

CHEMISTRY. 02

MARKING GUIDE

FORM SIX SYNDICATE

EXAMINATION

2025

wazaelimu.com

Question 01

- (i) The first observation shows that the rate is proportional to the concentration of propanone therefore since rate $\propto [\text{Propanone}]$ the reaction is first-order in propanone.
- (ii) The rate is independent of the iodine concentration, so that the reaction is zeroth-order in iodine
- (iii) pH = 1.0 corresponds to $[\text{H}^+] = 0.10 \text{ mol dm}^{-3}$
 pH = 0.70 corresponds to $[\text{H}^+] = 0.20 \text{ mol dm}^{-3}$
 Doubling the hydrogen ion concentration therefore double the rate applying that the reaction is first-order in hydrogen ions
 b) Solution

Use Arrhenius equation

At 30°C

$$\frac{E_a}{R} = \frac{50 \times 10^3 \text{ J/mol}}{8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 303.15 \text{ K}} = 19.84$$

At 20°C

$$\frac{E_a}{R} = \frac{50 \times 10^3 \text{ J/mol}}{8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 293.15 \text{ K}} = 20.57$$

The ratio of the rate constant is therefore

$$\frac{k(30^\circ\text{C})}{k(20^\circ\text{C})} = \frac{e^{-19.84}}{e^{-20.57}} = \frac{2.4 \times 10^9}{1.2 \times 10^9} \approx 2.0$$

∴ The ratio will be 2.0

(c) is The collision which results in to chemical reaction should be proper. 02

(d) Activation energy is the minimum amount of energy required for two substances to react. WHILE Intermediate unstable activated complex is the compound formed during the reaction. 02

(e) 50% means half of the ester has been hydrolysed so 88 min is half life of this hydrolysis reaction. Use this half life equation to determine rate constant k of the reaction. 01

$$t_{1/2} = \frac{\ln 2}{k}$$

$$K = 0.693$$

$$\frac{88\text{ min}}{= 7.875 \times 10^{-3} \text{ min}^{-1}}$$

From the first order equation

$$\frac{\ln \left(\frac{A_0}{A} \right)}{[A]} = kt$$

$$\frac{\ln (100)}{(100-80)} = 7.875 \times 10^{-3} t$$

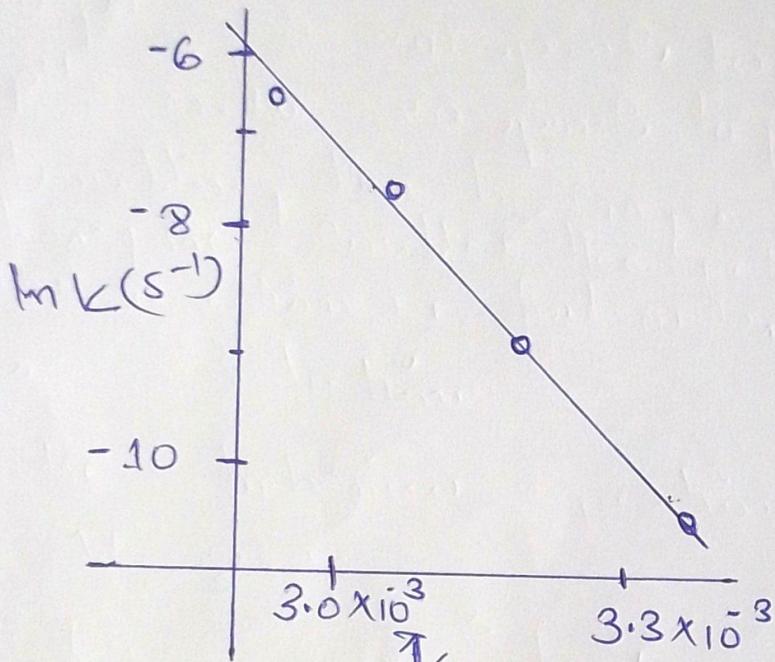
$$t = \frac{\ln 5}{7.875 \times 10^{-3}}$$

$$= 204.37 \text{ min}$$

∴ Time will be 204.37 min 01

(C). Make Arrhenius plot of $\ln k$ against $\frac{1}{T}$. The slope of the graph is $-\frac{E_a}{R}$
 Draw up the following table.

$\frac{1}{T} (K^{-1})$	3.33×10^{-3}	3.23×10^{-3}	3.13×10^{-3}	3.03×10^{-3}
$\ln k (s^{-1})$	-10.3	-8.91	-7.60	-6.50



The points are plotted in the graph above
 The slope of the line is

$$\text{slope} = \frac{8.12 - 9.38}{0.100 \times 10^{-3}} = -1.26 \times 10^4$$

If follows that

$$-\frac{E_a}{R} = -1.26 \times 10^4 K$$

so that

$$\begin{aligned}
 E_a &= 1.26 \times 10^4 \times R \\
 &\approx 1.26 \times 10^4 \times 8.314 \\
 &= 105 \text{ kJ/mol.}
 \end{aligned}$$

∴ The activation Energy is 105 kJ/mol.

Question 02

Q2 When common salt (NaCl) is added to saturated solution of AgCl the equilibrium will shift back toward the reactants and the solubility of AgCl will decrease.

OR: when a solution of NaCl is added to a saturated solution of AgCl the concentration of Cl^- ions increases, which increase the reaction quotient Q . As $Q > K_{\text{sp}}$ and precipitation occurs. Therefore AgCl will start to come out of the solution as a solid.

b Solution

From the equation

$$K_{\text{sp}} = [\text{Ag}^+][\text{Cl}^-]$$

The observed electrolytic conductivity due to the dissolved ions is

$$\begin{aligned} \kappa &= 1.96 \times 10^{-6} \text{ S cm}^{-1} - 0.12 \times 10^{-6} \text{ S cm}^{-1} \\ &= 1.84 \times 10^{-6} \text{ S cm}^{-1} \end{aligned}$$

Also the limiting molar conductivity is

$$\begin{aligned} \Lambda^\infty &= \lambda^\infty(\text{Ag}^+) + \lambda^\infty(\text{Cl}^-) \\ &= (61.9 + 76.4) \text{ S cm}^2 \text{ mol}^{-1} = 138.3 \end{aligned}$$

Again from the formula:

$$\Lambda = k/c$$

Therefore the concentration of ions is

$$\begin{aligned} c &= \frac{1.84 \times 10^{-6} \text{ S cm}^{-1}}{138.3 \text{ S cm}^2 \text{ mol}^{-1}} = 1.33 \times 10^{-8} \text{ mol/cm}^3 \\ &\approx 1.33 \times 10^{-5} \text{ mol/l dm}^{-3} \end{aligned}$$

Since $[\text{Ag}^+] = [\text{Cl}^-]$ in the electrolytic neutral solution we have $[\text{Ag}^+] = [\text{Cl}^-] = c$

$$K_{sp} = (1.33 \times 10^{-5} \text{ mol/dm}^3)^2 = 1.8 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$$

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∴ The value of K_{sp} will be $1.8 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$

(Q) Solution

Initial concentration of KOH
 $0.2 \text{ M} \rightarrow 1000 \text{ cm}^3$
 $\qquad\qquad\qquad \rightarrow 70 \text{ cm}^3$

$$\equiv \frac{0.2 \times 70}{1000} = 0.014 \text{ M}/150 \text{ cm}^3$$

To convert this come to std conc.

$$0.014 \text{ M} \equiv 150 \text{ cm}^3$$

$$x \equiv 1000 \text{ cm}^3$$

$$\text{Initial conc} \equiv 0.093 \text{ mol/dm}^{-3}$$

$$0.1 \text{ M} \equiv 1000$$

$$x \equiv 80 \text{ cm}^3$$

$$\equiv 0.1 \times 80$$

$$\frac{1}{1000} = 0.008 \text{ M}/150 \text{ cm}^3$$

Convert this into std conc.

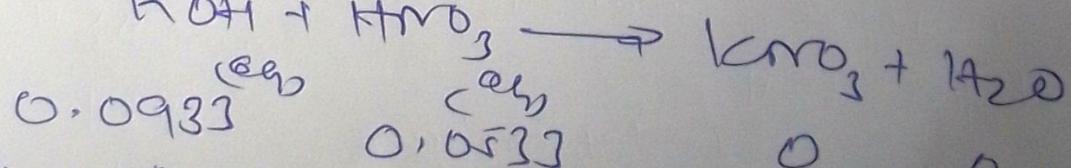
$$0.008 \text{ M} \equiv 150 \text{ cm}^3$$

$$x \equiv 1000 \text{ cm}^3$$

$$\equiv 0.008 \times 1000$$

$$\frac{1}{15} = 0.0533 \text{ M}$$

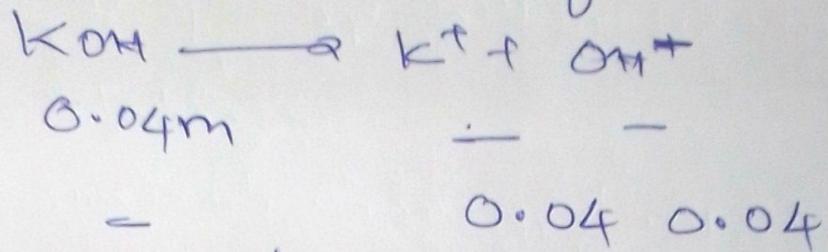
Equation: $\text{KOH} + \text{HNO}_3 \rightarrow \text{KNO}_3 + \text{H}_2\text{O}$



∴ Nitric acid will require only 0.0533 M of KOH for complete neutralization

$$0.093 - 0.0533 = 0.04 \text{ M}$$

0.04M of KOH will remain unreacted
Consider dissociation of KOH



From expression

$$K_w = [\text{H}^+] [\text{OH}^-]$$

$$[\text{H}^+] = \frac{K_w}{[\text{OH}^-]}$$

$$= \frac{1 \times 10^{-14}}{4 \times 10^2}$$

$$[\text{H}^+] = 2.5 \times 10^{-13}$$

from pH expression

$$\text{pH} = -\log [\text{H}^+]$$

$$= -\log (2.5 \times 10^{-13})$$

$$= 12.6$$

∴ The pH will be 12.6

(b) Solution

Let $x \text{ cm}^3$ to be volume of air and $y \text{ cm}^3$
be volume of sodium propanoate

$$x \text{ cm}^3 + y \text{ cm}^3 = 100 \text{ cm}^3$$

Data analysis

For propanoic acid

$$1 \text{ mol} \equiv 1000 \text{ cm}^3$$

$$2X \equiv x \text{ cm}^3$$

Initial std conc.

$$\frac{Z}{1000} \text{ moles} \xrightarrow{\quad} 100\text{cm}^3$$
$$\xrightarrow{\quad} 1000\text{cm}^3$$
$$= \frac{Z}{1000} \times 1000 \times \frac{1}{100} = \frac{Z}{100} \text{ mol/l dm}^3$$

Similarly for sodium propanoate

$$1\text{mol} \equiv 1000\text{cm}^3$$

$$1\text{mol} \equiv 1000\text{cm}^3$$

$$[\text{Salt}] = \frac{a\text{ mol}}{1000} / 100 \text{ after mixing}$$

into standard conc.

$$\frac{a}{100} \text{ mol} \xrightarrow{\quad} 100\text{cm}^3$$
$$\xrightarrow{\quad} 1000\text{cm}^3$$

$$[\text{Salt}] = \frac{a}{100} \times 1000 \times \frac{1}{100}$$
$$= \frac{a}{100} \text{ mol/l dm}^3$$

from $\text{pH} = \text{pka} + \log \frac{[\text{salt}]}{[\text{Acid}]}$

$$4 = 4.9 + \log \left(\frac{a/100}{2/100} \right)$$

$$4 - 4.9 = \log \left(\frac{a/100}{2/100} \right)$$

$$\frac{a}{2} = \log^{-1} (-0.9)$$

$$\frac{a}{2} = 0.126$$

$$a = 0.126 Z \text{ but } a = y, Z = x -$$

$$y = 0.126 x$$

from equation (i)

$$x + y = 100$$

$$x + 0.126x = 100$$

$$x = 88.81 \text{ cm}^3$$

$$y = 11.19 \text{ cm}^3$$

\therefore 88.81 cm^3 of propanoic acid must be
mixed with 11.19 cm^3 of sodium acetate.

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Question 03.

k_{dL} = Concentration of solute in the upper layer

Concentration of solute in the lower layer.

02

b. (i) Solution given

$$k_{dL} = \frac{1}{4}$$

$$k_{dL} = \frac{[P \text{ in ethyl ether}]^{\circ}}{[P \text{ in water}]^{\circ}}$$

$$x = 2.09 \quad [P \text{ in water}]$$

$$V_w = 50 \text{ cm}^3$$

$$X_1 = ?$$

$$V_f = 50 \text{ cm}^3$$

$$F = ?$$

from $k_{dL} = \frac{[P \text{ in ethyl ether}]^{\circ}}{[P \text{ in water}]^{\circ}}$

$$k_{dL} = \frac{f / V}{X - F}$$

$$4 = \frac{F / 50 \text{ cm}^3}{2g - F / 50 \text{ cm}^3}$$

$$4 = \frac{F}{2g - F}$$

$$8g - 4F = F$$

$$5F = 8g$$

$$F = 1.6g$$

\therefore The mass of P extracted from aqueous solution by 50 cm³ of ethyl ether is 1.6g

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(11) Solution

From the first extraction

$$K_{d1} = \frac{F}{V_r}$$

$$\frac{2g - F}{V_r}$$

$$4 = \frac{F}{25\text{cm}^3}$$

$$\frac{2g - F}{50\text{cm}^3}$$

$$4 = \frac{F}{2g - F} \times \frac{50\text{cm}^3}{25\text{cm}^3}$$

$$4 = \frac{2F}{2g - F}$$

$$8g - 4F = 2F$$

$$6F \leq 8g$$

$$F = 1.33g$$

∴ For the first extraction mass of extra
charcoal is $1.33g$.

For the second extraction

$$K_{d2} = \frac{F}{V_r}$$

$$\frac{m - F_1}{V_r}$$

$$\text{But } m = 2g - 1.33g = 0.67g$$

$$4 = \frac{F}{25\text{cm}^3}$$

$$\frac{0.67g - F_1}{50\text{cm}^3}$$

$$4 = \frac{F}{0.67g - F_1} \times \frac{50\text{cm}^3}{25\text{cm}^3}$$

$F_1 = 0.45g$
 ∴ Mass extracted for the second extraction
 $= 0.45g$

$$\begin{aligned}\text{Total mass extracted } (F_1) &= F_1 - F_1 \\ &= 1.73g + 0.48g - \\ &= 1.78g\end{aligned}$$

\therefore For successive extraction of 250cm^3 of ethoxyethane each the amount extracted of P is $1.78g$.

(c) The amount of P extracted in this is higher ($1.78g$) than that extracted in this which is $1.6g$. This shows that on dividing extraction using for many successive extractions will yield much amount of salt extracted compared with using the whole volume for only one extraction.

(d) soln.

Since there is $4g$ of G in 1litr ,

X of G would present in 500cm^3

$$X = \frac{4g \text{ of G} \times 500}{1\text{litr}}$$

But $1\text{litr} = 1000\text{cm}^3$

$$X = \frac{4g \times 500\text{cm}^3}{1000\text{cm}^3}$$

$$X = 2g \text{ of G.}$$

Mass of solute G present in 500cm^3 of aqueous solution is $2g$.

from $k_0 = \frac{\text{mass concentration of G in ethanol}}{\text{mass concentration of G in water}}$

$$K_d = \frac{1.59 / 100\text{cm}^3}{2g - 1.59 / 100\text{cm}^3}$$

$$K_d = \frac{1.59}{2g - 1.59} \times \frac{500\text{cm}^3}{100\text{cm}^3}$$

$$K_d = 4.5$$

\therefore Partition coefficient of solute G between pentan-1-ol and water is 1.5

Ques Solution
from

$$K_d = \frac{\text{Concentration of G in pentan-1-ol}}{\text{Concentration of G in water}}$$

$$1.5 = \frac{F / 100\text{cm}^3}{m - F / 500\text{cm}^3}$$

$$\text{But } m = 2g - 1.5g = 0.5g$$

$$1.5 = \frac{F}{0.5g - F} \times \frac{500\text{cm}^3}{100\text{cm}^3}$$

$$1.5 = \frac{5F}{0.5g - F}$$

$$20F = 7.5g$$

$$F = 0.375g$$

$$\text{Total solute extracted } R_t = 1.5g + 0.375g$$

$$\text{Mass of solute G remain} = 2g - 1.875g$$

$$= 0.125g$$

$$\text{Mass of solute G remain} = 0.125g$$

Question 04

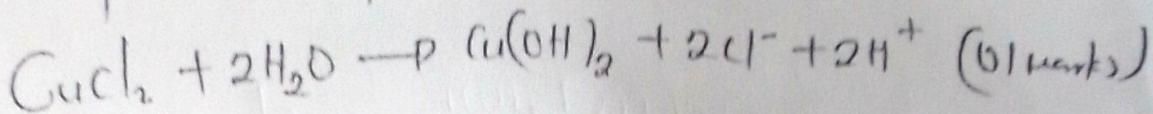
- (a) Fluorine has unexpectedly lower value of electronegativity.
- Fluorine has unexpectedly lower value of bond energy.
 - Fluorine does not disproportionate while other group member do
 - Fluorine has highest value of electronegativity than the other group members
 - Fluorine has highest oxidizing power than the other group members
 - Fluorine form stable covalent molecules with nonmetals than the other group VIIA (04 marks)

(b) $\text{HF} < \text{HCl} < \text{HBr} < \text{HI}$ (01 marks)

- As atomic size increase from fluorine to iodine down the group, the bond strength tend to decrease from HF to HI this make the bond to break easily and release ~~energy~~ hydrogen which in turns increase the acidity. (01 marks)

- (c) (i) Fluorine atom is very small with high charge density such that in F-F bond the atoms are too close to each other, making the repulsive force stronger between fluorine atoms making the dissociation process easier (02 marks)

(ii) Cu^{2+} being smaller in size with high effective nuclear attractive force and higher polarizing power, polarize water molecules and attract OH^- leaving H^+ ions as free ions which accounts for acidity of the solution. (01 marks)



(iii) Sodium and Potassium have large atomic size and fewer valence electrons making the metallic bond strength in their metallic lattice structure weaker, making them softer with lower density (02 marks)

(d) i) Concentration of the ore.

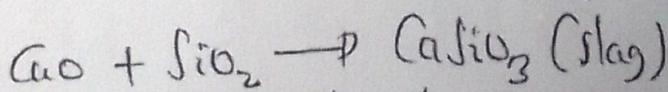
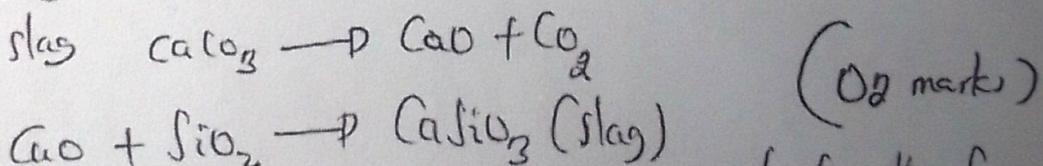
- Magnetic impurities contaminated with the Cassiterite is removed by magnetic separator, also lighter silicon containing materials are separated from the ore by gravity method. (01 marks)

ii) Roasting

- The ore is roasted so as to remove volatile impurities such as sulphur and arsenic. (01 marks)

iii) Smelting.

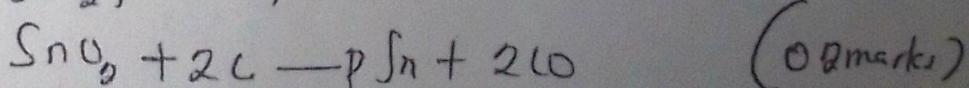
- To remove silica (SiO_2) found in the ore, calcium carbonate is introduced in the reverberator furnace, it first decomposes to give calcium oxide which combine with silica to form calcium silicate as molten slag



- Then, the molten slag is easily removed from the furnace.

iv) Reduction.

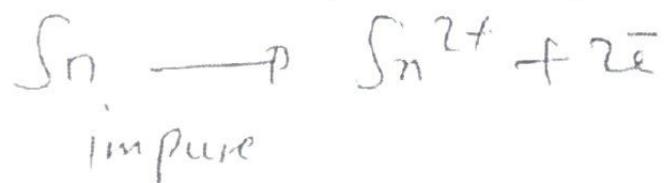
Cassiterite (SnO_2) is easily reduced by coke



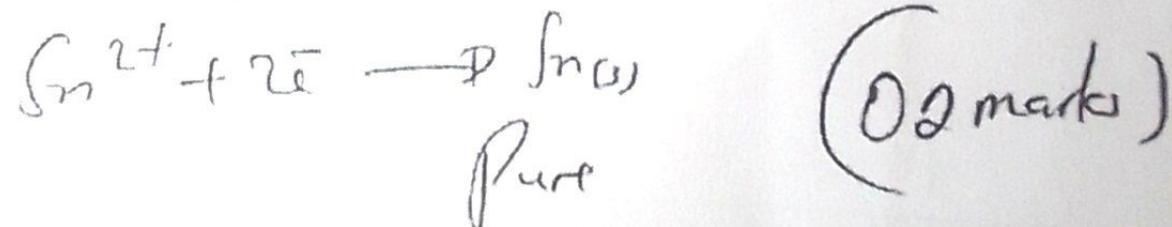
\therefore The metal obtained is impure which is to be purified.

v) Purification.

- Impure tin is purified by the electrolytic method where the impure tin is made the anode and the pure tin is made Cathode. The electrolyte used is the mixture of tin II Sulphate, dilute sulphuric acid and hexafluorosilicic acid.
- At the anode, the impure tin dissolves in the solution



- At the cathode, the ions, Sn^{2+} found in the solution get deposited at the cathode as pure metal



(02 marks)

Qn 5 (a)

Solution

Symbol	C	H	O
% composition	60	13.33	26.67
Divide the % composition by RAM	$\frac{60}{12}$	$\frac{13.33}{1.1}$	$\frac{26.67}{16}$
	5	13.33	1.67
Divide the answer above by the smallest value.	$\frac{5}{1.67}$	$\frac{13.33}{1.67}$	$\frac{1.67}{1.67}$
Ratios	3	8	1

Empirical formula is C_3H_8O

Molecular formula =

$$\text{But } M_w = n(E+F) = M_w$$

$2 \times \text{vapour density}$

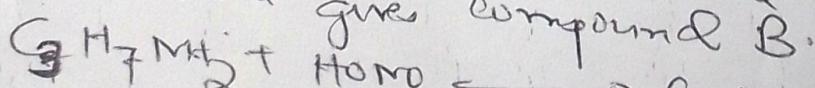
$$2 \times 30 = 60$$

$$n(C_3H_8O) = 60$$

$$\frac{60}{60} = \frac{60}{60}$$

Molecular formula will be C_3H_8O .

Compound A is $C_7H_7NH_2$ when reacts with nitrous acid gives compound B.



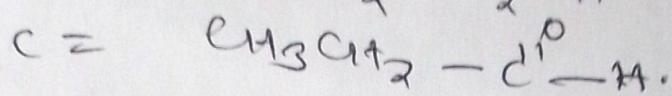
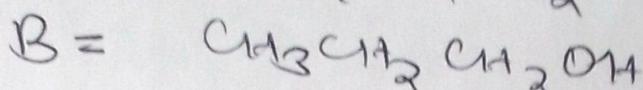
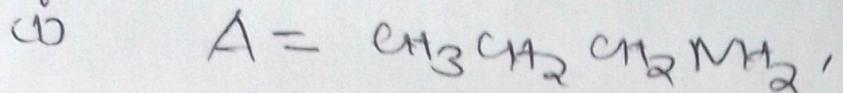
When B oxidized with H_2CrO_4 a weak carbonyl compound

$C_3H_7OH \xrightarrow{H_2CrO_4} CH_3CH_2-C(=O)-H$

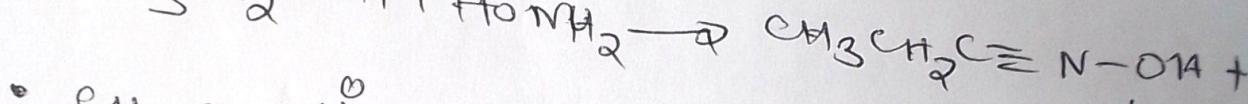
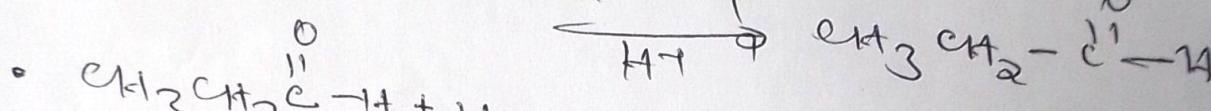
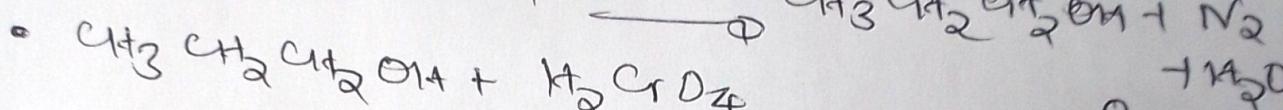
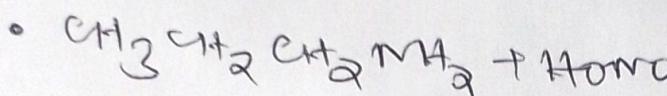
Compound C is an aldehyde because it can react with hydroxylamine to give oxime. Also it can react with Fehling's solution to form brick red ppt.

The structures of compound A, B and C

are:

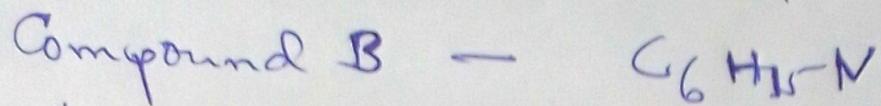
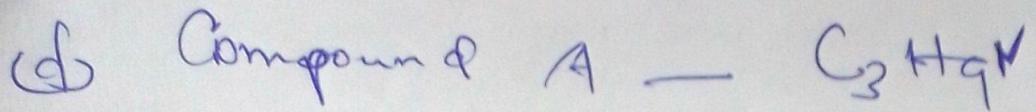


(ii)



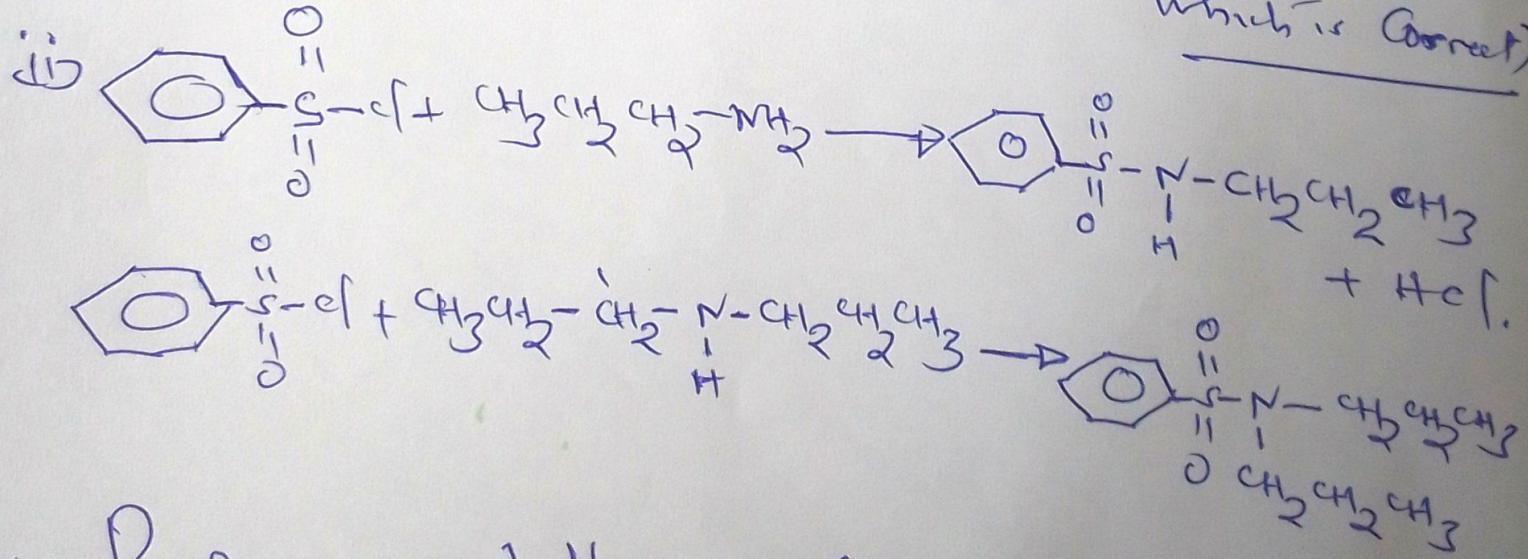
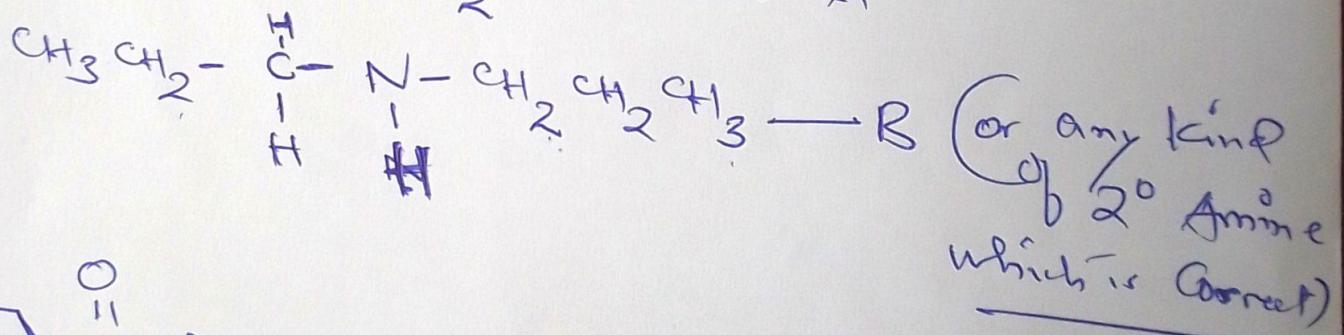
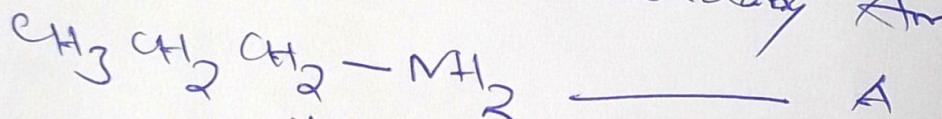
(iii) When chlorine as a with drawing group attached to carbonyl it will increase the acidity of carboxylic acid since it withdraws electrons away from the bond hence weaken the O-H bond hence easily released to the solution

(iv) When large sized alkyl group is attached to carboxylic acid, it decreases the acidity of carboxylic acid since it - supplies the electrons towards the functional group (-COOH) thus making the O-H bond strong thus it is difficult to release H⁺ into the solution



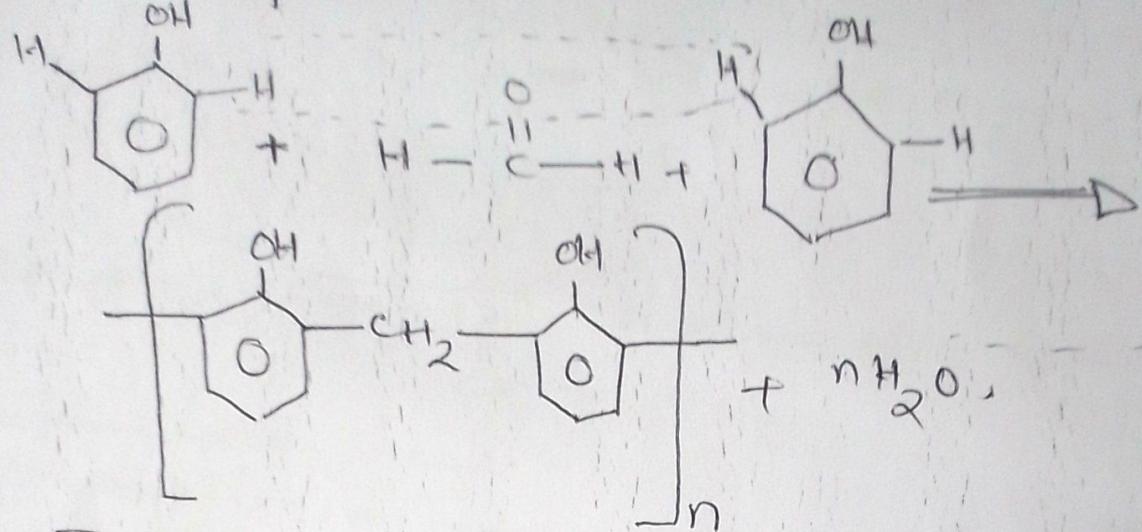
- Since the product formed when Compound A reacts with any Sulphonyl Chloride is soluble in alkali. Indicate that Compound A is primary Amine. (due to presence of acidic proton on the nitrogen atom of the Sulphonamide).
- Also, since the product formed when Compound A and B react with any Sulphonyl Chloride is insoluble in alkali. This indicate that Compound B is secondary Amine.

ii



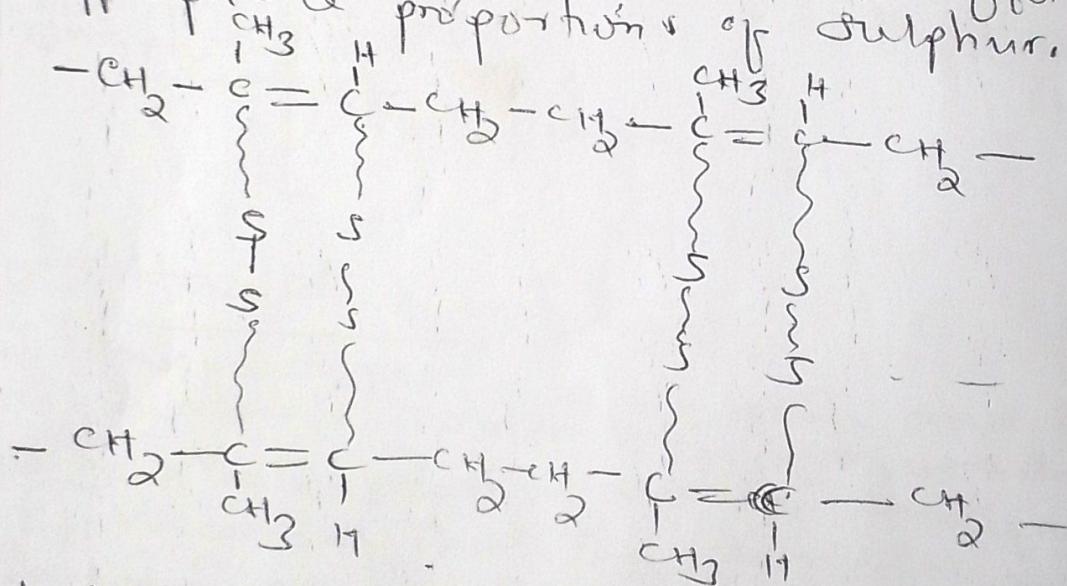
Product is soluble in Alkali due to presence of acidic proton and another is insoluble due to absence of acidic proton.

Qn 6 \rightarrow Bakelite is formed by condensation polymerization when phenol combine with - methanol.



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(ii) The natural rubber is modified by vulcanization process by introducing disulphide bonds between the polymer chains after adding appropriate proportion of sulphur.

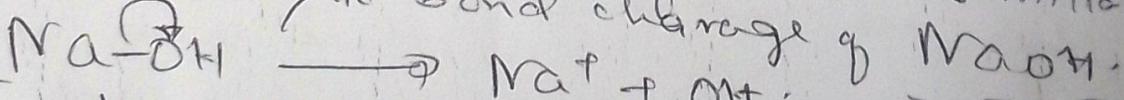


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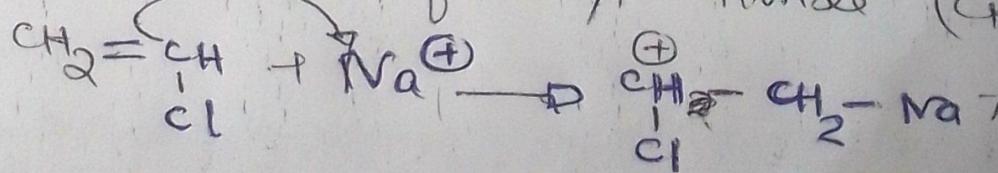
\rightarrow Initiation stage:

- It involve the formation of cation as initiator from heterolytic bond cleavage of NaOH.



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Then the cation formed is attacked by the double bond of vinyl chloride ($\text{CH}_2=\text{CHCl}$)

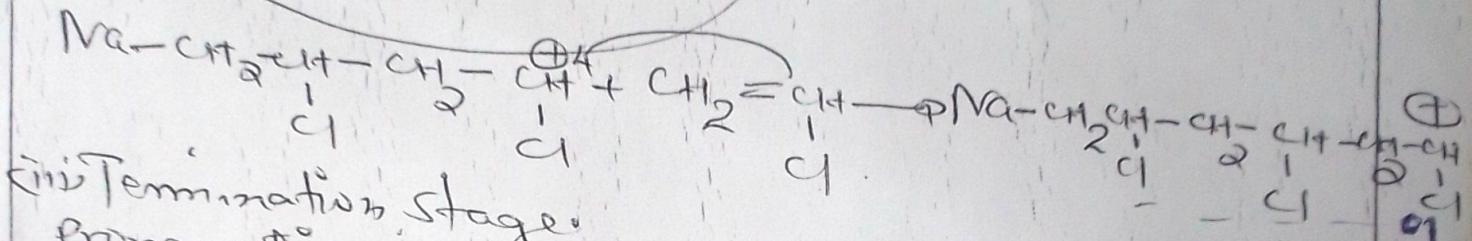
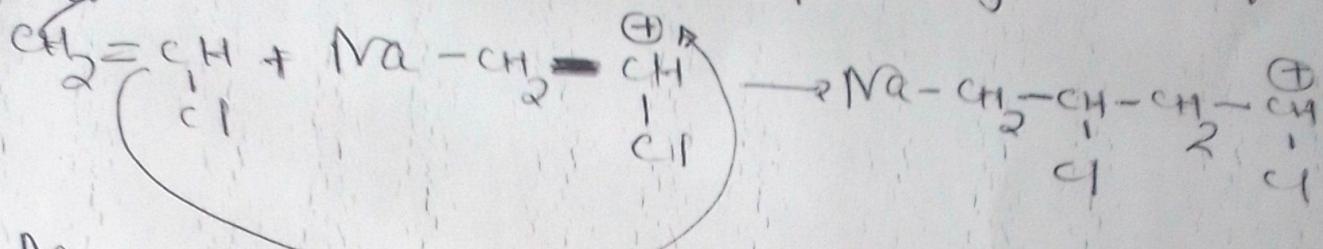


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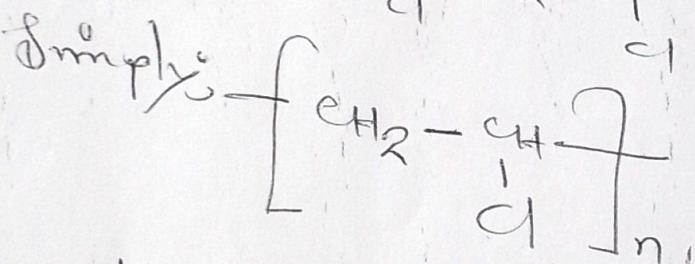
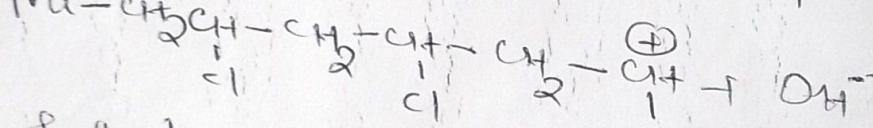
(i) Propagation Stage:

The carbocation formed continues to combine with monomers and the process goes on indefinitely.



(ii) Termination Stage:

Propagation is terminated when the carbocations combine with Anions.



(c) Hazards of polymers:

- (i) Unsafe disposal of plastic wastes and other polymer materials contribute to environmental pollution.
- (ii) Synthetic polymers are not biodegradable materials meaning that they do not decay when dumped on land or buried underground.

(iii) Massive production of polymers increases their accumulation around human settlements which is hazardous because they can easily catch fire and burn.

Uses of polymers:

- (i) Used in clothing such as synthetic fibers e.g. polyesters.
- (ii) Used as packaging materials.
- (iii) Manufacturing of construction materials.