PRESIDENT'S OFFICE REGIONAL ADMINISTRATION
AND LOCAL GOVERNMENT

DAR ES SALAAM REGION

FORM SIX MOCK EXAMINATION

CHEMISTRY - 2

MARKING GUIDE

(a) (i) - The solution should be dilute
- The solute should be non-electrolyte.
- The temperature should be constant. (2 marks)

(ii) $W_o = 10g$.

$V_u = 100cm^3$

$V_L = 5200cm^3$.

$kd = 5$.

$W_r = ?$

$n = 1$.

$$W_r = \left(\frac{V_L}{V_L + V_u kd}\right)^n W_o.$$

$$W_r = \left(\frac{5200}{5200 + (5 \times 100)}\right) \times 10.$$

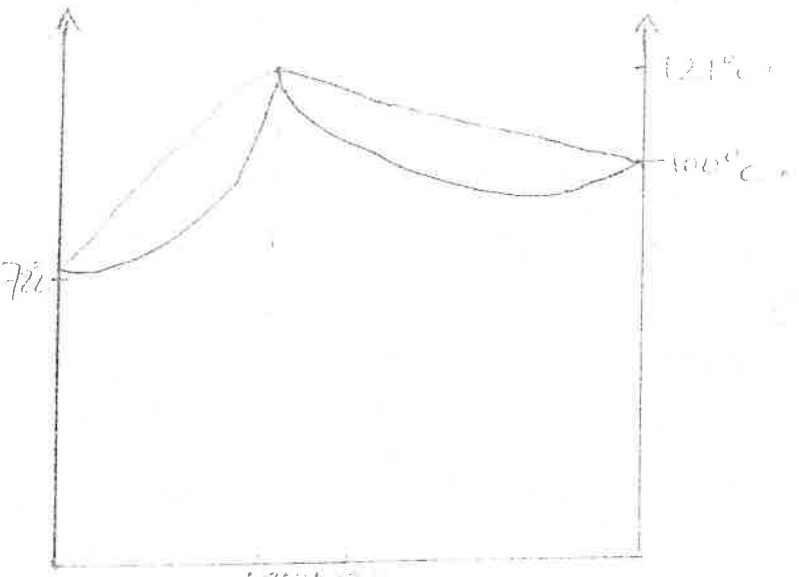
$W_r = 5g$.

$W_{extracted} = W_o - W_r = 10 - 5 = 5g$.

∴ Mass of Q extracted is 5g.

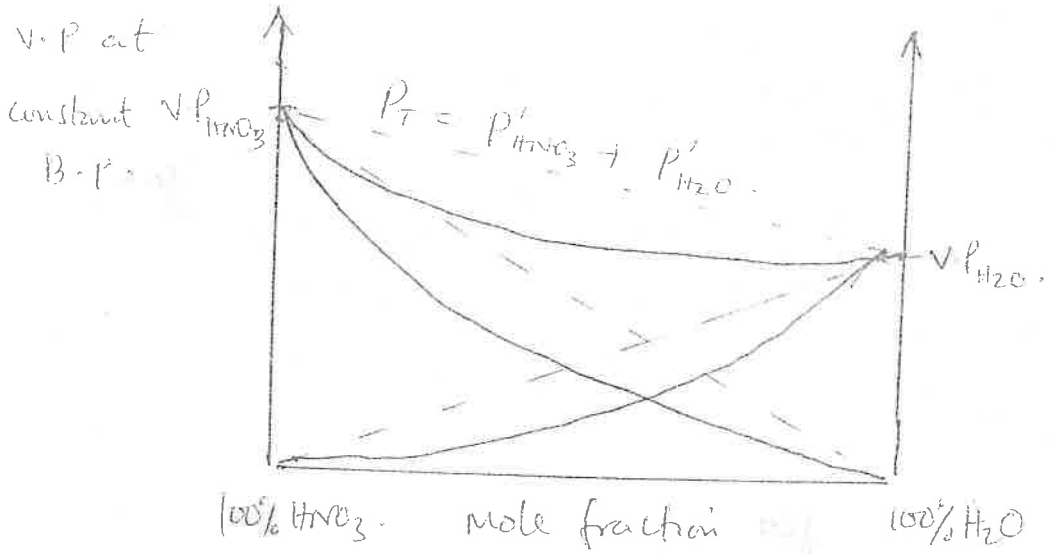
(b) Azeotropic mixture can not be separated by fractional distillation because azeotrope is a constant boiling mixture. When an azeotropic mixture is boiled, the composition of vapour is the same as that of an unboiled mixture.

(c) (i)



On fractional distillation of 68% HNO_3 the distillate will contain more water than nitric acid whereas the residue contain more HNO_3 than H_2O. On continuation of boiling and condensation, the distillate is pure H_2O and the residue is azeotropic mixture.

(ii) Vapour pressure against mole fraction.



(iii) Negative deviation.

2. (a) (i) Electrochemical cell -

(ii) Standard hydrogen electrode -

(iii) Electrode potential -

(b) (i) $E^{\ominus}_{cell} = E_R - E_L = E^{\ominus}_{Pb} - E^{\ominus}_{Al}$

$E^{\ominus}_{cell} = -0.126 - (-0.259) = 0.133\,V$

$K_c = \ln^{-1}\left(\frac{n E^{\ominus}_{cell}}{0.059}\right)$

$2 \mid Al \rightarrow Al^{3+} + 3e^-$

$3 \mid Pb^{2+} + 2e^- \longrightarrow Pb$

$2Al + 3Pb^{2+} \rightarrow 2Al^{3+} + 3Pb$

$n = 6$

$K_c = \ln^{-1}\left(\frac{6 \times 0.133}{0.059}\right)$

$K_c = 7.31 \times 10^5$

(ii) Molar mass of $PbI_2 = 207 + (127 \times 2) = 461 gmol^{-1}$

Molar conc of PbI_2 = $\frac{\text{Conc in } gdm^3}{\text{Molar mass}}$

$= \frac{0.11\,gdm^3}{461\,gmol^{-1}}$ (3)

Molar conc. of PbI_2 = 2.39×10^{-4} mol/dm³.

Let solubility of PbI_2 be x.

$PbI_2 \rightleftharpoons Pb^{2+} + 2I^-$

$[Pb^{2+}] = x$

$[I^-] = 2x$.

$K_{sp} = [Pb^{2+}][I^-]^2$.

$K_{sp} = (x)(2x)^2 = 4x^3$.

$K_{sp} = 4(2.39 \times 10^{-4})^3$

$K_{sp} = 5.461 \times 10^{-11}$ mol³ dm⁻⁹.

∴ solubility product of PbI_2 is 5.461×10^{-11} mol³ dm⁻⁹.

In 0.01M NaI

$NaI \longrightarrow Na^+ + I^-$

0.01M 0.01M.

$[Pb^{2+}] = x$

$[I^-] = 2x + 0.01 \approx 0.01$M.

$K_{sp} = [Pb^{2+}][I^-]^2$

$5.461 \times 10^{-11} = (x)(0.01)^2$.

$x = \frac{5.461 \times 10^{-11}}{(0.01)^2} = 5.461 \times 10^{-7}$M

∴ Solubility of PbI_2 in 0.01M NaI is 5.461×10^{-7}M.

PbI_2 is less soluble in 0.01M NaI due to common ion effects.

2. (c) $[A]_0 = 100\%$

$[A] = 100 - 99.9 = 0.1\%$.

from 1st order reaction

$$\ln \frac{[A]_0}{[A]} = kt.$$

$$k = \left(\ln \frac{[A]_0}{[A]}\right) \times \frac{1}{t}$$

$$k = \left(\ln \frac{100}{0.1}\right) \times \frac{1}{t}$$

(d) Let the rate of reaction at 20°C and x and at 50°C is 3x.

$T_1 = 20 + 273 = 293K$

$T_2 = 50 + 273 = 323K$

$E_a = ?$

From $\ln \frac{k_1}{k_2} = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$\ln \frac{x}{3x} = \frac{E_a}{8.31}\left(\frac{1}{323} - \frac{1}{293}\right)$

$\ln\left(\frac{1}{3}\right) = \frac{E_a}{8.31}\left(\frac{293 - 323}{323 \times 293}\right)$

$\frac{\ln\left(\frac{1}{3}\right) \times 8.31 \times 323 \times 293}{293 - 323} = E_a$

$28800J = E_a$

∴ Activation energy of the reaction is 28800J (28.8kJ).

3. (a) (i)  because it can form intermolecular hydrogen bonds.

(ii) $CH_3CH_2CH_2CH_2OH$ because it can form strong hydrogen bond.

(iii) CH_3CH_2OH b'se it can form hydrogen bond.

(b) (i) Polymers - Is a class of natural or synthetic substances composed of very large molecules made up of small chemical units called monomers.

(ii) Thermosetting polymer - Is a polymer that is obtained by irreversibly hardening a soft solid or viscous liquid polymer

(iii) Thermoplastic polymer - Is any plastic material that becomes pliable or mouldable at a certain elevated temperature and solidifies upon cooling.

(iv) monomers - Are small chemical substances which combine to form large molecules / polymers.

(c) (i) $\left(HN-\underset{\underset{CH_3}{|}}{CH}-\overset{O}{\overset{\|}{C}}\right)_n$.

(ii) 

(iii) $\left(HN-(CH_2)_6-NH\right)_n$

(iv) $\left(\overset{O}{\overset{\|}{C}}-(CH_2)_4-\overset{O}{\overset{\|}{C}}\right)_n$

(d) (i) $[Co(NH_3)_4Cl\,NO_2]\,Cl$

(ii) $K_2[Ni(CN)_4]$

(iii) $[Pt(NH_3)_3Br]\,Cl$

(iv) $K_3[CoF_6]$

4. (a) (i) Ethylamine is soluble in water due to its ability to form hydrogen bonds with water. On the other hand aniline is hydrophobic due to presence of benzene hence do not form hydrogen bonds.

(ii) methylamine in water react with ferric chloride to precipitate hydrated ferric oxide. due to +I-effect of methyl group CH_3NH_2 is more basic than water. Therefore in water methylamine produces OH^- ion by accepting H^+ ion from water. Ferric chloride ($FeCl_3$) dissociates in water to form Fe^{3+} and Cl^- ions.

(iii) Alcohols form strong hydrogen bonds in comparison to aliphatic amines due to high electronegativity of oxygen than nitrogen.

4. (b) A compound X is an amide bse it reacts with Br_2 in presence of NaOH.

S f of X is $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-NH_2$

$$CH_3CH_2-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[NaOH]{Br_2} CH_3CH_2NH_2 + CO_2$$

Y.

The s f of

X = $CH_3CH_2-\overset{O}{\overset{\|}{C}}-NH_2$

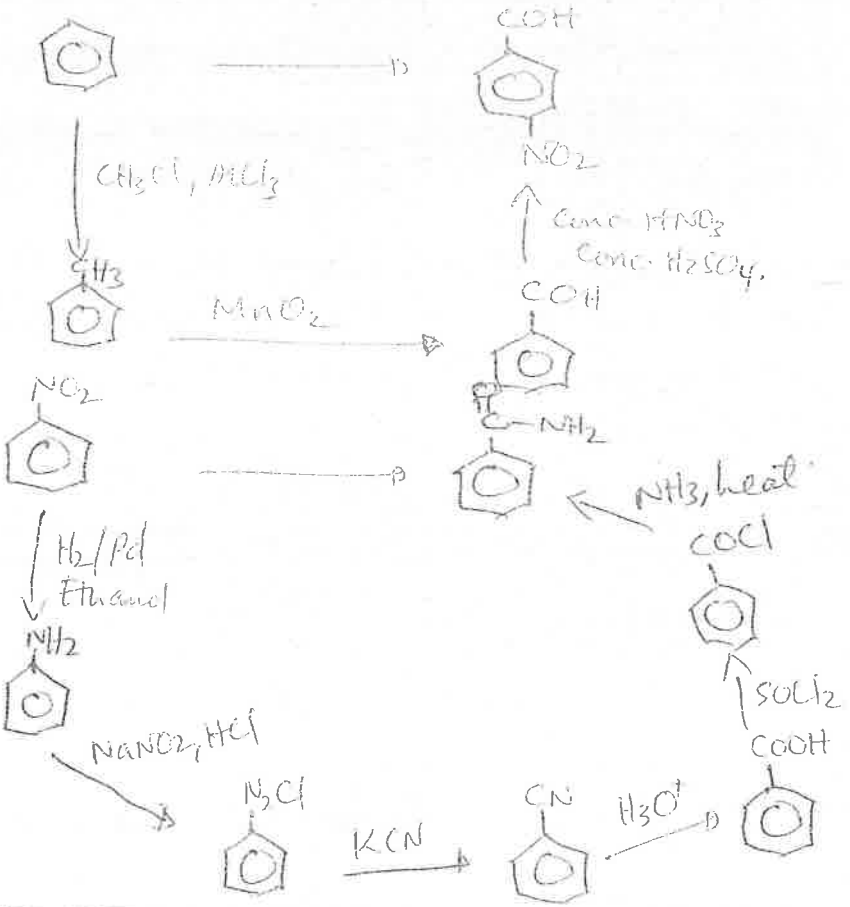
Y = $CH_3CH_2NH_2$

Chemical reactions.

$$CH_3CH_2-\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow{Br_2, NaOH} CH_3CH_2NH_2 + CO_2$$

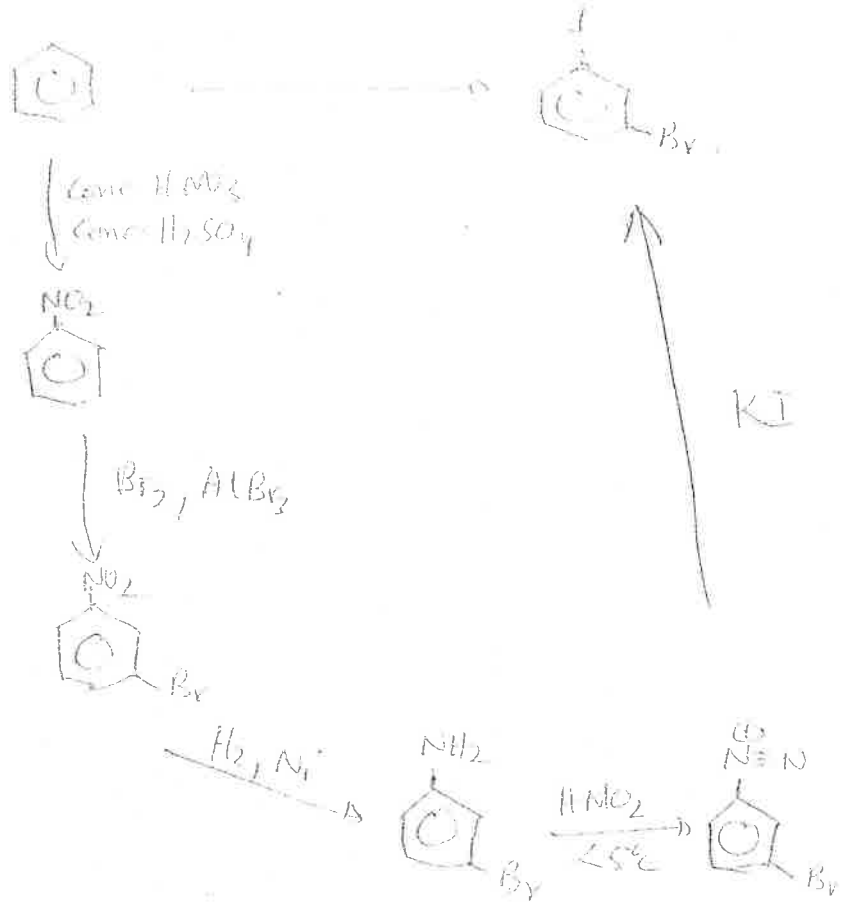
$$CH_3CH_2NH_2 + HNO_2 \longrightarrow CH_3CH_2OH + N_2$$

(c) (i)



(ii)

4. (c) (iii)



(d) (i) 4 - Hydroxyphenol

(ii) 4 - chlorophenylmethanol

(iii) Butan-2-ol

(iv) Pent-3-en-2-ol.

5. (a) (i) Bidentate ligands - Are ligands which can form two dative bonds with the central metal atom.
E.g. Ethylenediamine (en).

(ii) Coordination number - is the number of dative bonds formed between ligands and central metal ion.
E.g. $[CoF_6]^{3-}$.

5 (a) (iii) Ambidentate ligands:- Are ligands with two donor atoms but use one donor atom at once.

Eg. OCN^-

(iv) Polydentate ligands:- Are ligands with many donor atoms.

Eg. Ethylenediaminetetraacetato (EDTA).

(b) (i) The colour change of concentrated aqueous copper (II) chloride from bright green to light blue when diluted is due to change in the electronic environment of the copper ion. A concentrated solution results in green colour due to lesser d-d transitions, while dilution causes an increase in the d-d transitions and results in a light blue colour.

$$CuCl_2 + 6H_2O \longrightarrow [Cu(H_2O)_6]^{2+} + 2Cl^-$$

Bright green — Light blue. (aq) (aq)

(ii) Hydrated copper (II) sulphate have blue colour due to presence of water ligands which split the d-orbital and lead to light absorption. The anhydrous copper (II) sulphate is white due to absence of water ligands.

(9)

5.

(b) (iii) They it because of large number of unpaired electrons in their atoms, transition elements have stronger interatomic interaction and hence stronger bonding between atoms resulting in higher enthalpies of atomization.

(c) (i) Since the complex form one mole of AgCl with $AgNO_3$ hence the complex has only one Cl outside the complex.

Therefore the complex formula is $[Co(NO_2)_2Cl_3NH_3]Cl$

(ii) Ammine trichlorodinitrocobalt (III) Chloride

(d)

(i) Preparation

The ore is heated with carbon at about 1800°C under nitrogen.

$$Al_2O_{3(s)} + 3C_{(s)} + N_{2(g)} \xrightarrow{1800°C} 2AlN_{(s)} + 3CO_{(g)}$$

$$SiO_{2(s)} + C_{(s)} \xrightarrow{1800°C} Si_{(g)} + CO_{2(g)}$$

The silica gets reduced to silicon and carbondioxide. Volatile silicon and carbondioxide escapes leaving behind aluminium nitride.

On hydrolysis AlN gives $Al(OH)_3$.

$$AlN_{(s)} + 3H_2O_{(l)} \longrightarrow Al(OH)_{3(s)} + NH_{3(g)}$$

(10)

The obtained $Al(OH)_3$ precipitate is filtered and heated to obtain Al_2O_3:

$$2Al(OH)_{3(s)} \xrightarrow{1200^\circ C} Al_2O_{3(s)} + 3H_2O_{(g)}$$

(ii) electrolysis of pure alumina.

Pure Al_2O_3 obtained is melted in presence of cryolite and fluorspar. Cryolite and fluorspar reduce m.p of bauxite and make it a good conductor of electricity.

The cathode used and anode are both graphite.

Aluminium is discharged and collected at the bottom of the cell and is tapped from time to time.

$$Al^{3+}_{(l)} + 3e^- \longrightarrow Al_{(l)}$$

Oxygen is liberated at the anode. At high temperature of the cell, oxygen reacts to form carbondioxide and carbonmonoxide therefore the carbon anodes gradually vanish because each molecule of carbonmonoxide or carbondioxide carbonmonoxide given off takes away carbon with it.

$$2O^{2-}_{(l)} \longrightarrow O_{2(g)} + 2e^-$$

(a) (i) The reaction of alkylchloride C with KCN increase one carbon and on hydrolysis it gave acid A. This shows that the s.f of ester E was $CH_3CH_2\overset{O}{\overset{\|}{C}}-OC_2H_5$.

Name: Ethylpropanoate.

(ii) $CH_3CH_2\overset{O}{\overset{\|}{C}}-OC_2H_5 + H_2O \xrightarrow{H^+} \underset{A}{CH_3CH_2COOH} + \underset{B}{CH_3CH_2OH}$

$CH_3CH_2OH + SOCl_2 \longrightarrow CH_3CH_2Cl + SO_2 + HCl$
C

$CH_3CH_2Cl + KCN \longrightarrow \underset{D}{CH_2CH_2CN} + KCl$

$CH_3CH_2CN + H_2O \xrightarrow{H^+} CH_3CH_2COOH$

The S.f of

A = CH_3CH_2COOH

B = CH_3CH_2OH

C = CH_3CH_2Cl

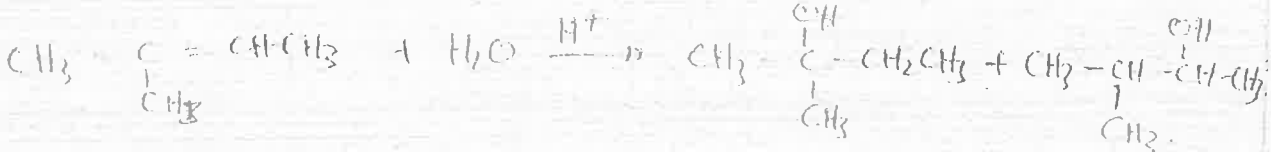
D = CH_3CH_2CN.

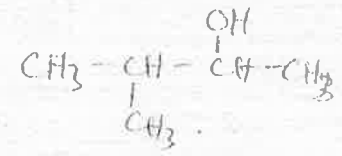
(b) From the products of ozonolysis the S.f of C can be deduced

$CH_3-\overset{O}{\overset{\|}{C}}-H$ and $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$.

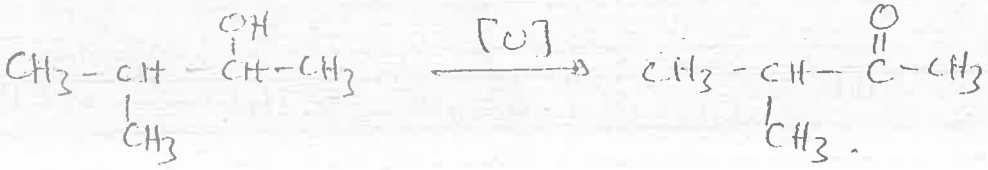
$CH_3-\underset{\underset{CH_3}{|}}{C}=O + O=CHCH_3 \longrightarrow CH_3-\underset{\underset{CH_3}{|}}{C}=CHCH_3$.

B can be formed by hydration of C.

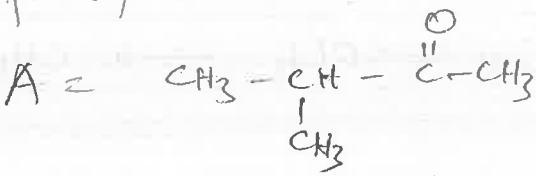


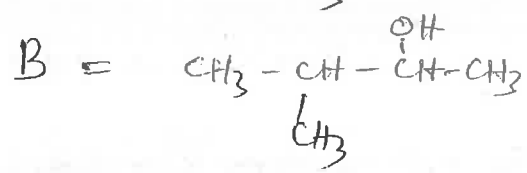
The correct s.f of B is 

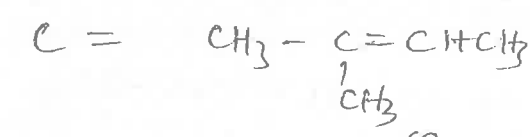
Oxidation of B gave A.



S.f of

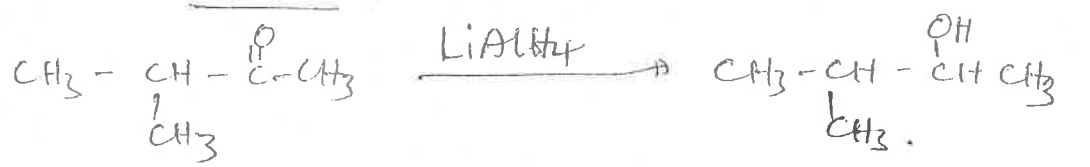
A =  3-Methylbutan-2-one --- 01

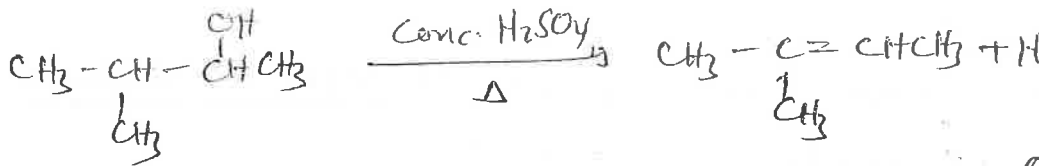
B =  3-Methylbutan-2-ol --- 01

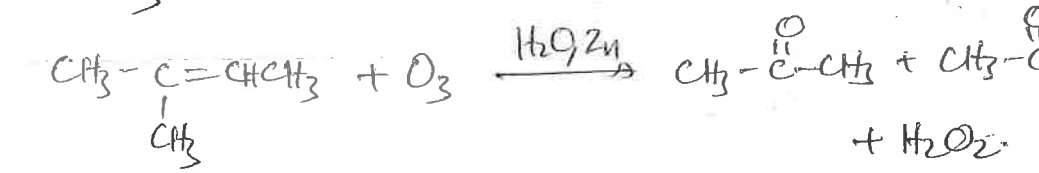
C =  2-Methylbut-2-ene --- 01

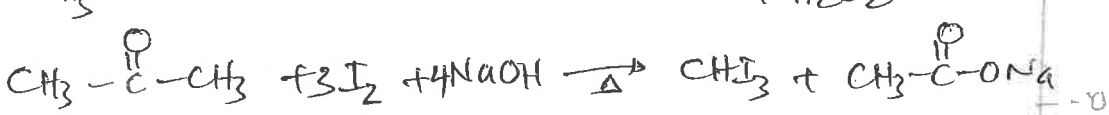
D =  Propanone.

Reactions:



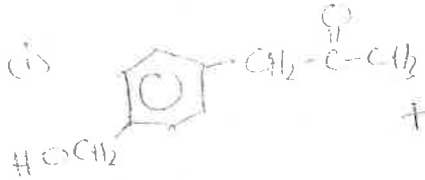




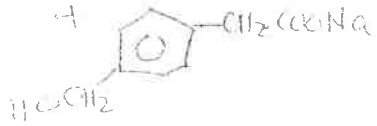


6- (c)

(i)

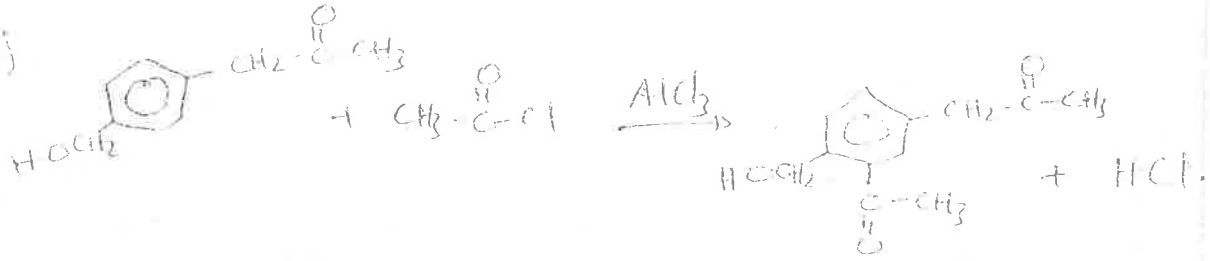


$+ 3I_2 + 4NaOH \xrightarrow{\Delta} CHI_3$

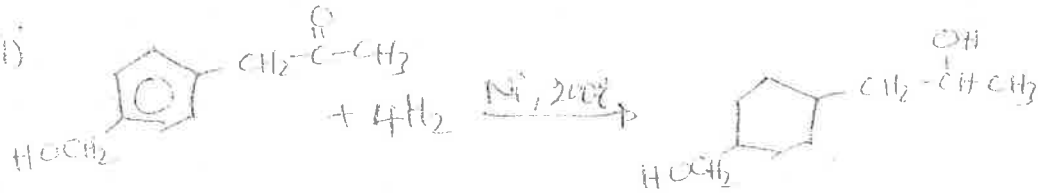


$+ 3NaI + 3H_2O$

(ii)



(iii)



(iv)