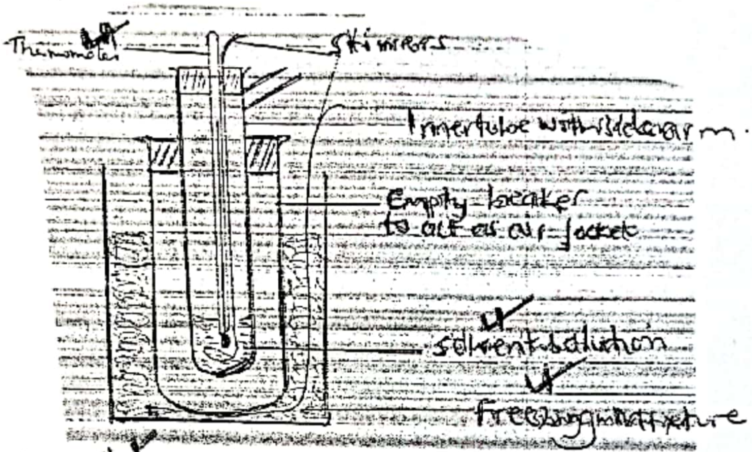
WAKISSHA
MARKING GUIDE
Uganda Advanced Certificate of Education
CHEMISTRY P525/2

1. (a) Freezing point depression constant is the depression of freezing point caused when one mole of a non-volatile solute is dissolved in 1000g of a pure solvent. (01) **(01)**

(b) (i)



A known mass of a pure solvent ag is placed in an inner tube with side arm. It is fitted with a stirer and a thermometer. The inner tube is them fitted into an empty tube to act as air jacket to minimize super cooling. The whole set up is lowered in to a beaker containing a freezing mixture are continuously being stirred.

The steady temperature at which the solvent freezes is read and recorded as $T_1{}^0C$. The tube with side arm is removed from the freezing mixture and warmed with hands to melt the solvent.

A known mass of the solute (naphthalene) bg is added to the solvent through the side arm. The mixture is stirred to dissolve the solute and the solution is allowed to cool. The steady temperature at which the solution freezes is read and recorded as $T_2{}^0C$.

Treatment of result:
Freezing point depression = $(T_1T_2)^0C$
Let K_f be the freezing point depression constant for the solvent.ag of the solvent (05)
dissolve ag of the solute 1000g of the solvent dissolve by $\left(\frac{b}{a}x100\right)$g of the solute.

$(T_1.T_2)^0C$ is the freezing point depression caused by $\left(\frac{b}{a}X100\right)$g of the solute

$K_f{}^0C$ is the freezing point depression caused by $\frac{b}{a}X1000X\frac{kf}{(T_1-T_2)}$

$\therefore$ Relative molecular mass of naphthalene = $\left(\frac{b\times1000\times kf}{a(T_1-T_2)}\right)$

(ii) The solution must be dilute
The solute should be not associate or dissociate in the solvent
The solute should not react with the solvent (02)
The solute should be non-volatile

(c) (i) see graph at the back

(ii) Freezing point of the pure cyclohexane is $6.42^0C \pm 0.2$ 01 **(01)**

(iii) $\text{Slope} = \dfrac{4.93 - {}^{-}2.6}{10 - 58}$

$$= \frac{7.53}{{}^{-}48}$$

$$= {}^{-}0.156875$$

$$T_1 - T_2 = DT = K_f\frac{m}{mr}$$

$$T_2 = \frac{{}^{-}kf}{mr} \times m + T_1$$ 3½

$$\text{Slope} = \frac{{}^{-}kf}{mr} = {}^{-}0.156875$$ 3½

$$Mr = \frac{+20.1}{+0.156875}$$

$$= 128.13$$

20

2\. (a) Buffer solution is a solution that resists change in pH when small amount of acidor base is added to it. 01 **(01)**

(b) Ammonia is a weak electrolyte that dissociate partially according to the equation.

$$NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_{4(aq)}^{+} + \bar{O}H_{(aq)}$$

Ammonium chloride is a strong electrolyte that dissociates completely according to the equation.

$$NH_4Cl_{(aq)} \rightarrow NH_{4(aq)}^{+} + Cl^{-}_{(aq)}$$

The presence of Ammonium ions from the salt suppresses the ionization of ammonia and thus the solution has a high concentration of un ionized ammonia molecules and ammonium ions.

On addition of small amount of the acid, the hydrogen ions from the acid reacts with hydroxide ions to form water.

∴ more ammonia ionizes to restore the hydroxide ion concentration and thus the PH is maintained.

0.5

On addition of a small amount of the alkali the hydroxide ions from the alkali react with ammonium ions to form ammonia and water.

$$NH_4^{+}{}_{(aq)} + {}^{-}OH_{(aq)} \rightarrow NH_{3(aq)} + H_2O_{(l)}$$

Almost all the hydroxide ions from the alkali and thus the PH is maintained.

(c) (i) $\text{No of moles of } NH_3 = \dfrac{50 \times 0.2}{1000}$

$$= 0.01 \text{ moles}$$

No of moles of $NH_4Cl = \frac{30\times0.25}{1000}$

$= 0,006$ moles $0\cdot0075\cdot$

Total volume of solution $=50+30$

$=80cm^3$ ✓

$[NH_3] = \frac{0.01}{80}x1000$ $\frac{0\cdot01}{80} x100 = 0\cdot125$

$=0.125 moldm^{-3}$ ✓

$[NH_4Cl] = \frac{0.006}{80}x1000$ $\frac{0\cdot0075}{80} x100 = 0\cdot09375$

$=0,075moldm^{-3}$ ✓ $pOH = 4\cdot75 + -0\cdot125$

$= \underline{4\cdot628}$

$POH = Pkb + \log_{10}\frac{(salt)}{(base)}$ ✓   **(04)**

$= -\log_{10}(1.78x10^{-5}) + \log_{10}\left(\frac{0.075}{0.125}\right)$ ✓ $pH = 14 - 4\cdot628$

$=4.52773+^-0.221849$ $pH = ~~13/75~~\ 9\cdot372$

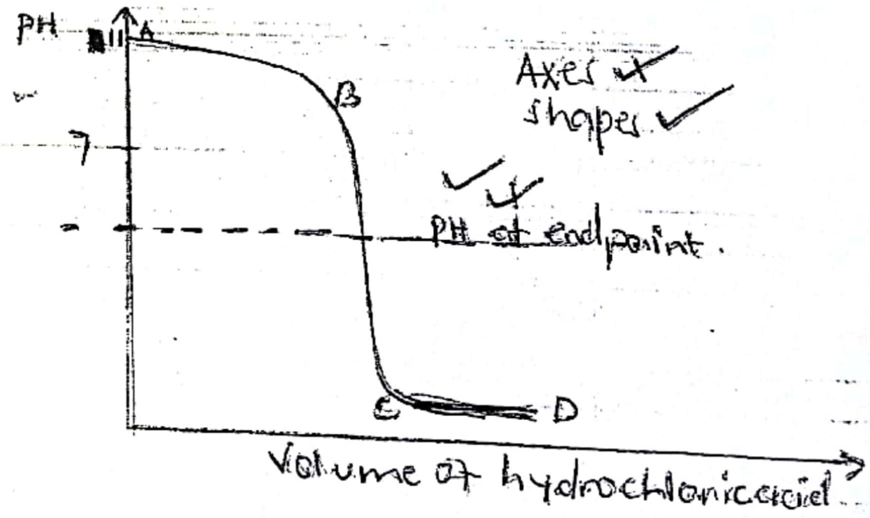
$=4.30588$ ✓

$NH_3 + H_2O \rightarrow NH_4^+ + OH$ $\therefore PH = 14 - POH$ $K_b = \frac{[NH_4^+][OH^-]}{[NH_3]}$

$= 14 - 4.30588$

$= 9.694$ ✓

(d) (i)



(ii) Initially the PH of ammonia solution is about 11 because ammonia is a weak base. Along AB< the PH decreases gradually being ammonia being neutralized by the acid but still in excess. ✓ **(03)**

© *WAKISSHA*

Point B is near the end acid, there is a sharp decrease in PH become the acid is strong. The PH at the end point is less than7 because the salt formed at the end point under goes hydrolysis to from acidic solution. Along CD, the PH increases gradually due to excess strong acid.

(iii) Methyl red because the salt formed undergoes hydrolysis to form a weakly acidic solution which is within the PH working range of methyl red. (2 ½)

20

3. (a) ns^2np^5

(b) (i) Fluorine reacts with water to form hydrogen fluoride (hydrofluoric acid) and oxygen gas. (04)

$2F_{2(g)} + 2H_2O_{(l)} \rightarrow 4HF_{(aq)} + O_{2(g)}$

The rest of the elements reacts react with water to form hypothalaous acid and hydrohalic acid

$X_2 + H_2)_{(l)}$ □ $HOX_{aq} + HX_{(aq)}$

($X = Cl_2$, Br, I)

The reactivity with water decreases down the group.

(ii) Fluorine reacts with cold dilute sodium hydroxide to form sodium fluoride, oxygen difluoride and water.

$2F_{2(g)} + 2NaOH_{(aq)} \rightarrow 2NaF_{(aq)} + OF_{2(g)} + H_2O$

The rest of the halogens reacts with cold dilute sodium hydroxide to form sodium hypohalide, sodium halide and water.

$X_2 + 2NaOH_{(aq)} \rightarrow NaOX_{(aq)} + NaX_{(aq)} + H_2O_{(l)}$

(X=Cl,Br,I) (5½)

Fluorine reacts with hot concentrated sodium hydroxide solution to form sodium fluoride, oxygen gas and water.

$2F_{29g)} + 4NaOH_{(aq)} \rightarrow 4NaF_{(aq)} + O_{2(g)} + 2H_2O_{(l)}$

The rest of the halogens react with hot concentrated sodium hydroxide to form sodium hydroxide to form sodium halite (V), sodium halide and water

$3X_2 + 6NaOH_{(aq)} \rightarrow NaXO_{3(aq)} + 5NaX_{(aq)} + 3H_2O_{(l)}$

(X= Cl, Br, I)

(iii) Sulphorous acid reacts with all the halogens in aqueous solution from hydrogen halide (hydrohalic acid) and sulphuric acid.

$X_2 + H_2SO_{3(aq)} + H_2O_{(l)} \rightarrow 2HX_{(aq)} + H_2SO_{4(aq)}$ (2½)

(c) (i) Pale green solution turns pale brown. (2½)

$Cl_{2(g)} + 2FeCl_{2(aq)} \rightarrow 2FeCl_{3(aq)}$

(ii) Colourless solution forms yellow precipitate (2½)

$Na_2S_2O_{3(aq)} + H_2O_{(l)} + Cl_{2(g)} \rightarrow Na_2SO_{4(aq)} + S_{(s)} + 2HCl_{(aq)}$

(iii) Green solution turns purple.

$2K_2MnO_{4(aq)} + Cl_{2(g)} \rightarrow 2KMnO_{4(aq)} + 2KCl_{(aq)}$ (2½)

20

=28.1

	C	H	Cl
% by mass	66.4	5.5	28.1
Moles	$\frac{66.4}{12}$	$\frac{5.5}{1}$	$\frac{28.1}{35.5}$
	5.533	5.5	0.79150
Mole	$\frac{5.533}{0.79150}$	$\frac{5.53}{0.79150}$	$\frac{0.79150}{0.79150}$
Ratio	7	7	1

(2½)

Empirical formula is C_7H_7Cl

(b) $PV = \frac{m}{mr}RT$

$$\frac{860}{760} \times 101325 \times 75.43 \times 10^{-6} = \frac{0.35}{mr} \times 8.314 \times 367.$$

$Mr = 126.5$

$(C_7H_7Cl)n = 126.5$

$(12x7+1x7+35.5)n = 126.5$

$126.5n = 126.5$

$n = 1$

Molecular formula is C_7H_7Cl

(03)

(c)

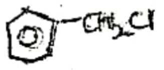
2-chloromethylbenzene

4-chloromethyl benzene

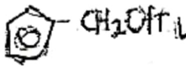
Chlorophenylmethane

(d)

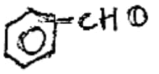
P is



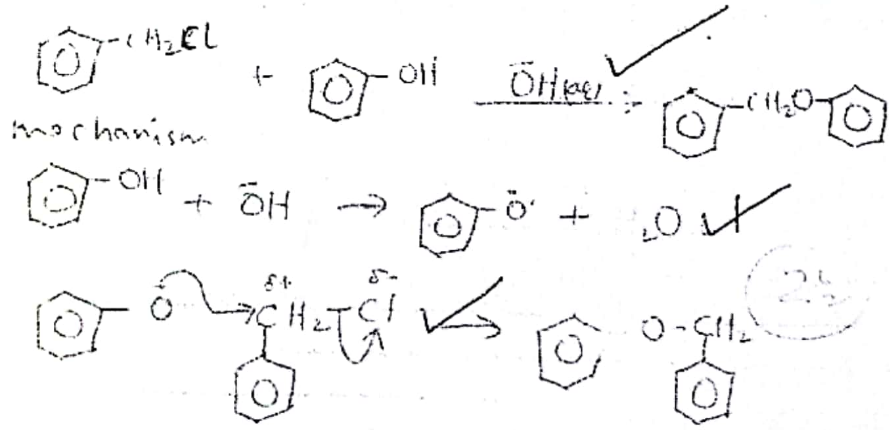
Q is



R is

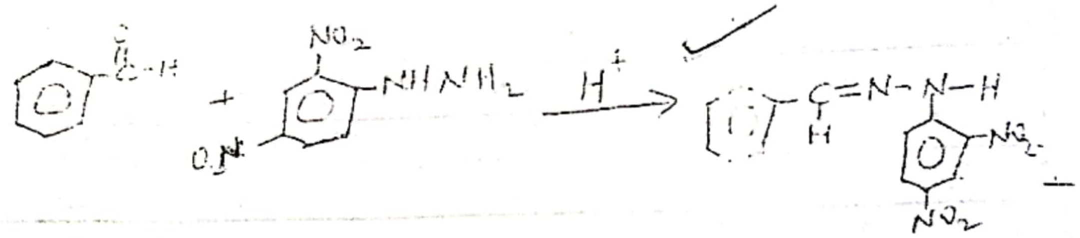


(e) (i)

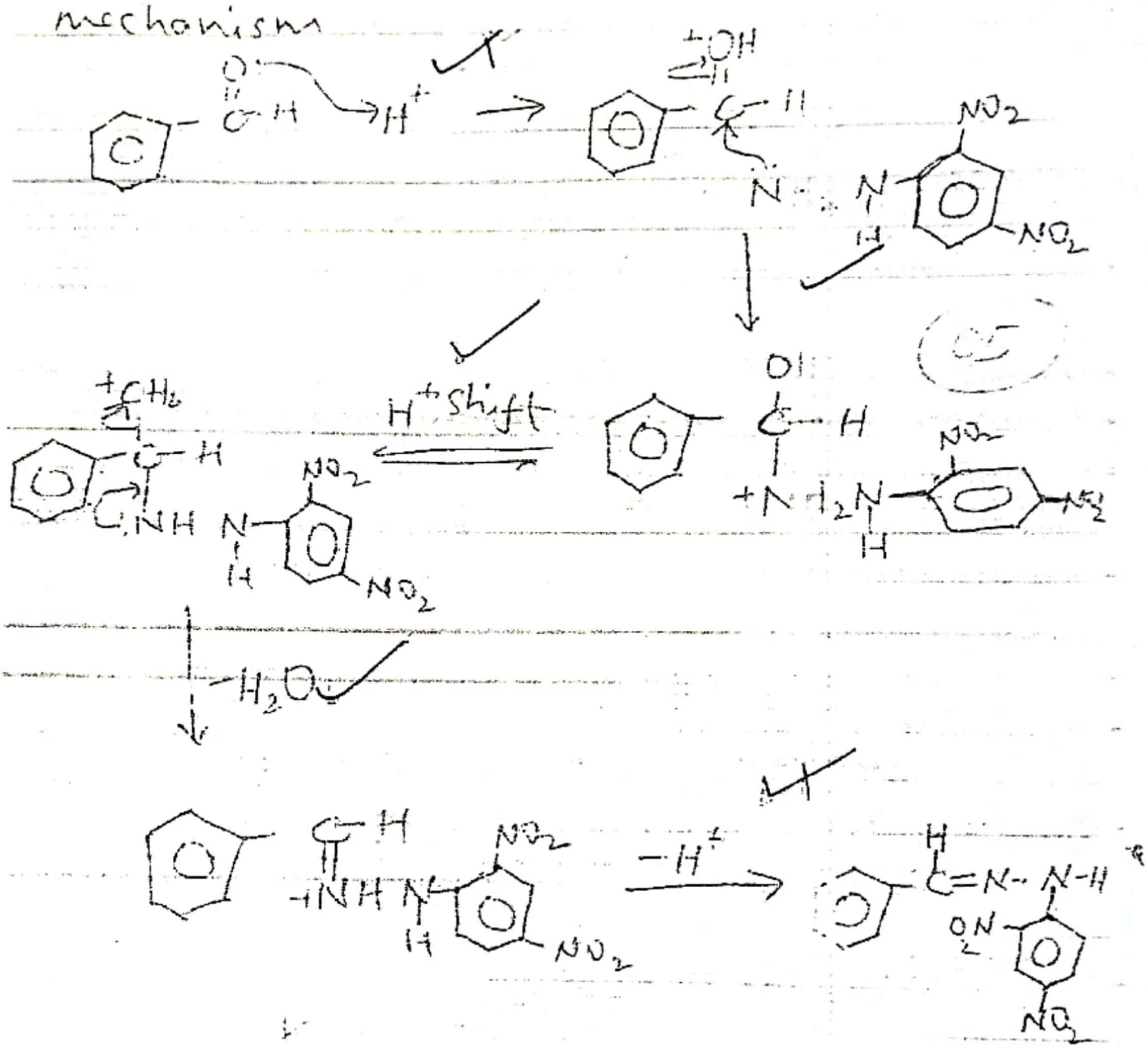


© WAKISSHA

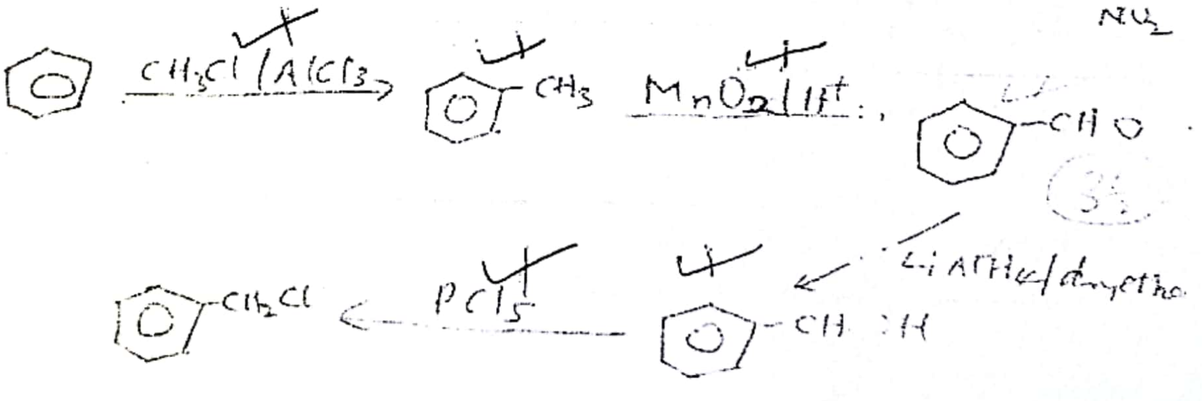
(ii)



mechanism



(f)



5. (a) (i) Order of reaction is the sum of the powers to which the concentration terms of the reactants are raised in the experimentally determined rate equation.
Rate constant is the constant of proportionality in the experimentally determined rate equation.

(ii) $2^x=2^1$
$x=1$
Order one with respect to $S_2O_3^{2-}$
$3^y=9$
$3^y=3^2$
$y=2$
Order two with respect to H^+

(iii) $\text{Rate} = K\left[S_2O_3^{2-}\right]\left[H^+\right]^2$

(iv) $$K=\frac{Rate}{\left[S_2O_3^{2-}\right]\left[H^+\right]^2}$$

$$\frac{\cancel{mol}\ \cancel{dm^{-3}}\ s^{-1}}{mol^2\ dm^{-6} \times \cancel{mol}\ \cancel{dm^{-3}}}$$
$$= mol^{-2}\ dm^{6}\ s^{-1}.$$

$$=\frac{7.00\times10^{-4}}{(0.40)(0.2)^2}$$

$= 4.375\text{x}10^{-2}mol^{-2}dm^6$

5. (b) Increase in temperature increases the rate constant of the reaction. Increase in temperature increases the kinetic energy of the reactants particles and collide more frequently and thus the rate of reaction increases which also increases the rate constant since the two are directly proportional.

Increase in temperature does not affect the activation energy the reactants instead it increases the number of molecules possessing the activation energy and thus more products are formed.

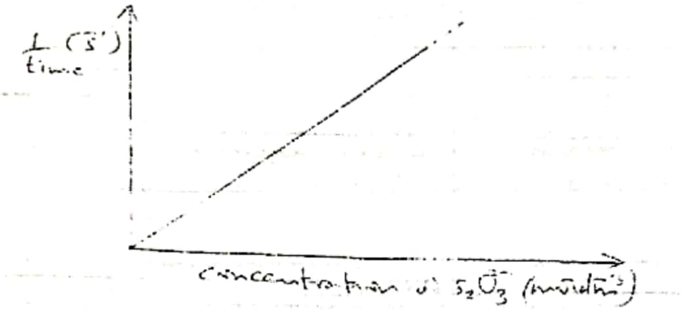
(c) Known volume of known concentrations of sodium thiosulphate are prepared from the stock solution and place in different beakers or conical flasks.

The beakers are placed on white pieces of paper with a cross or dot on them. A known fixed volumes of dilute hydrochloric are measured using measuring cylinders.

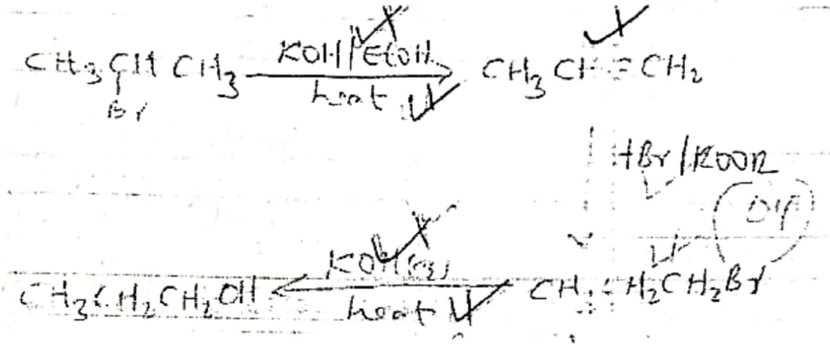
When dilute hydrochloric acid is added to the solution of sodium thiosulphate, a stop clock is started. The mixture is swirled while being viewed from above. The time taken when the yellow precipitate of sulphur blocks (obsecures) the cross from view is noted.

The experiment is repeated with different concentrations of sodium thiosulphate and the times recorded.

A graph of reciporical of time against concentration of sodium thiosulphate is plotted. A straight line graph is obtained an indication that the order of reaction with respect to Thiosulphate ion is one.

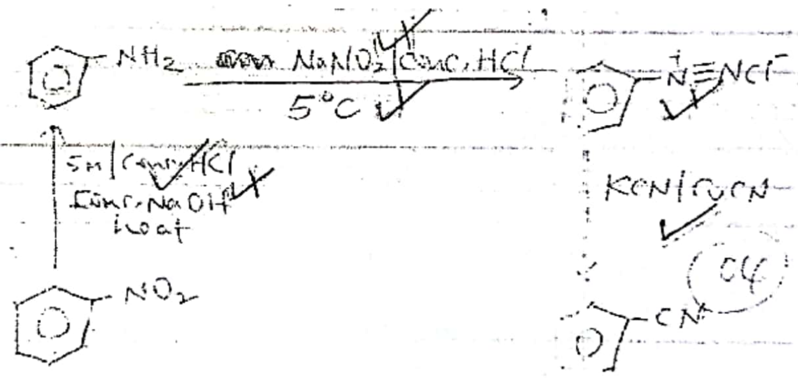


6. (a)

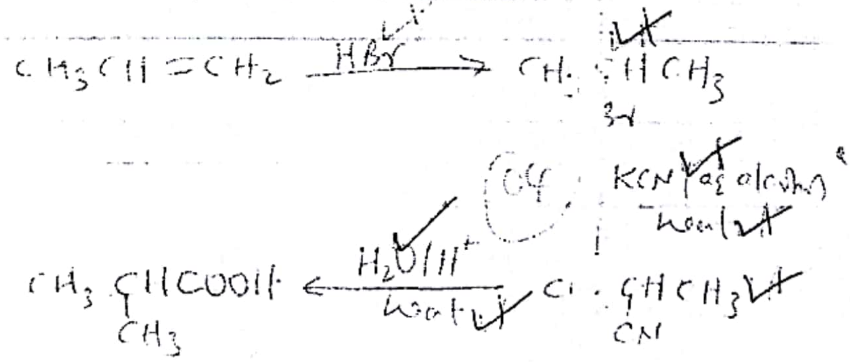


$CH_3CH(Br)CH_3 \xrightarrow[heat]{KOH/EtOH} CH_3CH=CH_2 \xrightarrow{HBr/ROOR} CH_3CH_2CH_2Br \xrightarrow[heat]{KOH(aq)} CH_3CH_2CH_2OH$

(b)

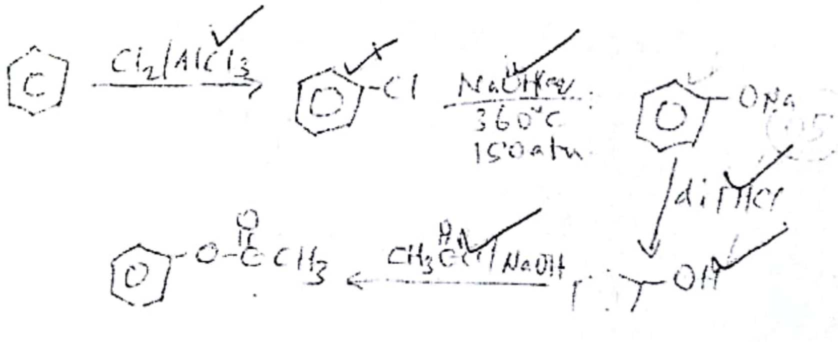


(c)

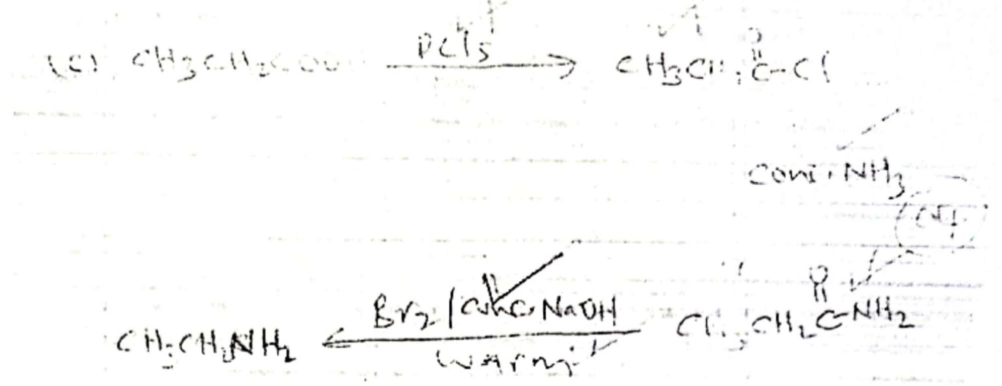


$CH_3CH=CH_2 \xrightarrow{HBr} CH_3CH(Br)CH_3 \xrightarrow[heat]{KCN/aq alcohol} CH_3CH(CN)CH_3 \xrightarrow[heat]{H_2O/H^+} CH_3CH(CH_3)COOH$

(d)



(e)



$$CH_3CH_2COOH \xrightarrow{PCl_5} CH_3CH_2\overset{O}{\overset{\|}{C}}-Cl \xrightarrow{conc.\ NH_3} CH_3CH_2\overset{O}{\overset{\|}{C}}-NH_2 \xrightarrow[warm]{Br_2/alk.\ NaOH} CH_3CH_2NH_2$$

7. (a) Lead(IV) oxide is a strong oxidizing agent and will **oxidize concentrated hydrochloric** acid to form chlorine and itself is reduced to lead(II) chloride.
$PbO_{2(s)}+4HCl_{(aq)} \rightarrow PbCl_{2(aq)}+Cl_{2(g)}+2H_2O_{(l)}$ (3½)

(b) Hydrogen sulphide is a reducing agent will **reduce Iron(III) ions to Iron(II)** ions and itself oxidized to sulphur.
$2FeCl_{3(aq)}+H_2S_{(g)} \rightarrow 2FeCl_{2(aq)}+S_{(s)}+2HCl_{(aq)}$ (3½)

(c) Chlorobenzene has a higher relative molecular mass than water and thus the intermolecular forces of attractions in chlorobenzene are stronger than those of water and therefore more energy is required to break the intermolecular forces in chlorobenzene than that in water

However when chlorobenzene is mixed with water an immiscible mixture is formed which Vapourises independent of each other. Thus the vapour pressure above the mixture is the sum of the individual vapour pressures. When the mixture is heated, the vapour pressure above the mixture can easily reach the external atmospheric acid making the mixture to boil it a temperature below the boiling points of individual components. **(04)**

(d) Chromium (III) ions react with hydroxide ions to form insoluble chromium (II) Hydroxide and since it is amphoteric of reacts with more hydroxide ions to form
soluble complex, tetrahydroxochromate (III) ion is hydroxochromate (III) ion.
The hexahydrochromate (III) ion is oxidized by Hydrogen peroxide to form chromate (VI) ion **(05)**
$Cr_{(aq)}^{3+}+3OH_{(aq)} \rightarrow Cr(OH)_{3(aq)}$
$Cr(OH)\,^{3-}_{6}\,_{(aq)}+3OH_{(aq)} \rightarrow Cr(OH)_6^{3-}{}_{(aq)}$
$2Cr(OH)_6^{3-}{}_{(aq)}+3H_2O_{2(aq)} \rightarrow 2CrO_{4(aq)}+2Cl_{(aq)}+3H_2O_{(l)}$

8. (a) Aluminum ions in aluminum chloride has a small ionic radium and high charge
Therefore the ion has very high charge density and rotaries the chloride ions leading to covalent bonding and thus aluminum chloride has weak covalent bonds which can break easily and as such sublimes on

heating sodium ion in sodium chloride has a big ionic radius and small charge density and cannot easily polarize the chloride ions and thus the compound is predominantly ionic with strong ionic bonds which require a lot of energy to be broken. Hence sodium chloride cannot sublime.

8. (a) (i) An ore is a naturally occurring rock from which an element (metal) can be extracted. **(01)**

(ii) Zinc blend $Z_n S$
Calamine $Z_n CO3$

(02)

(b) The ore is crushed and agitated with water and a flathing agent. Air is blown through the mixture. The impurities sink to the bottom and the ore with the frothing agent float on top.

The ore is skimmed off and dilute acid is added to break the froth. It is filtered off and dried.
The purified ore is roasted in air to form
Zinc oxide and sulphudioxide
$2ZnS_{(s)}+3O_{2(g)} \rightarrow 2ZnO_{(s)}+2SO_{2(g)}$
$ZnCO_{3(s)} \rightarrow Zn\ O_{(s)}+CO_{2(g)}$

(06)

Zinc oxide, coke and limestone are fed in to a blast furnace
Hot air is blown in to the furnace
Zinc oxide is reduced to Zinc by carbon monoxide or carbon.
$ZnO_{(s)}+C_{(s)} \rightarrow Zn_{(s)}+CO_{(g)}$

OR

$ZnO_{(s)}+CO_{(g)} \rightarrow Zn_{(g)}+CO_{2(g)}$
Zinc vapour distills off from the top of the furnace it is condensed (cooled) by a spray of molten lead.
Zinc is purified by redistillation.

OR

The ore is dissolved in (reacted with) dilute sulphuric acid to form Zinc ions $Zn_{(s)}+H_2SO_{4(aq)} \rightarrow ZnSO_{4(aq)}+H_2S_{(g)}$
$ZnCO_{3(s)}+\ H_2SO_{8(aq)} \rightarrow ZnSO_{4(aq)}+CO_{2(g)}+H_2O_{(l)}$

(06)

Milk of lime is added to precipitate the hydroxides of other element such as aluminum ions, iron (II) ions, lead (II) ions.
The mixture is filtered to obtain Zinc sulphate (zinc ions)
The filrate (zinc sulphate) is electrolyzed using aluminum cathode and lead anode.

$Zn_{(aq)}^{2+}+2e \rightarrow Zn_{(s)}$
Pure zinc is deposited at the cathode.

(c) (i) Zinc reacts with dilute sulphuric acid to form Zinc sulphate and hydrogen gas.
$Zn_{(s)}+H_2SO_4(aq) \rightarrow ZnSO_{4(aq)}+H_{2(g)}$

(04)

Scanned with CamScanner

Zinc reacts with concentrated sulphuirc acid on heating to form Zinc sulphate, sulphurdioxide and water.

$Zn_{(s)}+2H_2SO_{4(l)} \rightarrow ZnSO_{4(aq)}+SO_{2(g)}+H_2O_{(l)}$

(ii) Zinc reacts with hot concentrated sodium hydroxide solution to form sodium zincate and hydrogen gas.

$Zn_{(s)}+2OH^{-}_{(aq)}+2H_2O_{(l)} \rightarrow Zn(OH)_{4(aq)}^{2-}+H_{2(g)}$

(2½)

OR

$Zn_{(s)}+2OH_{(aq)} \rightarrow ZnO^{2-}_{2(aq)}+H_{2(g)}$

(d) (i) White precipitate soluble in excess ammonia to form a colourless solution.

(01½)

(ii) $Zn_{(aq)}^{2+}+2OH_{(aq)} \rightarrow Zn(OH)_{2(s)}$

$Zn(OH)_{2(s)}+4NH_{3(aq)} \rightarrow Zn(NH_3)_{4(aq)}+2OH_{(aq)}$ 03

20

END