrile —reduction→ Amine

(v) Benzene —Friedal craft→ Alkyl benzene

Methane (alkane) → Ethanoic acid (carboxylic acid)

Step 1:- $CH_4 \longrightarrow$ chloromethane

$CH_4 + Cl_2 \xrightarrow{UV} CH_3Cl + HCl$

Alkane → Alkyl halide

Step 2:- Chloromethane to cyanomethane

$CH_3Cl + KCN \xrightarrow{\text{Ethanoic}} CH_3-CN + KCl$

Step 3:- Hydrolysis of Nitrile (cyanomethane → ethanoic acid)

$CH_3-CN + 2H_2O \xrightarrow{HCl} CH_3COOH + NH_3$

Test used For identification of F.g:-

Br_2 water test → unsaturation

red brown → decolourized

$CH_4 + Br_2 \longrightarrow$ No change X

(Red brown)

$CH_2=CH_2 + Br_2 \longrightarrow CH_2Br-CH_2Br$ (decolourized) (1,2 Dibromo ethane)

(Red brown)

Test 2:- $AgNO_3$ Test

Use:- Detection of X

Reagent:- Aq ($AgNO_3$)

$R-Cl + AgNO_3 + CH_3CH_2-OH \longrightarrow R-CH_2CH_3 + AgCl + HNO_2$

(White ppt)

$R-Br + AgNO_3 + CH_3CH_2OH \longrightarrow R-CH_2CH_3 + AgBr + HNO_3$

(cream ppt)

$R-I + AgNO_3 + CH_3CH_2OH \longrightarrow R-CH_2CH_3 + AgI + HNO_3$

(Yellow ppt)

Test 3:- Iodoform Test

Alcohol → 1° alcohol → CH_3OH

Aldehyde → Ethanal

Ketone → Methyl ketone

Organic compound $+ I_2 + NaOH \longrightarrow CHI_3 + RCOONa + NaI + H_2O$

(Yellow ppt)

Test 4 SULPHUR:-

$Na_2S + Na_2[Fe(CN)_5NO] \longrightarrow Na_4[Fe(CN)_5NO]$

(Lassaigne's solution) (Sodium nitroprusside) (Violet ppt)

Test 5 Fehling:- $CH_3CHO + 2Cu^{2+} + 5OH^- + \text{Sodium tetra} \longrightarrow Cu_2O + CH_3COO^- + 3H_2O$

Test 5 Tollen's:- / Silver mirror test

$CH_3CHO + 2[Ag(NH_3)_2]^{1+} + OH^- \longrightarrow CH_3COO^- + 2Ag\downarrow + 2NH_3$

(Silver mirror)

Test of carboxylic acid:-

$CH_3COOH + Na_2CO_3 \longrightarrow CH_3COONa + H_2O + CO_2$

Test 7 To Distinguish Pri, sec, tert, alcohol

$RCH_2OH + [O] \longrightarrow RCHO$

$RCHO + [O] \longrightarrow RCOOH$

$RCH(OH)R + [O] \longrightarrow RCOR$

Types of Reaction Given by F.g:-

① Reactions of Alkanes:-

Free radical substitution mechanism

$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$

$CH_3Cl + Cl_2 \xrightarrow{h\nu}$ continue (Condition = diffused sunlight)

alkane + $Cl_2 \xrightarrow{h\nu}$ chloroalkane

② Reaction of unsaturated Hydrocarbon

Electrophilic Addition Reaction:-

$>C=C< + X^{\delta+}-Y^{\delta-} \longrightarrow -\overset{X}{\underset{|}{C}}-\overset{Y}{\underset{|}{C}}-$

$>C=C< + Z-Z \longrightarrow -\overset{Z}{\underset{|}{C}}-\overset{Z}{\underset{|}{C}}-$

Unsaturated → Saturated

(i) Oxidation Reaction:-

Propene + $KMnO_4 \xrightarrow[\text{cold}]{OH} CH_3-CH(OH)-CH_2OH$ (1,2-propane diol)

C=C → alcohol

Alkene undergo ozonolysis → Aldehyde and Ketone

$\xrightarrow[Zn, HCl]{O_3}$ Aldehyde + Ketone

$R-C\equiv C-R \xrightarrow[Zn, HCl]{O_3} R-\overset{O}{\overset{\|}{C}}-OH + \overset{O}{\overset{\|}{C}}-R$

Alkyne → carboxylic acid

③ Reaction of Alkyl halides:-

(i) Nucleophilic substitution Rxn:

$R-X \xrightarrow[CN^- \; NH_3]{OH^-} R-OH / NH_2 / CN + X^-$

(ii) Elimination Reaction:-

$-\overset{X}{\underset{|}{C}}-\overset{X}{\underset{|}{C}}- + \text{alc KOH} \xrightarrow{\Delta} -C=C- + KX + H_2O$

④ Reactions of carbonyl compounds:-

→ Nucleophilic addition → hydroxyl nitrile formation

→ Aldehyde —oxidation→ carboxylic acid → ketone ✗

→ Aldehyde —reduction→ 1° alcohols → ketone —reduction→ 2° alcohol

⑤ Reaction of carboxylic acid:-

→ carboxylic acid —React→ Base, Metal, Metal carbonate

→ Reaction carboxylic acid → Esterification

Thick Organic Conversions:-

"How to increase no. of bonds"
(– = ≡)

Halogenation + Dehydrohalogenation

Propane → Propene, Propyne

$CH_3-CH=CH_2 + Cl_2 \xrightarrow{CCl_4} CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2}$
Propene

$CH_3-\underset{Cl}{CH}-\underset{Cl}{CH_2} + KOH \xrightarrow{alc} CH_3-C\equiv CH + 2KCl + 2H_2O$
Propyne

"How to decrease no. of bonds":-

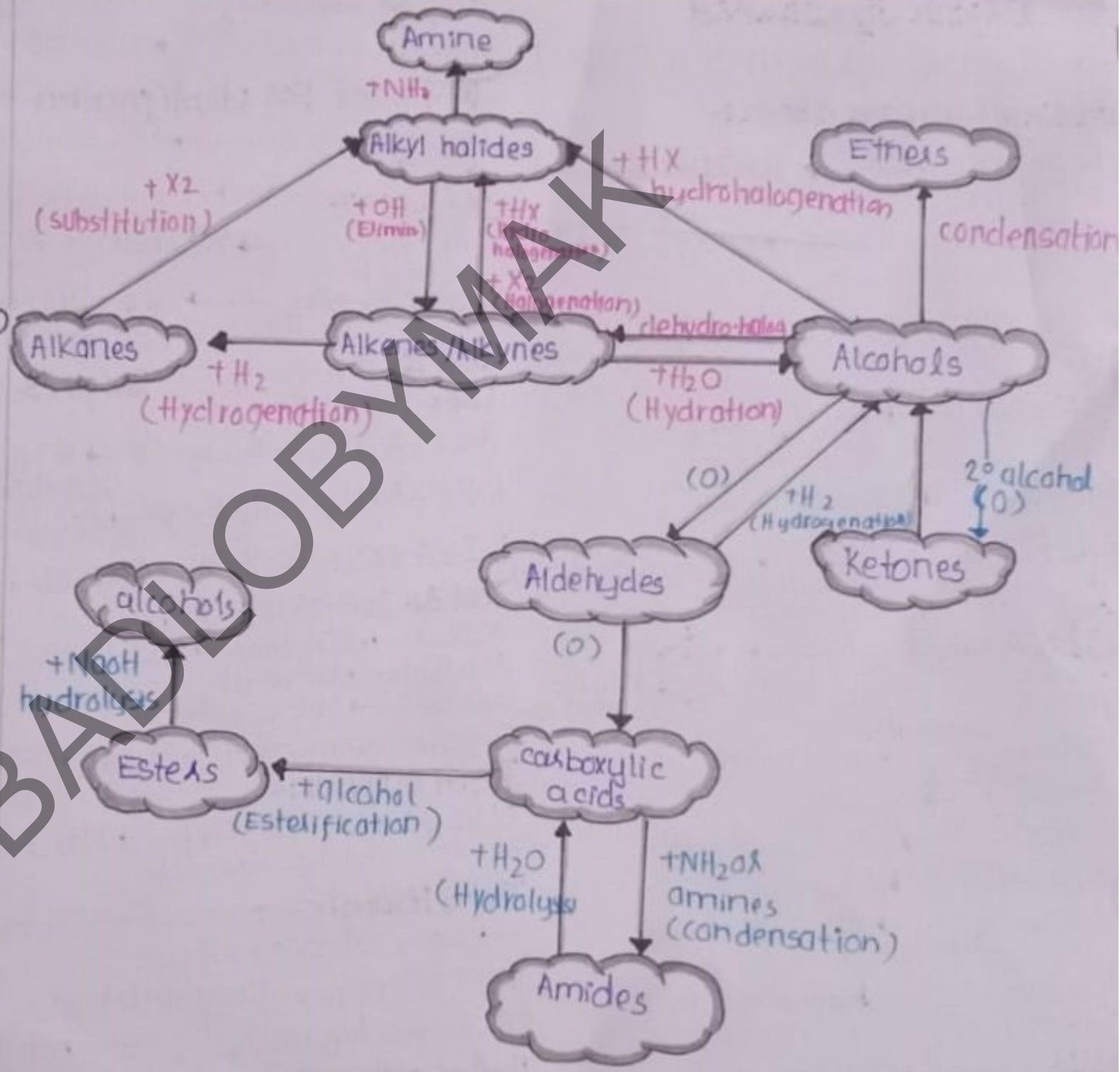
Propyne → Propene → Propane

$CH\equiv C-CH_3 + H_2 \xrightarrow[200-300^{\circ}c]{Ni} CH_2=CH-CH_3$
Propyne — Propene

$CH_2=CH-CH_3 + H_2 \xrightarrow[200-300^{\circ}c]{Ni} CH_3-CH_2-CH_3$
Propene — Propane

"How to increase no. of carbon"

1-step → Halogenation
2-step → Rxn with (Na) Metal



Teacher's Name:-
Mam Ayesha
Student Name:-