P525/2
CHEMISTRY
(Theory)
Paper 2
Nov./Dec. 2019
2½ hours

UGANDA NATIONAL EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(THEORY)

Paper 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES:

Answer **five** *questions including* **three** *questions from section* **A** *and any* **two** *from Section* **B**.

Write the answers in the answer booklet(s) provided.

Begin each question on a fresh page.

Mathematical tables and squared paper are provided.

Silent non-programmable scientific electronic calculators may be used.

Use equations where necessary to illustrate your answers.

Where necessary, use the following:

[H=1; C=12; O=16;]

Turn Over

SECTION A (60 MARKS)

Answer **three** *questions from this section.*

1. (a) The atomic numbers of scandium and manganese are 21 and 25 respectively. Write the electronic configuration of:

(i) Scandium. (*01 mark*)
(i) Manganese. (*01 mark*)
(i) Scandium(III) ion. (*01 mark*)
(ii) Manganese(VII) ions. (*01 mark*)

(b) Explain why scandium only forms compounds in which it's oxidation state is +3, while manganese forms compounds in which its oxidation states are +2 and +7. (*03 marks*)

(c) Potassium hydroxide was fused with manganese(IV) oxide in the presence of oxygen to form a green solid *X*. Solid *X* dissolved in water to form a green solution. On bubbling carbon dioxide gas through the green solution, a purple solution *Y* and a brown solid were formed.

(i) Name solid *X* and write equation for the reaction leading to the formation of *X*. (*2½ marks*)

(ii) Write equation leading to the formation of solution *Y*. (*1½ marks*)

(d) When sulphur dioxide was bubbled through acidified solution *Y*, the colour of the solution turned from purple to colourless. Explain. (*3½ marks*)

(e) State what would be observed and write equation for the reaction that would take place if to the resultant solution in (d) was added;

(i) dilute sodium hydroxide solution. (*03 marks*)
(ii) acidified barium nitrate solution. (*2½ marks*)

2. (a) (i) Explain what is meant by the term **partition coefficient**? (*02 marks*)
(ii) State **four** conditions under which partition law is valid. (*02 marks*)

(b) (i) **Describe an experiment to determine the partition coefficient of iodine between ether and water.** (*06 marks*)

(ii) **Give four reasons why ethoxyethane (ether) is most commonly used in solvent extraction of organic compounds from their aqueous solution.** (*02 marks*)

concentration of a solute
between two solvents when shaken
together and allowed to distribute itself and attain
equilibrium and staying in the same molecular state
at a constant temperature and pressure

(c) The partition coefficient of a substance Z between methylbenzene and water is 12. Calculate the mass of Z that will be extracted from 200 cm^3 of an aqueous solution containing 8.0 g of Z, by:

(i) shaking with 50 cm^3 of methylbenzene. (*02 marks*)

(ii) shaking successively with two separate 25 cm^3 – portions of methyl benzene. (*04 marks*)

(iii) comment on your answers in (i) and (ii). (*01 mark*)

(d) State **two** applications of partition law other than solvent extraction. (*01 mark*)

3. (a) The boiling points of 2-chlorobutane and 2-iodobutane are 68 °C and 119 °C respectively. When treated separately with aqueous sodium hydroxide, followed by acidified silver nitrate solution, 2-chlorobutane forms a white precipitate after about 15 minutes, whereas 2-iodobutane forms a white precipitate almost immediatley.

Explain; -I

(i) Why the boiling point of 2-chlorobutane is lower than that of 2-iodobutane. (*02 marks*)

(ii) The formation of the white precipitate in 2-chlorobutane takes a longer time than in 2-iodobutane. (*03 marks*)

steric hinderence

(b) Write;

(i) equation for the reaction of 1-chlorobutane with aqueous sodium hydroxide. (*01 mark*)

(ii) the mechanism for the reaction in (b)(i). (*01 mark*)

(c) The reaction in (b)(i) is exothermic. Sketch a labelled potential energy versus reaction co-ordinate diagram for the reaction. (*2½ marks*)

(d) (i) Write equation for the conversion of benzene to chlorobenzene. (*01 mark*)

(ii) Outline a mechanism for the reaction in (d)(i). (*03 marks*)

(e) Write equation(s) to show how 2-bromobutane can be converted to butanone. (*2½ marks*)

(f) (i) Name **one** reagent that would be used to confirm the formation of butanone. (*01 mark*)

(ii) State what would be observed if butanone was present. (*01 mark*)

(iii) Write equation for the reaction of butanone and the reagent you have named in (f)(i). (*01 mark*)

(g) A solution containing iodine and sodium hydroxide was added to butanone. State what was observed. (*01 mark*)

4. (a) (i) Define the term **standard enthalpy change** of a reaction. (*01 mark*)

(ii) Briefly, describe how the enthalpy of neutralisation of nitric acid by sodium hydroxide can be determined. (*05 marks*)

(iii) Explain why the enthalpy of neutralisation of sodium hydroxide by nitric acid is 57.1 kJ mol^{-1} whereas the enthalpy of neutralisation of sodium hydroxide by hydrocyanic acid is 12.0 kJ mol^{-1}. (*02 marks*)

(b) The heat change that takes place when one mole of gaseous ion is completely dissolved in enough solvent is called hydration energy.

State the factors that affect hydration energy and explain their effects. (*04 marks*)

(c) The standard enthalpies of hydration and lattice energies of lithium chloride and potassium chloride are given in Table **1**.

Table 1

Salt	**Lattice energy ($kJ\ mol^{-1}$)**	**Hydration energy ($kJ\ mol^{-1}$)**
Potassium chloride	−862	−883
Lithium chloride	−718	−695

(i) Calculate the enthalpy of solution of lithium chloride and potassium chloride. (*2½ marks*)

(ii) State which one of the two salts would be more soluble in water at a given temperature and give a reason for your answer. (*01 mark*)

(a) Using the thermochemical data below, determine the lattice energy of sodium chloride. (*4½ marks*)

Heat of atomisation of sodium = 108 kJ mol^{-1}

Dissociation energy of chlorine = 242.2 kJ mol^{-1}

Ionisation energy of sodium = 500 kJ mol^{-1}

Electron affinity of chlorine = −364 kJ mol^{-1}

Enthalpy of formation of sodium chloride = −411.3 kJ mol^{-1}

SECTION B (40 MARKS)

Answer any **two** *questions from this section.*

5. (a) Carbon, silicon, tin and lead are some of the elements in group (IV) of the Periodic Table.

Discuss the reactivity of the elements with;

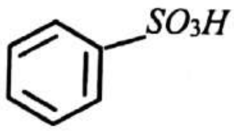
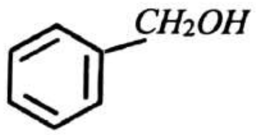
(i) water, (*04 marks*)

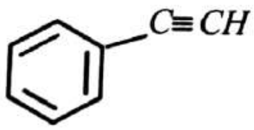
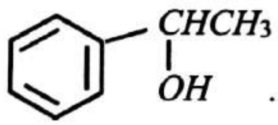
(ii) sodium hydroxide solution, (*06 marks*)

(iii) concentrated sulphuric acid. (*7½ marks*)

(b) State what would be observed and write equation for the reaction that would take place if excess concentrated hydrochloric acid was mixed with lead(IV) oxide and heated. (*2½ marks*)

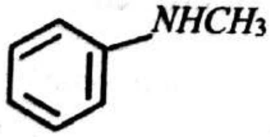
6. Write equations to show how the following compounds can be synthesized.

(a)  from  . (*4½ marks*)

(b)  from  . (*3½ marks*)

(c) $CH_3-\underset{}{\overset{OH}{\overset{|}{C}H}}-CH_3$ from CH_3CH_2COOH. (*3½ marks*)

(d) $CH_3-\overset{NH_2}{\overset{|}{C}H}-CH_3$ from $CH_3-\underset{\underset{H}{|}}{\overset{OH}{\overset{|}{C}}}-CH_3$. (*03 marks*)

(e)  from $HC\equiv CH$. (*5½ marks*)

(01 mark)

7. (a) Define the term **eutectic mixture**?

(b) Briefly, describe how a phase diagram of a mixture of biphenyl and naphthalene can be determined in the laboratory. (03 marks)

(c) Table 2 shows the melting points of various mixtures of naphthalene – biphenyl.

Table 2

Mole fraction of naphthalene	0.125	0.275	0.450	0.625	0.800
Melting point (^oC)	58.0	47.0	40.0	53.0	68.0

(i) Draw a fully labelled diagram of the naphthalene- biphenyl system. (*The melting of naphthalene and biphenyl are 80 ^oC and 71 ^oC respectively.*) (05 marks)

(ii) Determine the eutectic temperature and the composition of the eutectic mixture. (03 marks)

(d) Describe the changes that would take place if a liquid mixture of the above system containing 80% biphenyl was cooled from 85 ^oC to 30 ^oC. (06 marks)

(e) Explain what would be observed when increasing quantities of biphenyl are added to naphthalene. (02 marks)

8. Explain each of the following observations and where applicable illustrate your answer with equation(s):

(a) Hydrogen sulphide is a gas at room temperature whereas water is a liquid under similar conditions. (4½ marks)

(b) When a cold mixture of sodium nitrite and concentrated hydrochloric acid solution is added separately to ethylamine and phenylamine, bubbles of a colourless gas are produced with ethylamine but phenylamine only forms a colourless solution. (6½ marks)

(c) When hydrazine (NH_2NH_2) is added to an acidified solution of potassium manganate(VII), the potassium manganate(VII) solution turns from purple to colourless and a colourless gas is evolved. (04 marks)

(d) When a limited amount of chlorine is added into sodium thiosulphate solution, a yellow precipitate is formed. (05 marks)

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Signature P525/2 2019
Subject .... Paper code ....
Random No. | Personal Number

Q1 (a)(i) Sc. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
(ii) Mn $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
(iii) Sc^{3+} $1s^2 2s^2 2p^6 3s^2 3p^6$
(iv) Mn^{7+} $1s^2 2s^2 2p^6 3s^2 3p^6$

(b) Scandium loses two electrons of 4s-orbital and one electron from 3d-orbitals to form scandium (III) ion which has the outermost 3p subenergy level which is full and stable.
Manganese loses two electrons of the 4s orbital to form manganese (II) ion having half filled 3d-orbitals that are stable.
Manganese can also lose the two 4s orbital electrons and five electrons of the 3d-orbitals to form $3p^6$ subenergy level which is full and stable forming manganese(VII) ion.

(c) (i) Potassium manganate(VI)
$4KOH_{(s)} + 2MnO_{2(s)} + O_{2(g)} \rightarrow 2K_2MnO_{4(s)} + 2H_2O_{(l)}$
or $4OH^-_{(l)} + 2MnO_{2(s)} + O_{2(g)} \rightarrow 2MnO_4^{2-}{}_{(s)} + 2H_2O_{(l)}$
(ii) $3MnO_4^{2-}{}_{(aq)} + 2CO_{2(g)} \rightarrow 2MnO_4^-{}_{(aq)} + MnO_{2(s)} + 2CO_3^{2-}{}_{(aq)}$
or $3MnO_4^{2-}{}_{(aq)} + 4H^+_{(aq)} \rightarrow MnO_{2(s)} + 2MnO_4^-{}_{(aq)} + 2H_2O_{(l)}$
or $3MnO_4^{2-}{}_{(aq)} + 4CO_{2(g)} + 2H_2O_{(l)} \rightarrow 2MnO_4^-{}_{(aq)} + MnO_{2(s)} + 4HCO_3^-{}_{(aq)}$

(d) Sulphur dioxide reduced manganate (VII) ions to manganese(II) ion
$2MnO_4^-{}_{(aq)} + 5SO_{2(g)} + 2H_2O_{(l)} \rightarrow 2Mn^{2+}_{(aq)} + 5SO_4^{2-}{}_{(aq)} + 4H^+_{(aq)}$
or $2MnO_4^-{}_{(aq)} + 5SO_3^{2-}{}_{(aq)} + 6H^+_{(aq)}$

(e) (i) White precipitate turns brown on standing
$Mn^{2+}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mn(OH)_{2(s)}$
$4Mn(OH)_{2(s)} + O_{2(g)} \rightarrow 2Mn_2O_3 \cdot 2H_2O$ or $2Mn_2O_3 + 4H_2O$
or $2MnO_{2(s)} + 2H_2O$
(ii) White precipitate
$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$

2 (a)(i) This is the ratio of the concentration of a solute btn two immiscible liquids solvents in the same container at constant temp ✓

(ii) - The temp of the entire system should be constant ✓
- The solute should be in the same molecular state in both solvents ✓
- The solute should not react with the solvents ✓
- The solution should not be saturated ✓

b) A known mass of Iodine is dissolved in a known volume of ether. A known volume of water is added to the separating funnel, shaken for some time and left to stand at a fixed temp. After settling, a known volume of the ether layer is pipetted and titrated against a standard solution of sodium thiosulphate in the presence of starch indicator. The rxn is represented by the equation $I_{2(aq)} + 2S_2O_3^{2-}{}_{(aq)} \rightarrow 2I^-_{(aq)} + S_4O_6^{2-}{}_{(aq)}$ ✓ The concentration of Iodine in ether is calculated ✓. The concentration of Iodine in water is determined by substraction ✓. The partition coefficient is obtained from the expression $KD = \frac{[I_2] \text{ in ether}}{[I_2] \text{ in water}}$ ✓

OR Iodine is introduced into a mixture of ether and water in a separating funnel. The mixture is shaken and allowed to settle at a constant temperature ✓. At equilibrium a known volume of the ether layer is pipetted and titrated with standard solution of sodium thiosulphate in the presence of starch indicator to calculate the conc of Iodine in ether. The reaction is represented by the eqn $I_{2(aq)} + 2S_2O_3^{2-}{}_{(aq)} \rightarrow 2I^-_{(aq)} + S_4O_6^{2-}{}_{(aq)}$ ✓
The same procedure is repeated ✓ for the aqueous layer to obtain the concentration of Iodine in water. The partition coefficient is obtained from the expression $KD = \frac{[I_2] \text{ in ether}}{[I_2] \text{ in } H_2O}$ ✓

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Subject .... Paper code ..../.....

Random No.						
Personal Number						

(ii) - It's immiscible with water ✓
- It's a good organic solvent ✓
- It's a very volatile and hence can be distilled off or removed after use ✓
- It's generally inert, can't react with most organic compounds ✓

c(i) If x g of Z is extracted by ether, $(8-x)$ g of Z remains in water.

$$\frac{x}{50} \times \frac{200}{8-x} = 12$$ ✓✓

$$x = 6g$$ ✓

(ii) If x_1 g of Z is extracted by ether, $(8-x_1)$ g remains in water. $\frac{x_1}{25} \times \frac{200}{8-x_1} = 12$ ✓✓

$$x_1 = 4.8g$$ ✓

Mass remaining after 1st extraction $= (8-4.8) = 3.2g$ ✓

If x_2 g of Z is extracted by ether $(3.2-x_2)$ g remains in water

$$\frac{x_2}{25} \times \frac{200}{3.2-x_2} = 12$$ ✓✓

$$x_2 = 1.92g$$ ✓

Total mass extracted $= (4.8+1.92) = 6.72g$.

(iii) Smaller successive portions of the same solvent extract more solute than one large volume used at once ✓

(d) - Determining formula of complex ions ✓
- Determination of equilibrium ~~complex~~ constant ✓
- Chromatography ✓

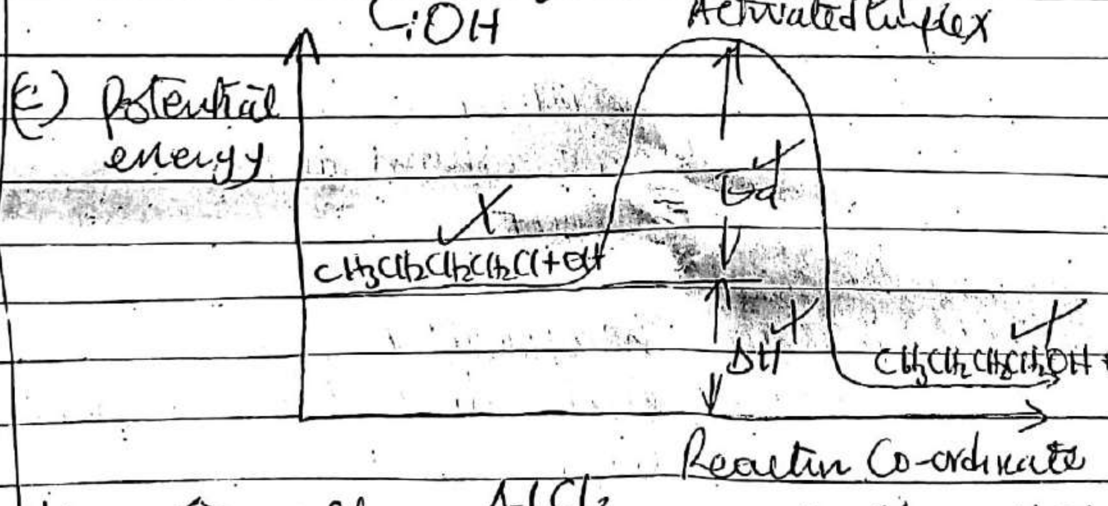
(a) (i) Iodine has ~~sm~~ a bigger atomic radius than Chlorine. 2-Iodobutane has a higher molecular mass than 2-Chlorobutane. Thus, 2-Iodobutane molecules are held by stronger Van der waals forces than 2-Chlorobutane. Hence more heat energy is required to overcome the stronger Vander Waal's forces in 2-Iodobutane.

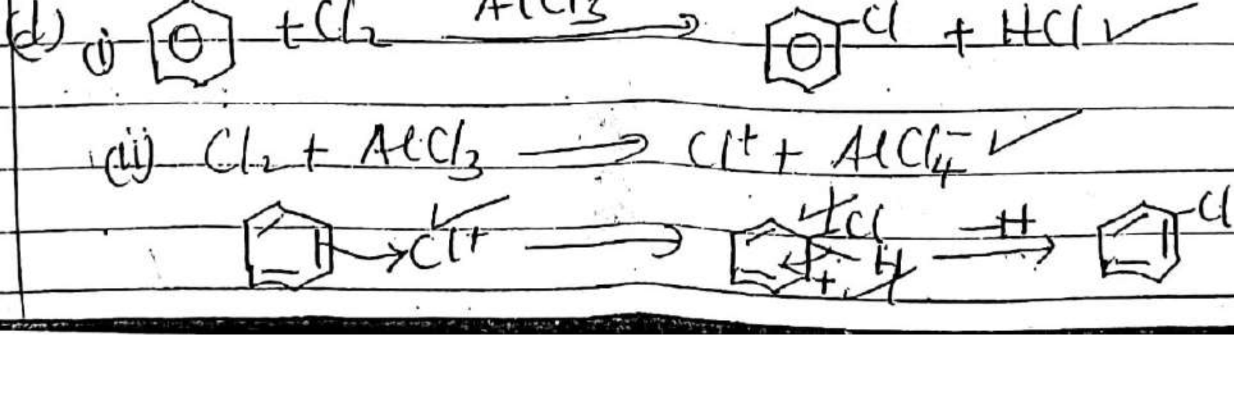
(ii) Iodine has a bigger atomic radius than chlorine. The Carbon-iodine bond is longer and weaker than the Carbon-Chlorine bond. Thus the iodine atom is more easily substituted by the hydroxide ion than the chlorine atom. Hence more time is taken by chloride ions to form the insoluble silver chloride than that ~~of~~ taken by the ~~bromide~~ iodide ions to form silver iodide.

(b) (i) $CH_3CH_2CH_2CH_2Cl \xrightarrow{NaOH(aq)} CH_3CH_2CH_2CH_2OH + Cl^-$

(ii) $CH_3CH_2CH_2CH_2-Cl \xrightarrow{heat} CH_3CH_2CH_2CH_2OH + Cl^-$

$:OH^-$

(c) 

(d) (i) 

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Subject .... Paper code ..../.......

Random No.					
Personal Number					

(e) $CH_3\underset{Br}{C}HCH_2CH_3 \xrightarrow[heat]{\bar{O}H(aq)} CH_3\overset{OH}{C}HCH_2CH_3$

$\downarrow MnO_4^-/H^+$, heat

$CH_3\overset{O}{C}CH_2CH_3$.

or $CH_3\overset{Br}{C}HCH_2CH_3 \xrightarrow[heat]{KOH(aq)/C_2H_5OH} CH_3CH=CHCH_3$

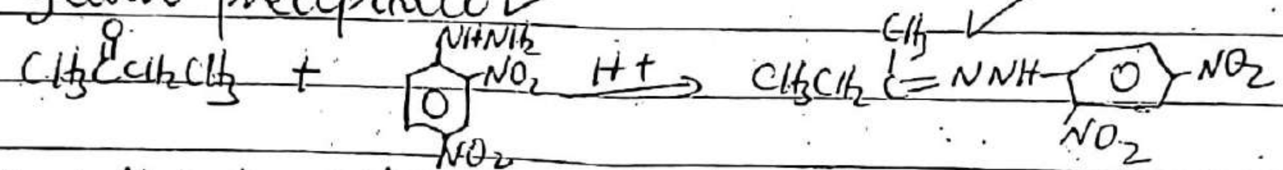
$CH_3CH=CHCH_3 \xrightarrow{Cl_2/CCl_4} CH_3\overset{Cl}{C}H\overset{Cl}{C}HCH_3 \xrightarrow[heat]{KOH/C_2H_5OH} CH_3C\equiv CCH_3$

$CH_3CH=CHCH_3 \xrightarrow[heat]{H_2O/H^+} CH_3\underset{OH}{C}HCH_2CH_3 \xrightarrow[Heat]{MnO_4^-/H^+} CH_3\overset{O}{C}CH_2CH_3$

$CH_3C\equiv CCH_3 \xrightarrow[HgSO_4, 60°C]{H^+/H_2O} CH_3\overset{O}{C}CH_2CH_3$

f (i) 2,4 - dinitrophenylhydrazine solution / Brady's reagent

(ii) yellow precipitate

(iii) 

(y) yellow precipitate

(4) (a) (i) Is the enthalpy change when a reaction takes place in molar quantities as shown in the equation under standard conditions (1atm and 298K)

(ii) A known volume (V_1) of a standard solution of nitric acid (M_1) is placed in a plastic beaker (insulated calorimeter) and its initial temperature t_1°c is recorded. A known volume (V_2) of a standard solution of sodium hydroxide (M_2) is placed in another container and its initial temperature t_2°c is recorded. The amount of the alkali must be equal to or more than that of acid. The alkali is added to the acid and the mixture stirred and the highest steady temperature t_3°c included

Assumptions

Density of solution = $1 g cm^{-3}$

S.H.C of the solution = $4.2 J g^{-1} {}^{0}C^{-1}$

Heat capacity of the container is negligible

Average ~~temp~~ initial temp = $\frac{t_1+t_2}{2} = t_i {}^{0}C$

Temp change $\Delta T = (t_3 - t_i) {}^{0}C$

Mass of soln = $(V_1 + V_2) \times 1 g cm^{-3} = (V_1+V_2) g$

Heat change = $((V_1+V_2) \times 4.2 \times \Delta T) J$

Moles of acid = $\left(\frac{M_1 V_1}{1000}\right)$ moles

~~Heat evolved = $(V_1+V_2) \times 4.2$~~

$\frac{M_1 V_1}{1000}$ moles of acid liberated $((V_1 + V_1) \times 4.2 \times \Delta T) J$

1 mole of acid liberated $\frac{(V_1+V_2) \times 4.2 \times \Delta T \times 1000}{M_1 V_1}$

Heat of neutralisation of nitric acid

$= -\left[\frac{(V_1+V_2) \times 4.2 \times \Delta T}{M_1 V_1}\right] kJ mol^{-1}$.

(iii) Nitric acid is a strong acid and sodium hydroxide is a strong base. The only reaction involved is between hydrogen ions and hydroxide ions to form water. $OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$.

Hydrocyanic acid is a weak acid. The reaction involves further ionisation of weak acid which is endothermic $HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$ $\Delta H = +Q$ kJ mol^{-1}

The overall enthalpy change $= -57.1 + Q = -12 kJ mol^{-1}$

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Random No					
Personal Number					

Subject .... Paper code ..../......

(b) Ionic radius. When ionic radius is small, the forces of attraction of the ions for water molecules is strong and the hydration energy is therefore higher.
Ionic Charge. When ionic charge is high, the force of attraction of the ions for water molecules is strong and therefore the hydration energy is high.

(c)(i) For LiCl ; $\Delta H_{soln} = \Delta H_{Lattice} + \Delta H_{hydration}$

$= +718 + -695 = +23 kJmol^{-1}$

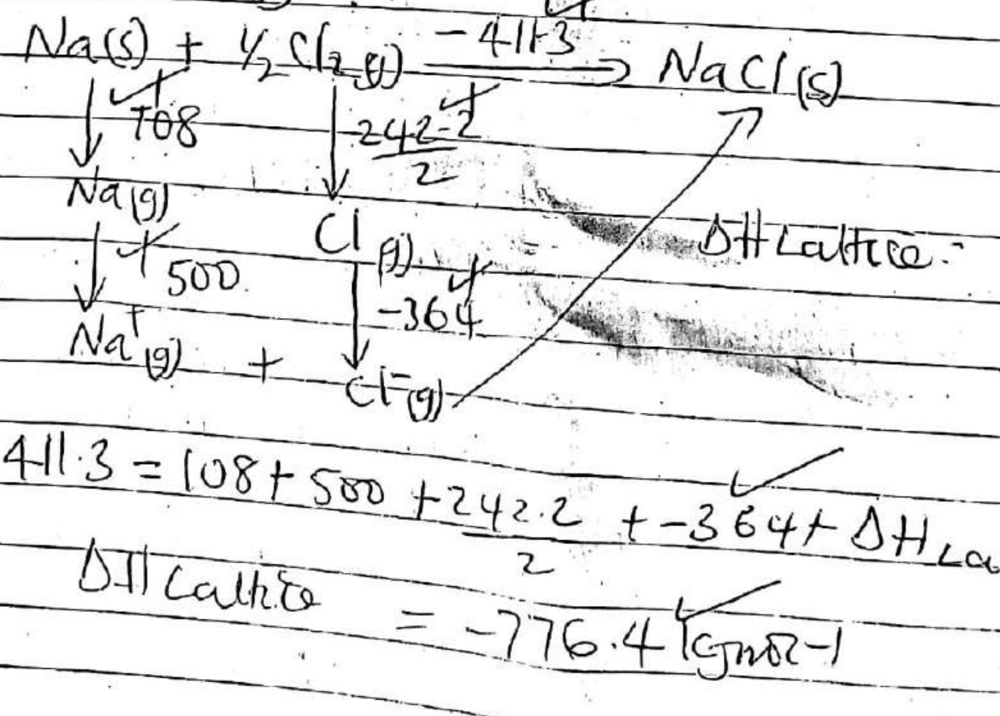
For KCl $\Delta H_{soln} = \Delta H_{lattice} + \Delta H_{hydration}$

$= +862 + -883$

$= -21 kJmol^{-1}$

(ii) Potassium chloride is more soluble in water because the enthalpy of solution is exothermic or the magnitude of the hydration energy is more than lattice energy

(d)



$-411.3 = 108 + 500 + \frac{242.2}{2} + -364 + \Delta H_{Lattice}$

$\Delta H_{Lattice} = -776.4 kJmol^{-1}$

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Signature ....

Subject .... Paper code .... Random No. | | | |

Personal Number

5. (i) Heated Carbon reacts with steam to form Carbonmonoxide and hydrogen.

$C(s) + H_2O(g) \xrightarrow{heat} CO(g) + H_2(g)$

Heated silicon reacts with steam to form silicon(iv)oxide and hydrogen

$Si(s) + 2H_2O(g) \rightarrow SiO_2(s) + 2H_2(g)$

Lead reacts with soft water in the presence of oxygen to form lead(ii)hydroxide ~~an~~ $2Pb(s) + 2H_2O(l) + O_2(g) \rightarrow 2Pb(OH)_2(s)$.

Silicon reacts with hot Concentrated (dold dilute) sodium hydroxide solution to form sodium silicate and hydrogen gas

$Si(s) + 2OH^-(aq) + H_2O(l) \rightarrow SiO_3^{2-}(aq) + 2H_2(g)$

Tin reacts with hot concentrated sodiumhydroxide solution to form sodiumstannate(iv) and hydrogen gas

$Sn(s) + 2OH^-(aq) + H_2O(l) \rightarrow SnO_3^{2-}(aq) + 2H_2(g)$

Lead reacts with hot concentrated sodium hydroxide solution to form sodium plumbate(ii) and hydrogen gas

$Pb(s) + 2OH^-(aq) \rightarrow PbO_2^{2-}(aq) + H_2(g)$

(ii) Carbon reacts with hot concentrated Sulphuric acid to form Carbondioxide and sulphur dioxide and water.

$C(s) + 2H_2SO_4(l)(aq) \rightarrow CO_2(g) + 2SO_2(g) + 2H_2O(l)$

Tin reacts with hot Concentrated Sulphuric acid to form tin (iv) sulphate, sulphur dioxide and water

$Sn(s) + 4H_2SO_4(aq) \rightarrow Sn(SO_4)_2(aq) + 2SO_2(g) + 4H_2O(l)$

Lead reacts with hot concentrated sulphuric acid to form lead(II)sulphate, sulphur dioxide and water

$Pb(s) + 2H_2SO_4(aq) \rightarrow PbSO_4(s) + SO_2(g) + 2H_2O(l)$

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Signature .... Random No.

Subject .... Paper code .... Personal Number

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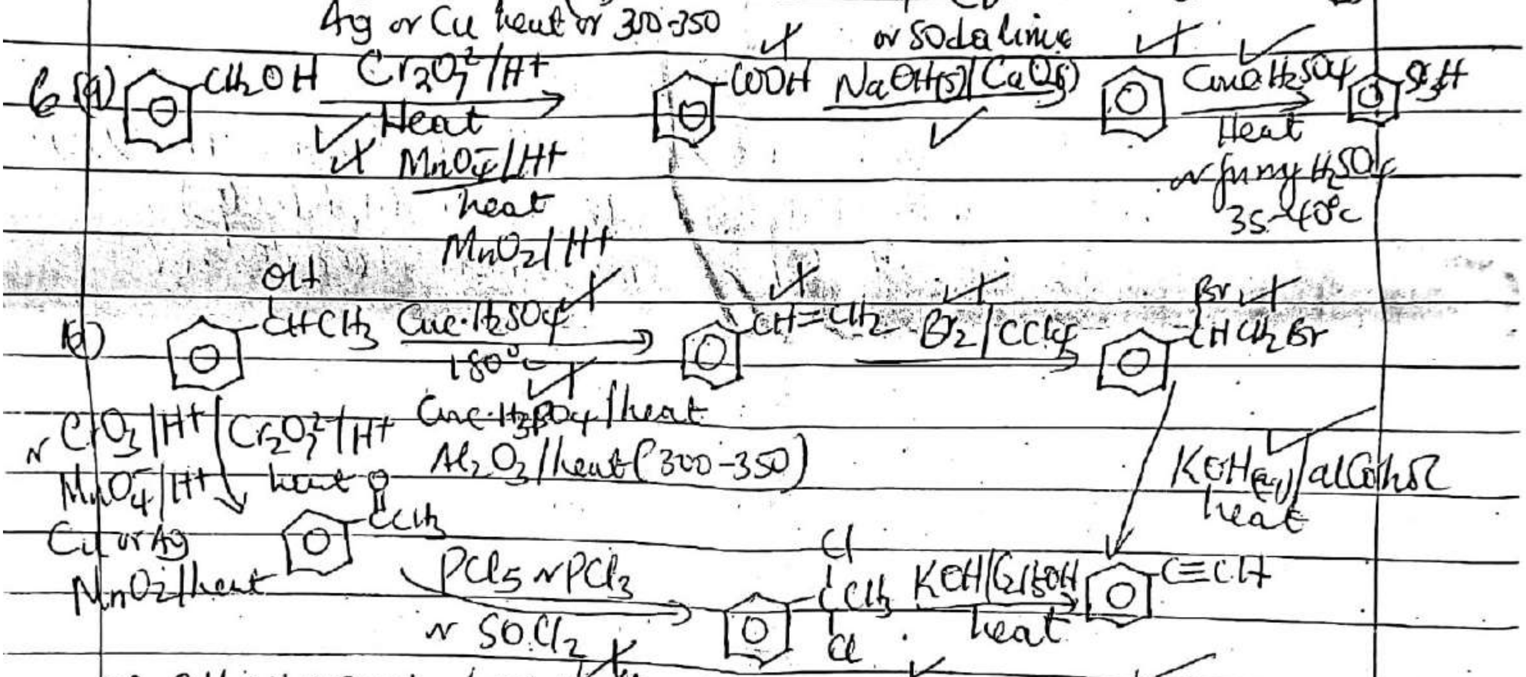
(b) Brown solid dissolves with effervescence of a greenish yellow gas to form a colourless solution

$PbO_2(s) + 6HCl(aq) \rightarrow PbCl_4^{2-}(aq) + 2H_2O(l) + Cl_2(g) + 2H^+(aq)$

or $PbO_2(s) + 6HCl(aq) \rightarrow H_2PbCl_4(aq) + 2H_2O(l) + Cl_2(g)$



(c) $CH_3CH_2COOH \xrightarrow{LiAlH_4/\text{Dry ether or } B_2H_6} CH_3CH_2CH_2OH \xrightarrow[170-180°C]{\text{Conc. } H_2SO_4} CH_3CH=CH_2$

$CH_3CH=CH_2 \xrightarrow[\text{heat}]{\text{Conc. } H_2SO_4,\ H_2O} CH_3CH(OH)CH_3$

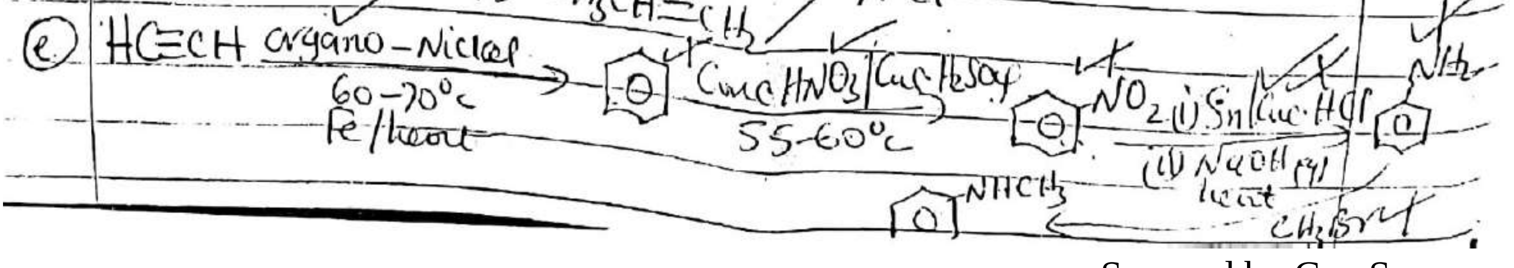
$CH_3CH=CH_2 \xrightarrow{HCl} CH_3CHClCH_3$

$CH_3CH(OH)CH_3 \xrightarrow{ZnCl_2/\text{Conc. } HCl} CH_3CHClCH_3$

$CH_3CHClCH_3 \xrightarrow[\text{heat}]{NaOH(aq)} CH_3CH(OH)CH_3$

(d) $CH_3CH(OH)CH_3 \xrightarrow{PCl_5,\ PCl_3 \text{ or } SOCl_2} CH_3CHClCH_3 \xrightarrow[\text{heat}]{NH_3(\text{alcohol})} CH_3CH(NH_2)CH_3$

$CH_3CH(OH)CH_3 \xrightarrow[180°C]{\text{Conc. } H_2SO_4} CH_3CH=CH_2 \xrightarrow{HCl} CH_3CHClCH_3$



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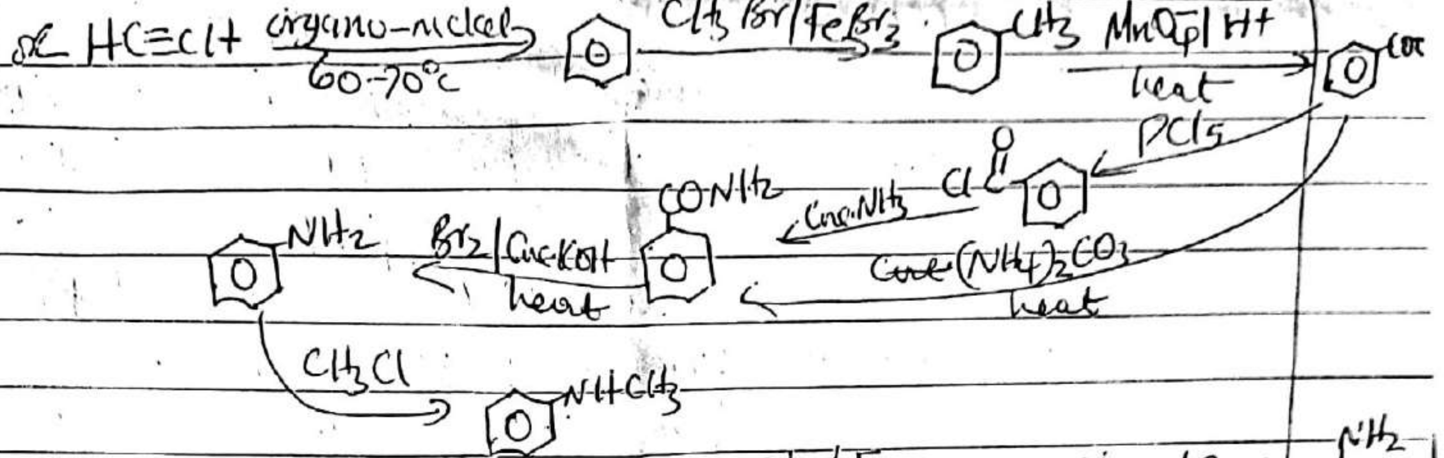

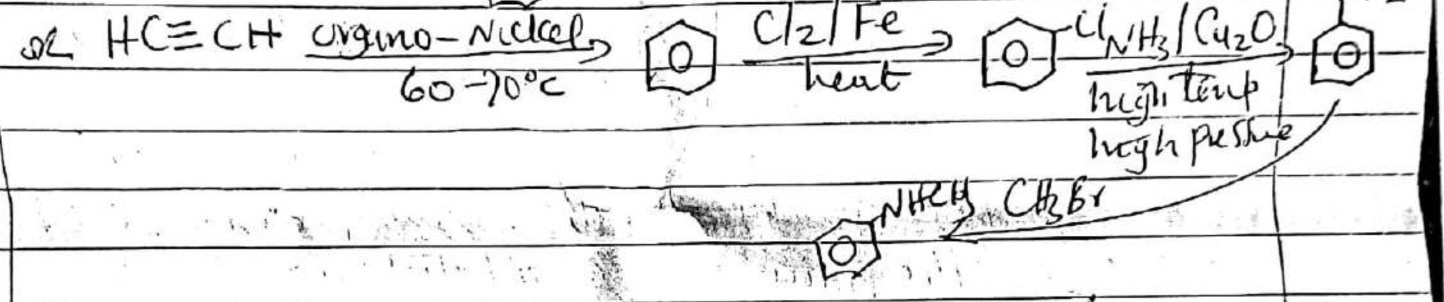

(7) (a) A solid mixture which melts at constant temperature to form a liquid of the same composition

or

A liquid mixture which freezes/solidifies at constant temperature without change in composition.

(b) - Mixtures of various compositions of solid naphthalene and biphenyl are prepared.

- Each mixture is heated separately until it melts.

- Each mixture is allowed to cool while stirring and the constant temperature at which it solidifies/freezes is recorded.

- The melting points of pure naphthalene and pure biphenyl are determined in the same way.

- A graph of melting points against compositions is plotted and phase diagram drawn.

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(C)(i) Axes Title PlOts Shape Regions

(ii) Eutectic temperature is 35-37 °c (36 ± 1 °c)
Eutectic Composition is 0.4 ± 0.01 Naphthalene

(d) From 85°c, the mixture cools to 53°c (point p) without change in phase or (Composition).
At point P biphenyl begins to solidify as the mole fraction (or Composition) of Naphthalene (~~gm~~ increases in the liquid mixture.
The Melting point / freezing point decreases up to the eutectic point (temp) as further cooling is done.
At the eutectic point the temperature and Composition remains constant until the whole System solidifies and then the solid mixture cools with no change in phase (Composition) up to 30°c.

(e) The Melting point of naphthalene reduces up to the eutectic point
At the eutectic point, the melting point is constant and further addition of biphenyl increases the Melting point towards that of pure biphenyl.

(8) (a) Oxygen has small atomic radius and high electronegativity compared to Sulphur.
The O-H bond is strongly polar whereas the S-H bond is not.
Water molecules are held together by hydrogen bonds whereas hydrogen sulphide molecules are held by Van der Waals forces

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which are weaker than hydrogen bonds. Hence water has a higher boiling point than hydrogen sulphide.

(b) Ethylamine reacts with cold solution of sodium nitrite and concentrated hydrochloric acid to form ethanol and nitrogen.

$CH_3CH_2NH_2 \xrightarrow[<10^{\circ}C]{NaNO_2 / Conc.HCl} CH_3CH_2OH + N_2$

~~Ethyl~~ Phenylamine reacts with a cold solution of nitrous acid at a temperature below 10°c ~~to~~ form Benzene diazonium salt which is more stable.

$C_6H_5NH_2 \xrightarrow[<10^{\circ}C]{NaNO_2 / Conc.HCl} C_6H_5\overset{+}{N}\equiv N$

(c) Hydrazine reduces acidified manganate (VII) ions to manganese (II) ions and is oxidized to nitrogen.

$4MnO_4^-(aq) + 5NH_2NH_2(g) + 12H^+(aq) \rightarrow 4Mn^{2+}(aq) + 16H_2O(l) + 5N_2(g)$.

(d) Chlorine oxidises excess sodium thiosulphate solution to sulphate ions with formation of sulphur.

$Cl_2(g) + S_2O_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + S(s) + 2H^+(aq) + 2Cl^-(aq)$

or Chlorine reacts with water to form hydrochloric acid and hypochlorous acid (an acidic solution)

$Cl_2(g) + H_2O(l) \rightarrow HCl(aq) + HOCl(aq)$

Sodium thiosulphate disproportionates in the acidic solution to form sulphur.

$S_2O_3^{2-}(aq) + 2H^+(aq) \rightarrow SO_2(g) + H_2O(l) + S(s)$