



## HOIMA DIOCESE EXAMINATIONS BOARD

### UACE CHEMISTRY P1

#### MARKING GUIDE

Answer all questions from this Section.

1. (a) State what is meant by the term Relative atomic mass of element. (01 mark)  
R.A.M. of an element is the ratio of the average mass of its naturally occurring atoms to a twelfth of the mass of an atom of the Carbon-12 isotope. (1)

- (b) (i) Element P has five isotopes with isotopic masses 75, 74, 73, 72 and 70 and relative abundances 7.67, 36.74, 7.67, 27.37 and 20.55 respectively.

Calculate the relative atomic mass of P. (02 marks)

$$\text{RAM of P} = \frac{\sum \text{Isotopic mass} \times \text{Relative abundance}}{100}$$

$$= \frac{(75 \times 7.67) + (74 \times 36.74) + (73 \times 7.67) + (72 \times 27.37) + (70 \times 20.55)}{100}$$

$$\text{RAM of P} = 72.6306 \approx 73$$

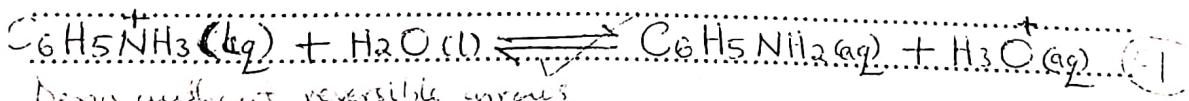
- (ii) Name two methods used to produce positive ions in a mass spectrum. (01 mark)

Electron ionisation ✓

Thermal ionisation ✓

Chemical ionisation

- (a) Phenylamine hydrochloride  $C_6H_5NH_3Cl$  undergoes hydrolysis when dissolved in water write an equation for the reaction. (01 mark)



Reversible reaction

- (b) A 0.2 M solution of phenylamine hydrochloride has a pH of 3.5. Calculate:

- (i) The molar concentration of hydrogen ions in solution. (02 marks)

$$pH = -\log [H_3O^+]$$

$$3.5 = -\log [H_3O^+]$$

$$[H_3O^+] = 3.16228 \times 10^{-4} \text{ mol dm}^{-3}$$

Answer without units

(ii) The hydrolysis constant,  $K_h$ , of phenylamine hydrochloride. (02 marks)

$$K_h = \frac{[C_6H_5NH_2][H_3O^+]}{[C_6H_5NH_3^+]}$$

Assumptions

$$[C_6H_5NH_2] = [H_3O^+]$$

$$[C_6H_5NH_3^+] \text{ at equilibrium} = \text{initial } [C_6H_5NH_3^+] \quad K_h = 5.0 \times 1.0 \times 10^{-7} \text{ mol dm}^{-3}$$

3. The label on the nitric acid bottle reads as follows: 70% m/v nitric acid, Relative density 1.42 g cm<sup>-3</sup>, Relative molecular mass = 63.01.

(i) Calculate the molarity of nitric acid. (01½ marks)

1 cm<sup>3</sup> of solution contains 1.42 g of acid

$$1000 \text{ cm}^3 \text{ of solution contains } (1.42 \times 1000) \quad = 15.775 \text{ mol dm}^{-3} \text{ of nitric acid}$$

$$= 14.20 \text{ g dm}^{-3} \text{ of acid}$$

$$\text{Mass of pure acid} = \left( \frac{70}{100} \times 14.20 \right)$$

$$= 9.94 \text{ g dm}^{-3} \text{ of acid}$$

63.01 g of acid contain 1 mole

9.94 g of acid contain  $(\frac{1}{63.01} \times 9.94) M$

(ii) 12.5 cm<sup>3</sup> of nitric acid was diluted to 250 cm<sup>3</sup> of solution in a volumetric flask. What volume of that solution will neutralize 20 cm<sup>3</sup> of 0.1 M sodium carbonate solution?

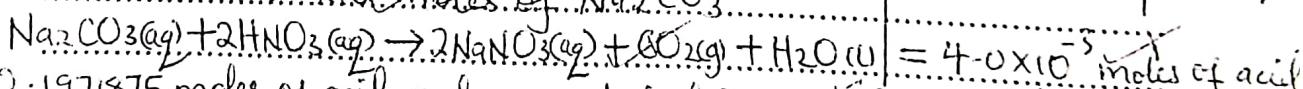
12.5 cm<sup>3</sup> of solution has  $(15.775 \times 12.5) \text{ moles}$

$$= 0.1971875 \text{ moles of acid}$$

1000 cm<sup>3</sup> of solution contains 0.1 moles of Na<sub>2</sub>CO<sub>3</sub>

20 cm<sup>3</sup> of solution contains  $(0.1 \times 20) \text{ moles of Na}_2\text{CO}_3$

$$= 2.0 \times 10^{-3} \text{ moles of Na}_2\text{CO}_3$$



0.1971875 moles of acid react are contained in 250 cm<sup>3</sup> of solution

$4.0 \times 10^{-3}$  moles of acid are contained in  $(250 \times 4.0 \times 10^{-3})$

$$= 5.071315372 \text{ cm}^3 \text{ of solution}$$

4. (a) The osmotic pressure of an aqueous solution a non-electrolyte containing 8.15 g in 1.5 dm<sup>3</sup> of solution is 70930 Pa at 25°C. Calculate the freezing point of the solution. ( $K_f$  of the electrolyte = 1.86°C mol<sup>-1</sup> kg<sup>-1</sup>). (03 marks)

$$\Pi V = nRT$$

$$70930 \times 1.5 \times 10^{-3} = \frac{8.15 \times 8.314 \times (25 + 273)}{M_r}$$

$$M_r = 189.785345179 \text{ g}$$

1.5 dm<sup>3</sup> of water dissolved 8.15 g of non-electrolyte

1.0 dm<sup>3</sup> of water dissolved  $(\frac{8.15}{1.5}) \text{ g}$  of non-electrolyte

$$= 5.4333 \text{ g non-electrolyte}$$

$189.785345179$  cause depression in extent of  $1.86^\circ\text{C}$   
 $5.4333$  cause depression of  $1.86 \times 5.43$   
 $= 189.785345179$

$$= 0.05325^\circ\text{C}$$

Freezing point of solution

$$= (0 - 0.05325)^\circ\text{C}$$

(b) State any three assumptions made in the above calculation. (01½ marks)

Any correct 3

An aqueous solution is sufficiently dilute.

Non-electrolyte is non-volatile.

Non-electrolyte does not react with water.

Non-electrolyte does not associate (polymerise) or ionise / dissociate in water.

5. The table below shows the atomic radius and the first ionization energy of some elements in period (III) of the periodic table.

Element	Na	Mg	Al	Si	P	S	Cl
Atomic radius (nm)	0.186	0.160	0.143	0.117	0.110	0.104	0.099
First ionization energy (kJ mol⁻¹)	496	738	577	787	1060	1000	1251

- (a) (i) State how atomic radius of the elements varies across the period. (01 mark)

Atomic radius decreases from Sodium to magnesium to aluminium to silicon to phosphorous to Sulphur to chlorine.

- (ii) Explain your answer in (a) (i). Same (03 marks)

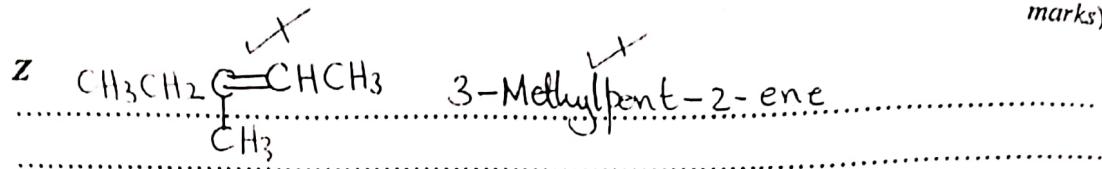
Across the period, an electron is added to the energy level/shell and a proton to the nucleus. This increases both screening effect and nuclear charge respectively. But increase in nuclear charge outweighs increase in screening because no new shell is added. The effective nuclear charge increases and the outermost electrons are attracted closer to the nucleus hence reducing atomic radius.

- (b) Explain how atomic radius affects the first ionization energy. (02 marks)

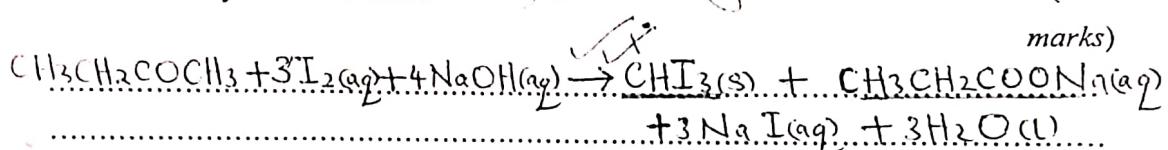
The smaller the atomic radius, the higher the first ionisation energy. When atomic radius is small, the outer electrons are near / closer to the nucleus and hence experience higher nuclear attraction. So that very high heat energy is absorbed to remove the first mole of electrons.

6. An organic compound  $Z$ ,  $C_6H_{12}$ , reacts with ozone water and zinc dust to give two different products  $M$  and  $L$ .  $M$  contained 22.22% oxygen but gave no observable change with warm acidified potassium dichromate solution.

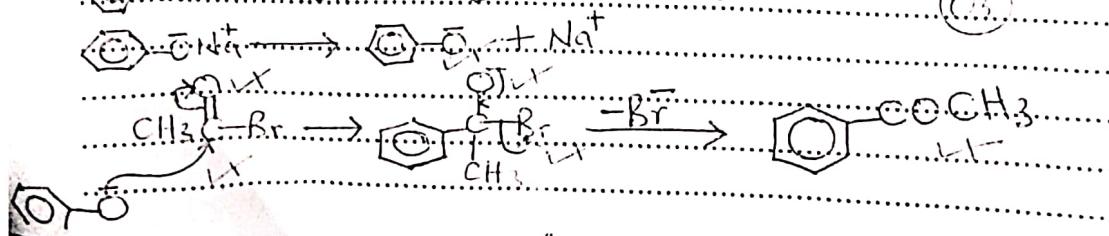
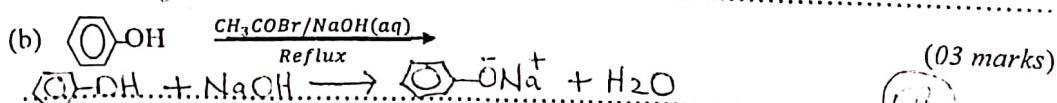
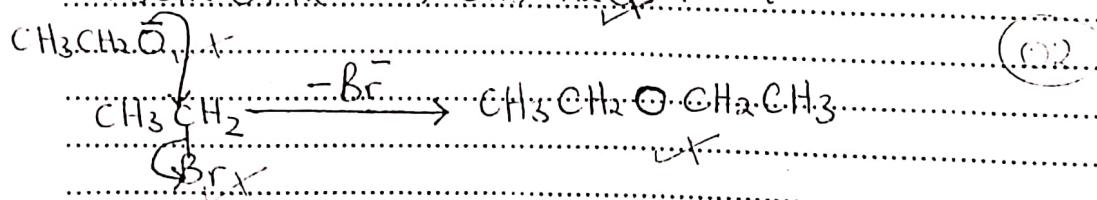
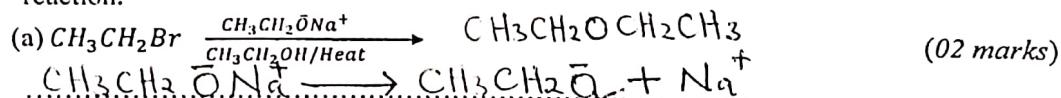
(a) Write down the structural formula and IUPAC names of; (03 marks)



- (b) Write a balanced equation of reaction between  $M$  and iodine in the presence of sodium hydroxide solution. Deduct  $\frac{1}{2}$  for missing state on  $\text{CHI}_3$  (01½ marks)



7. Complete the following equations and in each case outline the accepted mechanism for the reaction.



8. Lithium is in group I of the Periodic Table but its properties differ from those of other group I elements but resemble those of magnesium, a group II element.

(a) State the name given to this type of relationship.

(01)

(01 mark)

..... Diagonal ✓

- (b) Give four examples of the properties in which Lithium differs from other group one elements. 4. Lithium ~~oxide~~ is covalent while chlorides of other group one elements are ionic. (04 marks)

1. Lithium carbonate decomposes when heated to form lithium oxide and carbon dioxide gas while other carbonate of group I elements do not.

2. Lithium directly combines with nitrogen when heated to form lithium nitride while other group I elements do not.

3. Lithium reacts with oxygen when heated to form normal oxide only while other group I elements form normal oxides, peroxides and superoxides.

(c) Name two other pairs of elements that show a similar type of relationship like Lithium and Magnesium.

(01 mark)

Boron and Silicon

Beryllium and Aluminium

(01)

9. Compound Q is a blue - green solid. Q dissolves in water to give a green solution. The solution of Q formed a red precipitate when reacted with aqueous ammonia followed by butanedione-dioxime and a reddish - brown solution when a few drops of Iron (III) chloride solution was added to it and boiled. When Q was heated it decomposed to a green solid Z and a gas Y that formed an orange precipitate with Brady's reagent.

(a) Identify Q, Z and Y.

(03 marks)

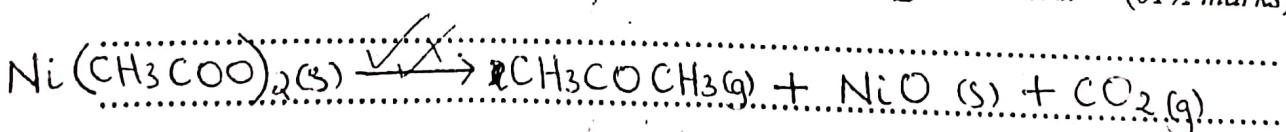
Q  $\text{Ni}(\text{CH}_3\text{COO})_2$  Nickel (II) ethanoate

Z  $\text{NiO}$  Nickel (II) oxide

Y  $\text{CH}_3\text{COCH}_3$  (g) OR Propanone Vapour

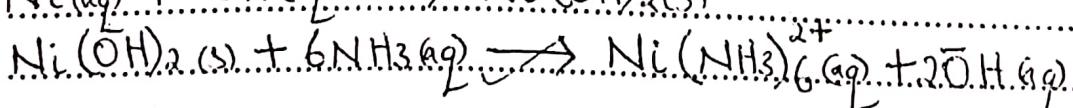
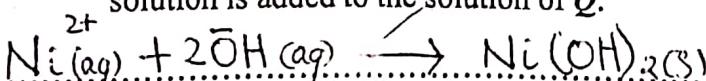
(03)

(b) Write equation for the reaction that took place when Q was heated. (01½ marks)



- (c) Write equation(s) for the reaction(s) that would take place when excess ammonia solution is added to the solution of Q.

(02 marks)



## SECTION B: (54 MARKS)

*Answer any six questions from this Section.*

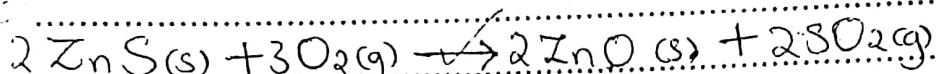
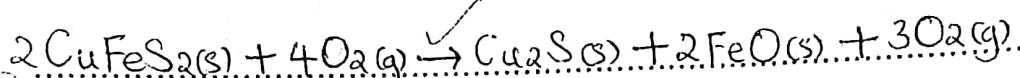
10. Zinc and copper are extracted from zinc blende ( $ZnS$ ) and copper pyrites ( $CuFeS_2$ ) respectively.

- (a) (i) State the method by which the ores are concentrated (0½ mark)

~~Deny wrong~~ Froth flotation.....~~X~~ (0½ mark)  
 Spilling (ii) Give a reason for your answer in (a) (i) above. (01 mark)  
 (01) The impurities are denser than water and so sink to the bottom of the container, leaving the concentrated ore floating on the surface.

- (b) The concentrated ores are then roasted in air and the product reduced by carbon monoxide.

- (i) Write equation for the reaction that takes place when each ore is roasted. (02 marks)

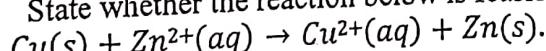


- (ii) State how each metal is purified after reduction. (01 marks)

(01) Blister Copper is purified by electrolysis  
 Zinc is purified by Distillation

- (c) The electrode potentials of  $Zn^{2+}(aq)/Zn(s)$  and  $Cu^{2+}(aq)/Cu(s)$  are  $-0.76V$  and  $+0.34V$  respectively.

- (i) State whether the reaction below is feasible or not.



(0½ mark)

The reaction is not feasible.

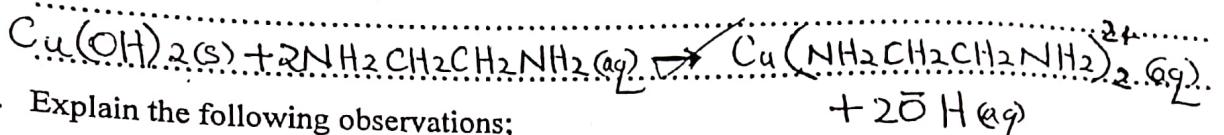
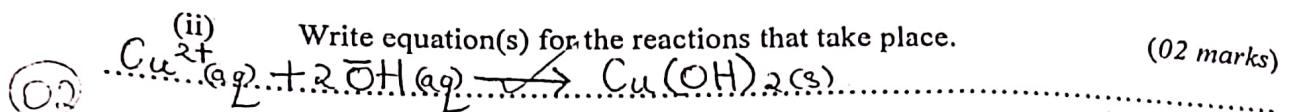
- (ii) Give a reason for your answer in (c) (ii) above. (01 mark)

(01) The reduction of Zinc potential of Zinc cell is negative while that of Copper half cell is positive.

- (d) An aqueous solution of ethane -1, 2- diamine was added to a solution of copper (II) sulphate

- (i) State what is observed. (01 mark)

(01) Blue precipitate (solid) soluble in excess to form a clear blue solution.



11. Explain the following observations;

(a) The melting point of calcium oxide is  $2580^\circ\text{C}$  whereas that of beryllium oxide is  $2530^\circ\text{C}$ . Both beryllium ion and calcium ion have the same charge but beryllium ion has a smaller ionic radius, higher charge density and higher polarising power than calcium ion. This makes beryllium oxide predominantly covalent while calcium oxide purely ionic. The covalent bonds in beryllium oxide require a lower amount of heat energy to break than the ionic bonds in calcium oxide.

(b) The bond angle in water is bigger than that in hydrogen sulphide. (02 marks)

Both water and hydrogen sulphide have a bent or V-shape with each molecule having two lone pairs of electrons on the central atom. However, oxygen is more electronegative than sulphur atom and hence oxygen atom attracts the bond pairs more towards itself which in turn results in higher repulsions of bond pairs hence a higher bond angle.

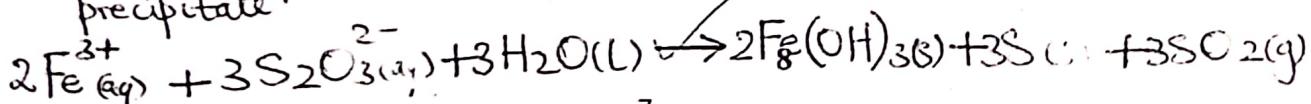
(c) When hydrogen iodide is treated with concentrated sulphuric acid, iodine is liberated whereas when hydrogen chloride is similarly treated, chlorine is not evolved. (03 marks)

The atomic radius of iodine atom is bigger than that of chlorine atom. The iodine atom is thus a stronger reducing agent than chlorine atom and can easily be oxidised to iodine whereas the chlorine atom can not easily be oxidised.

$$2\text{HI}(\text{g}) + \text{H}_2\text{SO}_4(\text{l}) \rightarrow \text{I}_2(\text{g}) + \text{SO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$$

(d) When an aqueous solution of sodium thiosulphate is added to an aqueous solution of iron (III) chloride, a yellow precipitate is observed. (02 marks)

The iron(III) ions in iron(III) chloride has a high charge, small ionic radius, high charge density and high polarisation of water molecules. This causes cationic hydrolysis to form insoluble iron(III) hydroxide and liberate hydrogen ions which react with thiosulphate ions to form sulphur which is a yellow precipitate.



12. 1.65 g of a bromo alkane X was heated with excess sodium hydroxide solution. The resulting solution was cooled, acidified with excess nitric acid and diluted with water to 100 cm<sup>3</sup>. 10 cm<sup>3</sup> of the resultant solution required 13.0 cm<sup>3</sup> of 0.1 M silver nitrate for complete precipitation of bromide ions as silver bromide.
- (a) Calculate the molecular mass of X.
- 1000 cm<sup>3</sup> of soln contain 0.1 moles of Ag<sup>+</sup>  
 13.0 cm<sup>3</sup> of soln contain (0.1 × 13.0)
- Ag<sup>+</sup> = 1.3 × 10<sup>-3</sup> moles of Ag<sup>+</sup>
- Ag<sup>(aq)</sup> + Br<sup>(aq)</sup> → AgBr<sup>(s)</sup>
- 1 mole of Ag<sup>+</sup> react with 1 mole of Br<sup>-</sup>  
 $1 \times 10^{-3}$  mole of Ag<sup>+</sup> react with  $(1 \times 1.3 \times 10^{-3})$
- = 1.3 × 10<sup>-3</sup> moles of Br<sup>-</sup>
- 100 cm<sup>3</sup> of soln contain 1.3 × 10<sup>-3</sup> moles of Br<sup>-</sup>  
 100 cm<sup>3</sup> of soln contain  $(1.3 \times 10^{-3} \times 100)$
- = 0.013 moles of Br<sup>-</sup>
- 1 mole of Br<sup>-</sup> liberated by 1 mole of X  
 0.013 mole of Br<sup>-</sup> was liberated by  $(0.013 \times 1)$
- = 0.013 moles of X
- 0.013 mole of X contain 1.65 g  
 1 mole of X contain  $(\frac{1.65 \times 1}{0.013})$
- = 126.923076923 g of X
- (Q4)
- Br + NaOH(aq) → R-OH(aq) + NaBr(aq)
- (b) (i) Deduce the molecular formula of X. (02 marks)
- C<sub>n</sub>H<sub>2n+1</sub>Br = 126.923076923 ✓
- 12n + (2n + 1) + (79.9 × 1) = 126.923076923
- n = 3.287
- n ≈ 3 ✓
- Molecular formula of X is C<sub>3</sub>H<sub>7</sub>Br ✓
- (Q2)
- (ii) Write down the structured formula and IUPAC names of all the possible isomers of X. (03 marks)
- Br  
 CH<sub>3</sub>CHCH<sub>3</sub> ✓ 2-Bromo-propane
- CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>Br ✓ 1-Bromo-propane
- (Q3)

Sulphuric acid to form the corresponding sulphate, sulphur dioxide and water. (a) Beryllium, magnesium, calcium and barium are some of the elements that belong to group II of the periodic table. Discuss the reactions of the elements with sulphuric acid.

(Q6)

Beryllium reacts with warm dilute sulphuric acid to form beryllium sulphate and hydrogen gas because it's amphoteric element.

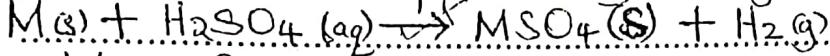
(06 marks)

$\text{Be(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{BeSO}_4(\text{aq}) + \text{H}_2(\text{g})$

Magnesium reacts with cold dilute sulphuric acid to form magnesium sulphate and hydrogen gas because it's basic element.

$\text{Mg(s)} + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{H}_2(\text{g})$

Calcium, strontium and barium react with cold dilute sulphuric acid to form respective sulphate and hydrogen gas but the reaction stops prematurely due to formation of insoluble sulphates.



M = Ca or Ba

(b) (i) State how the solubilities of the sulphates of group II elements vary down the group.

(01 mark)

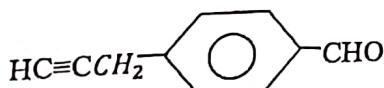
The solubility of the sulphates of group II elements decreases from beryllium to magnesium to calcium to strontium to barium.

(ii) Explain your answer in (b) (i).

(02 marks)

This is because cationic radius increases, both lattice energy and hydration energy of the cations decreases. However, due to high product of charges, the hydration energy decreases more rapidly than lattice energy hence a decrease in solubility of the sulphates.

14. An organic compound R has a structural formula:



(a) Name the functional group in R and a reagent which can be used to identify each of the functional groups. In each case, state what is observed and write an equation for the reaction which takes place.

(i) Name of the functional group.

(0½ mark)

Carbonyl group.

Reagent.

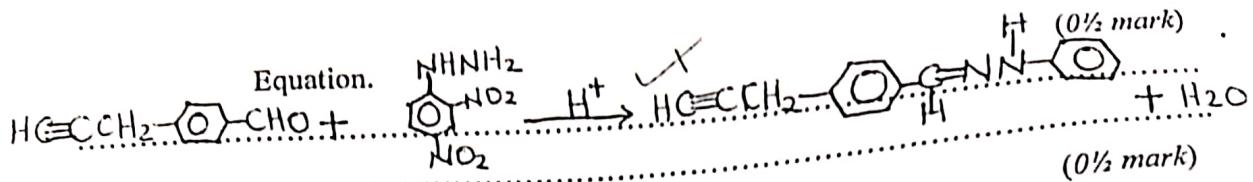
2,4-Dinitrophenylhydrazine solution | Sodium hydrogen sulphite solution

(0½ mark)

Observation.

Yellow precipitate | White crystalline precipitate

(0½ mark)



(ii) Name of the functional group.

Carbo to carbon triple bond

(0½ mark)

Reagent.

Bromine water | Bromine liquid

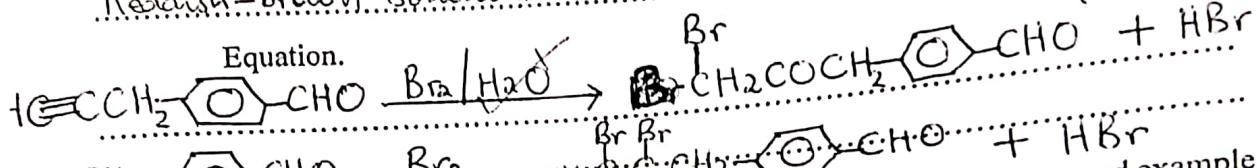
(0½ mark)

Observation.

Reddish-brown solution turns colourless. Red liquid turns colourless

(0½ mark)

Equation.



(b) Name the reagent which can be used to distinguish compound R from a named example of another compound in the same homologous series considering each of the functional groups. In each case, state what will be observed.

(0½ mark)

Compound 1

Any aliphatic aldehyde such as  $\text{HCHO}$ ,  $\text{CH}_3\text{CHO}$  etc.

(01 mark)

Reagent

Fehling's solution and heat

(01 mark)

Observations

$\text{H}\equiv\text{CCH}_2-\text{C}_6\text{H}_4-\text{CHO}$  No observable change

$\text{CH}_3\text{CHO}$  Reddish-brown precipitate

(0½ mark)

Compound 2

Any alkyne with an internal/hidden triple bond,  $\text{CH}_3\equiv\text{CCH}_3$

(01 mark)

Reagent

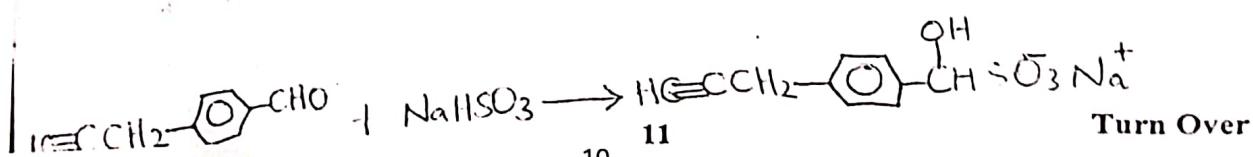
Ammoniacal silver nitrate solution | Ammoniacal copper(I) chloride solution

(01 mark)

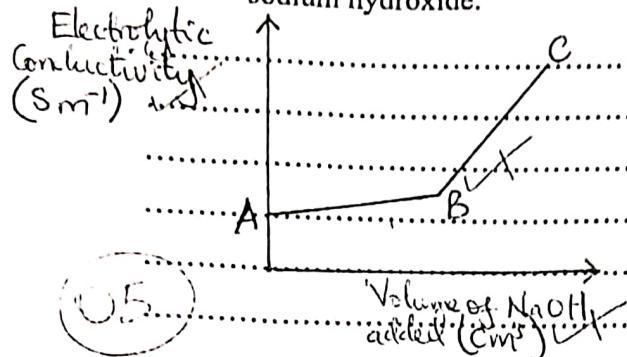
Observations

$\text{H}\equiv\text{CCH}_2-\text{C}_6\text{H}_4-\text{CHO}$  White precipitate | Red precipitate

$\text{CH}_3\equiv\text{CCH}_3$  No observable change



15. (a) Sketch and explain the conductimetric curve for the titration of ethanoic acid and sodium hydroxide. (05 marks)



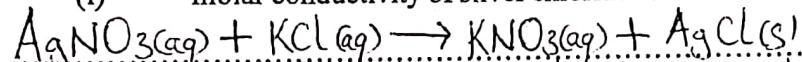
Initially, conductivity is low at A because ethanoic acid is a weak acid and only partially ionises to give fast moving and highly conducting hydrogen ions. Conductivity increases along AB as sodium hydroxide is added due to formation a strong salt, which

contains sodium than ethanoic acid although the hydrogen ions are being neutralised. Point B is the endpoint and conductivity is due to ethanate and sodium ions. Conductivity then increases due to an increase in the concentration of hydroxide ions and sodium ions from excess sodium hydroxide solution added which completely dissociates.

- (b) The molar conductivities of silver nitrate, potassium nitrate and potassium chloride are 134.0, 143.2 and 140.8 S cm<sup>2</sup> mol<sup>-1</sup> respectively at infinite dilution at 25 °C.

Calculate the;

- (i) molar conductivity of silver chloride at infinite dilution at 25 °C. (01½ marks)



$$\begin{aligned}\Lambda_c(\text{AgCl}) &= \Lambda_c(\text{AgNO}_3) + \Lambda_c(\text{KCl}) - \Lambda_c(\text{KNO}_3) \\ &= 134.0 + 140.8 - 143.2\end{aligned}$$

$$\Lambda_c \approx \Lambda_0 = 131.6 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\Lambda_0 = \frac{1000K}{C}$$

being mark it

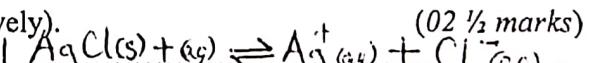
(01)

Kohlrausch law is written stated.

- (ii) Solubility product,  $K_{sp}$  of silver chloride at 25 °C. (The conductivity of water and saturated solution of silver chloride are  $5.5 \times 10^{-8}$  and

$$1.934 \times 10^{-6} \text{ S cm}^{-1}$$
 respectively).

$$\begin{aligned}K(\text{AgCl}) &= K_{\text{solution}} - K_{\text{water}} \\ &= 1.934 \times 10^{-6} - 5.5 \times 10^{-8} \\ &= 1.879 \times 10^{-6} \text{ S cm}^{-1}\end{aligned}$$



$$\begin{aligned}K_{sp} &= [\text{Ag}^+][\text{Cl}^-] \\ &= (1.428 \times 10^{-5})^2\end{aligned}$$

$$= 2.039184 \times 10^{-10} \text{ mol}^2 \text{ dm}^{-6}$$

$$\Lambda_c \approx \Lambda_0$$

$$\Lambda_0 = \frac{1000K}{C}$$

$$131.6 = \frac{1000K}{C}$$

$$C = 1.428 \times 10^{-5} \text{ mol dm}^{-3}$$

16. (a) Explain what is meant by the term partition coefficient. (01½ marks)
- This is a constant ratio of the concentrations of a solute dissolved in two immiscible liquids (solvents) in contact at a constant temp and at equilibrium provided the solute remains in the same molecular state in both solvents/liquids.

- (b) 100 cm<sup>3</sup> of an aqueous solution of Q containing 30g per litre of Q was shaken with 100 cm<sup>3</sup> of trichloromethane. The distribution coefficient of Q between trichloromethane and water is 2. Calculate the mass of Q which was extracted.

$$\begin{array}{l} 100 \text{ cm}^3 \text{ of Solution Contains } 30 \text{ g of Q} \\ 100 \text{ cm}^3 \text{ of Solution Contains } \frac{(30 \times 100)}{1000} \text{ g of Q} \\ = 3 \text{ g of Q} \end{array}$$

$$y = \frac{y}{3-y}$$

$$y = 2 \text{ g}$$

Mass of Q extracted  
is 2.0 g

Let mass of Q extracted be y

$$K_D = \frac{[Q]_{\text{CHCl}_3}}{[Q]_{\text{water}}} \quad \checkmark$$

$$[Q]_{\text{water}}$$

$$2 = \frac{y}{100} \times \frac{100}{3-y} \quad \checkmark$$

(02.2)

- (c) Calculate the mass of Q which will be extracted if the solution of Q in (b) is shaken with two successive portions of 50 cm<sup>3</sup> of trichloromethane. (04 marks)

Let mass of Q extracted by

first portion be m

first portion be x g

$$2 = \frac{x}{50} \times \frac{100}{3-x}$$

$$x = 1.5 \text{ g} \quad \checkmark$$

Mass remaining in water = 3 - 1.5

$$= 1.5 \text{ g} \quad \checkmark$$

$$2 = \frac{m}{50} \times \frac{100}{1.5-m}$$

$$m = 0.75 \text{ g} \quad \checkmark$$

$$\begin{aligned} \text{Total mass extracted} &= (x+m) \text{ g} \\ &= (1.5 + 0.75) \text{ g} \quad \checkmark \end{aligned}$$

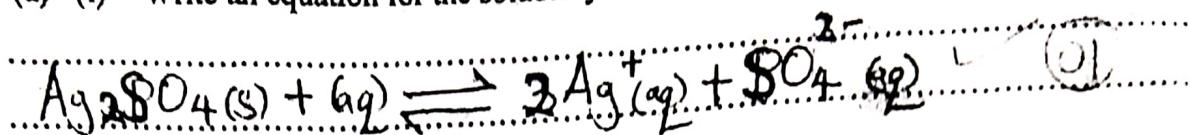
$$= 2.25 \text{ g} \quad \checkmark$$

(04)

- (d) Comment on your answers in (b) and (c).

The mass extracted to two successive 50 cm<sup>3</sup> portions is more than that extracted by one 100 cm<sup>3</sup> portion. (01 mark)

17. (a) (i) Write an equation for the solubility of silver sulphate in water. (01 mark)



- (ii) Determine the molar concentrations of silver and sulphate ions in a saturated solution of silver sulphate at 25°C.

(The  $K_{sp}$  of silver sulphate is  $1.7 \times 10^{-5}$  mol dm<sup>-3</sup> at 25 °C). (03 marks)

Let Solubility of silver sulphate be S.

$$K_{sp} = [\text{Ag}^+][\text{SO}_4^{2-}]$$

$$1.7 \times 10^{-5} = (2S)^2 \times S$$

$$S = 0.0161980501 \text{ mol dm}^{-3}$$

$$[\text{Ag}^+] = 2(0.0161980501) = 0.03239611801 \text{ mol dm}^{-3}$$

$$[\text{SO}_4^{2-}] = S = 0.0161980501 \text{ mol dm}^{-3}$$

$$[\text{SO}_4^{2-}] = S = 0.0161980501 \text{ mol dm}^{-3}$$

- (b) State and explain how the solubility of silver sulphate would be affected if the following substances were added.

- (i) Sulphuric acid solution. (02½ marks)

Solubility of silver sulphate decreases. Sulphuric acid is soluble and ionises to produce a high concentration of sulphate ion which is a common ion. This increases the concentration of sulphate ions in solution so that ionic product of sulphate ions and silver ions exceeds the  $K_{sp}$  value of silver sulphate and hence it is precipitated which reduces its solubility.

- (ii) Barium nitrate solution. (02½ marks)

Solubility of silver sulphate increases. This is because barium nitrate is a soluble salt, dissociates to form barium ions and nitrate ions. The barium ions react with sulphate ions from the equilibrium. This reduces the concentration of sulphate ions from the equilibrium, ionic product of silver ions and sulphate ions reduces and is exceeded by the solubility product of silver sulphate and hence solubility increases.

END



## HOIMA DIOCESE EXAMINATIONS BOARD

UACE CHEMISTRY P2

MARKING GUIDE

In all cases accept ionic equations

- 1 (a) The Partial Vapour pressure of a component in a solution at a given temperature is equal to the vapour pressure of pure component at the same temperature multiplied by the mole fraction of the pure component in the solution  
or Relative lowering of the vapour pressure (at a given temperature) is equal to the mole fraction of the solute.
- (b) When the intermolecular forces of attraction between the molecules of the mixture are stronger than the intermolecular forces of attraction between the molecules of the pure components. And the solution is formed with evolution of heat and reduction in the total volume of the mixture.

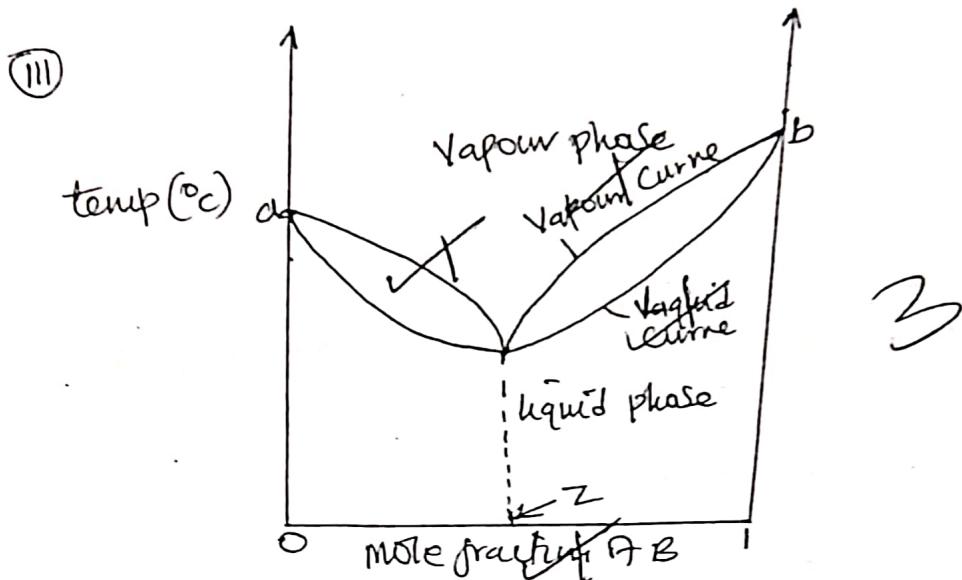
(c) (i)  $P_A = \frac{1}{5} \times 68.793 = 13.6585 \text{ KNM}^{-2}$

$$P_B = \frac{4}{5} \times 45.9 = 36.72 \text{ KNM}^{-2}$$

$$\begin{aligned} P_T &= P_A + P_B \\ &= 13.6585 + 36.72 \\ &= 50.3785 \text{ KNM}^{-2} \end{aligned}$$

3

- (d) Positive deviation. Actual vapour pressure of the mixture is higher than expected from Raoult's law. This shows that the intermolecular forces of attraction between the molecules of the mixture are weaker than between the pure components.



- a - Boiling point of Pure A
- b - Boiling point of Pure B.
- Z - Azeotropic composition.

When a mixture containing about 30% of A is fractionally distilled, it boils to form vapour which contains a higher percentage of A than original liquid mixture which cools to form a liquid richer in A. Continuous boiling and cooling finally forms a zero azeotropic mixture as the distillate and pure B as the residue.

- (d) (i) Is a technique used to separate a substance that is immiscible with water from a non-volatile substance at a temperature below the boiling point of water.

$$(ii) \text{ Rfm of ZNP} = 5x_1 + 6x_2 + 16x_3 + 14 = 139 \\ \text{ VP of ZNP} = 750 - 654 = 96 \text{ mm Hg}$$

$$\begin{aligned} \text{let the mass of ZNP} &= x_g \\ \text{Mass of H}_2\text{O} &= (35-x)_g \end{aligned} \quad \boxed{12}$$

$$\frac{\text{Mass of ZNP}}{\text{Mass of H}_2\text{O}} = \frac{\text{VP}_{\text{ZNP}} / R_{\text{Rm}}}{\text{VP}_{\text{H}_2\text{O}} \times 18}$$

$$\frac{2C}{35-x} = \frac{96 \times 139}{654 \times 18}$$

$$\begin{aligned}\text{Mass of } 4\text{NP} &= 18.595 \text{ g} \\ &= (53 - 18.595) \\ &= 34.405 \text{ g}\end{aligned}$$

$$\text{Percentage of } 4\text{NP} = \frac{34.405}{53} \times 100 = 64.9\%.$$

2. (a) (i) Mass of H =  $(\frac{2}{18} \times 2.7) = 0.3 \text{ g}$

$$\text{Mass of C} = \left( \frac{12}{22.4} \times 5.04 \right) = 2.7 \text{ g}$$

$$\text{Mass of O} = 3.4 - (0.3 + 2.7) = 0.4 \text{ g}$$

	C	H	O
Mass Moles	$\frac{2.7}{12} = 0.225$	$\frac{0.3}{1} = 0.3$	$\frac{0.4}{16} = 0.025$
Molar ratio	$\frac{0.225}{0.025} = 9$	$\frac{0.3}{0.025} = 12$	$\frac{0.025}{0.025} = 1$

$$\text{empirical formula of Q is } \text{C}_9\text{H}_{12}\text{O}$$

①  $WV = \frac{\text{Mass}}{R_{\text{Rm}}} \times RT$

$$50662.5 \times 1.0 \times 10^{-3} = \frac{2.8}{R_{\text{Rm}}} \times 8.31 \times 298$$

$$R_{\text{Rm}} = \frac{2.8 \times 8.31 \times 298}{50662.5 \times 1.0 \times 10^{-3}} = 136.86$$

$$(C_9H_{12}O)_n = 136.86$$

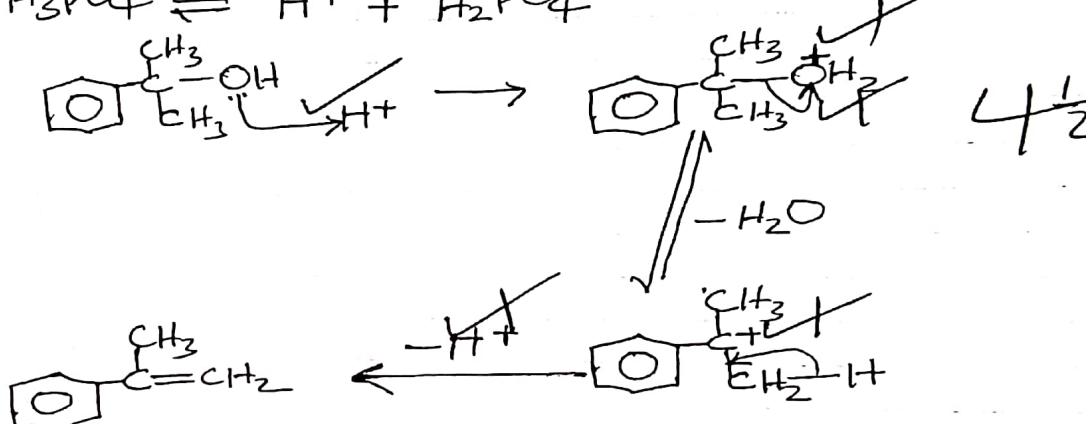
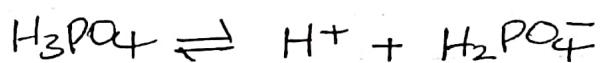
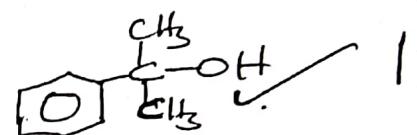
$$136n = 136.86$$

$$n = 1$$

MF & Q is  $C_9H_{12}O$

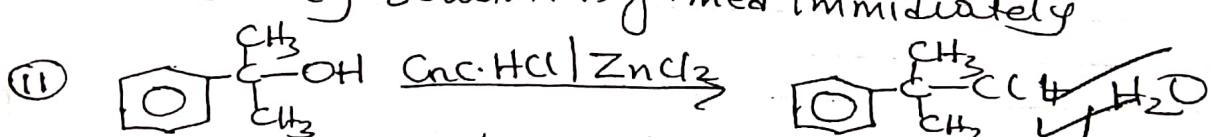
H<sub>2</sub>

(b) 2-Phenylpropan-2-ol or

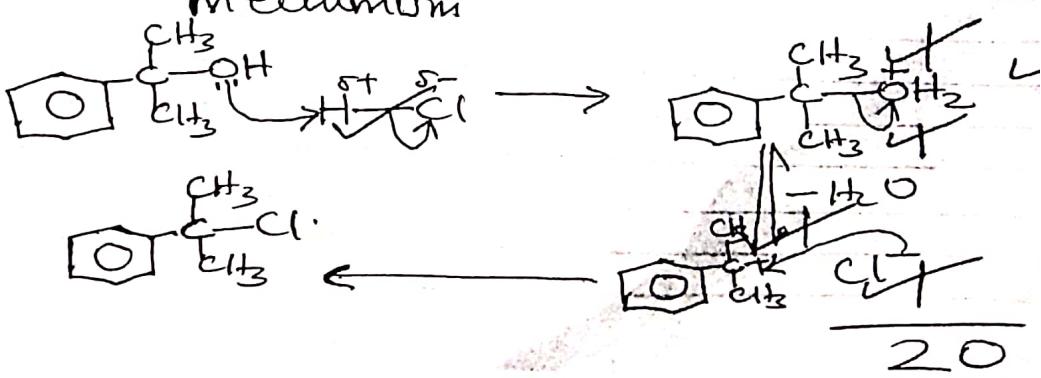


(d) (i) Anhydrous zinc chloride and concentrated hydrochloric acid.

Cloudy solution is formed immediately

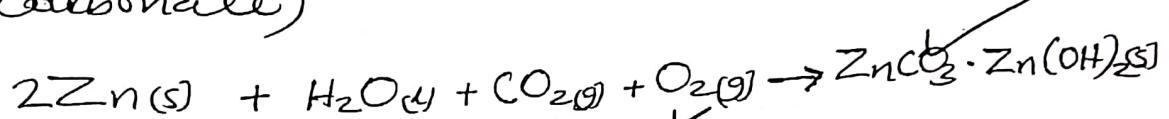


Methionium

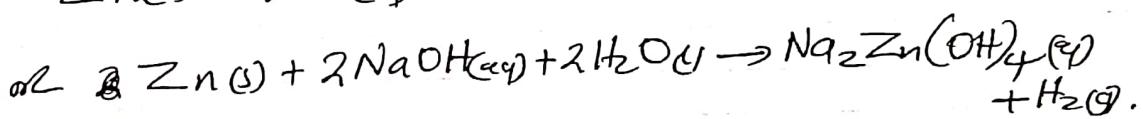
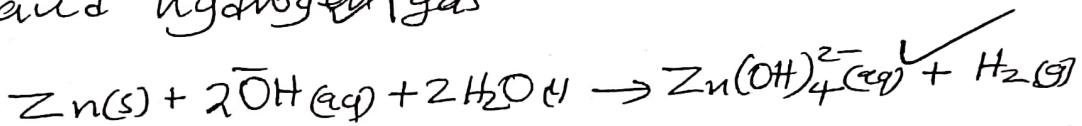


3 (a) (i) ~~Heated~~ zinc reacts with (dry) air to form  
~~Zinc oxide~~  
 $2\text{Zn(s)} + \text{O}_2\text{(g)} \longrightarrow 2\text{ZnO(s)}$

~~Zinc reacts slowly with moist air to form basic zinc carbonate (or hydrated zinc carbonate)~~ 5



(ii) Zinc reacts with hot concentrated sodium hydroxide solution to form sodium zincate and hydrogen gas 2½



(iii) ~~Heated~~ zinc reacts with steam to form zinc oxide and hydrogen gas 2½



(b) (i)  $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10}$  Zn

$\text{Zn}^{2+}: 1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$   
 Both zinc atoms and zinc ion have 3 completely filled 3d-orbitals.

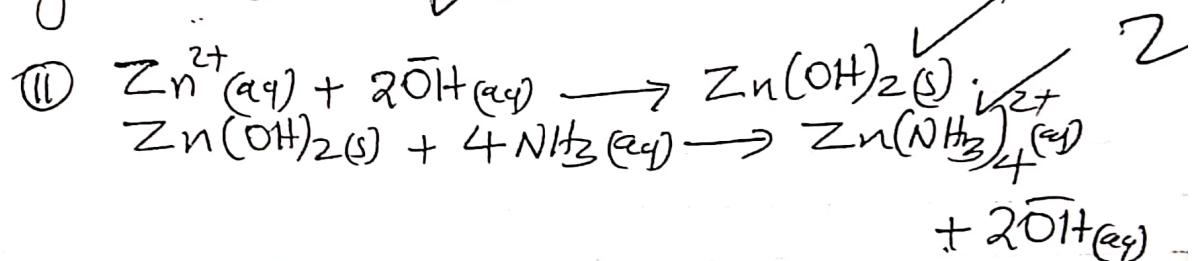
(ii) - Both zinc and magnesium react with dilute acids to form corresponding salts and hydrogen gas 2

- Both zinc and magnesium react with steam when heated to form respective oxides and hydrogen gas.

- Both zinc and Magnesium react with ~~any~~  
~~oxygen when heated to form respective oxides~~

- The carbonates and nitrates of both zinc and Magnesium decompose on heating to form the respective oxides.

(C) (i) White precipitate soluble in excess to 2 form a colourless solution



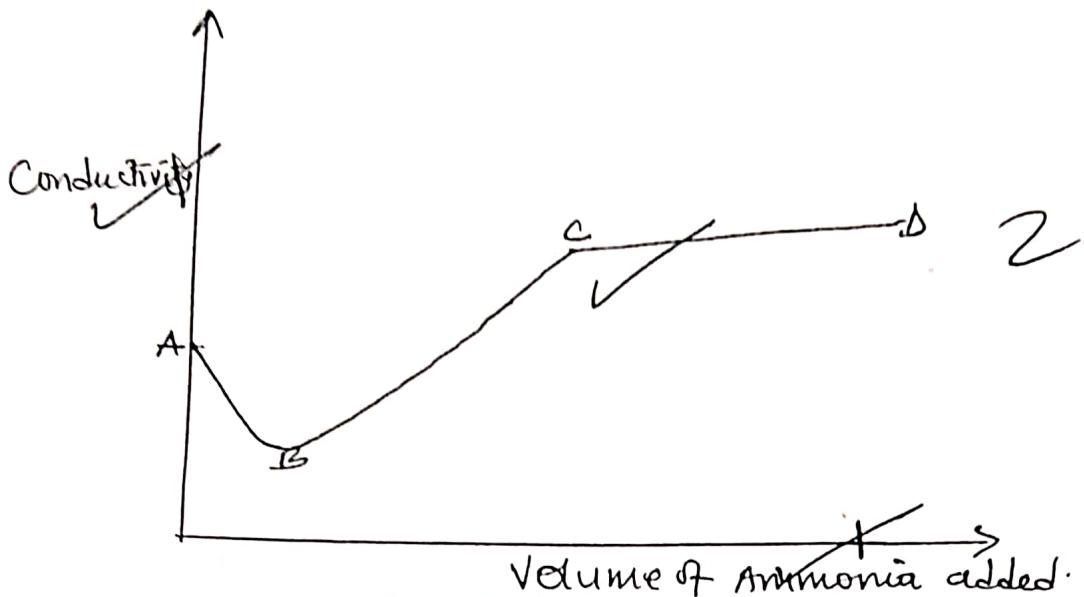
(4) (a) (i) Conductivity is the reciprocal of resistivity.

or Is the conductance of a solution of an electrolyte enclosed between two electrodes which are of unit cross-sectional area and unit length apart.

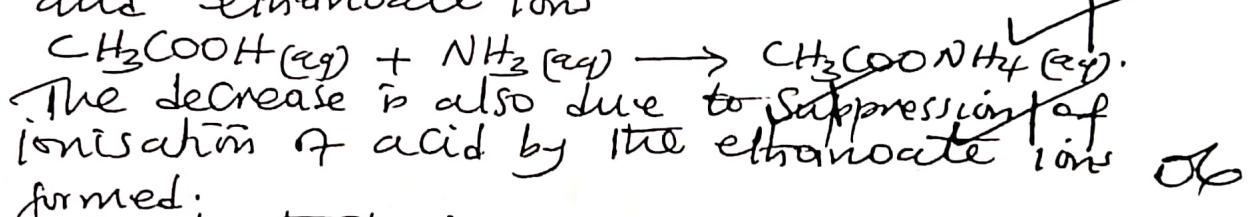
(ii) Molar conductivity is defined as Conductivity divided by Concentration.

or Molar conductivity is defined as Conductivity Multiplied by dilution.

or Is the Conductivity of a solution containing one mole of an electrolyte in a given volume of solution enclosed between two electrodes of unit cross-sectional area and unit length apart.



At A, the conductivity is low because ethanoic acid is a weak electrolyte and only partially ionises to form few conducting hydrogen ions. Conductivity decreases from A to B due to neutralisation of hydrogen ions by ammonia and replaced by slow conducting ammonium and ethanoate ions.



Conductivity increases from B to C due to formation of ammonium ethanoate which is a strong electrolyte. Point C is the end point and conductivity is high because the electrolyte formed is stronger than the reactants.

Conductivity almost remains constant due to suppression of ionisation of ammonia by ammonium ions from the salt formed.

$$\begin{aligned}
 \text{C(i) } \lambda_{\text{H}_2\text{O}} &= \lambda_{\text{KOH}} + \lambda_{\text{HNO}_3} - \lambda_{\text{KNO}_3} \\
 &= 273.1 + 421 - 145 = 548.1 \text{ ohm}^{-1}\text{cm}^2\text{mol}^{-1}
 \end{aligned}$$

(11) ~~18 cm<sup>3</sup> of H<sub>2</sub>O contain 1 mole  
1000 cm<sup>3</sup> of H<sub>2</sub>O contain  $\frac{1 \times 1000}{18}$  moles.~~

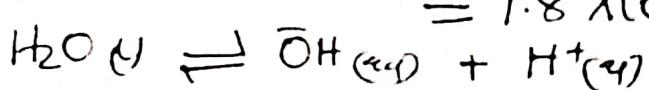
$$\lambda_c = \frac{1000 k}{c} \checkmark$$

$$\lambda_c = \frac{1000 \times 5.4 \times 10^{-8}}{1000/18} \checkmark$$

$$\lambda_c = 9.72 \times 10^7 \text{ ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$$

$$\alpha = \frac{\lambda_c}{\lambda_0} = \frac{9.72 \times 10^7}{548.1} \quad 4$$

$$= 1.8 \times 10^9 \checkmark$$



$$K_w = c_a \cdot c_a \cdot \checkmark$$

$$= c^2 \alpha \checkmark$$

$$= \left(\frac{1000}{18}\right)^2 (1.8 \times 10^9)^2 \checkmark$$

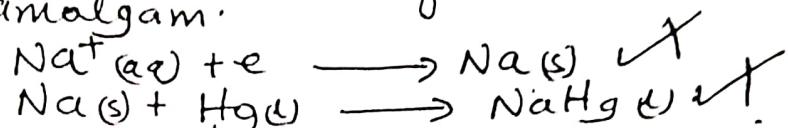
$$= 1.0 \times 10^{-14} \text{ mol}^2 \text{dm}^{-4} \checkmark$$

(d) Sodium ion has smaller ionic radius than rubidium ion. It has a higher charge density than rubidium ion hence greatly attract a large amount of water molecules around itself making it highly hydrated and heavy. This reduces its conductivity. Rubidium ion has larger ionic radius and low charge density and hence less hydrated making lighter and highly conducting than sodium ion.

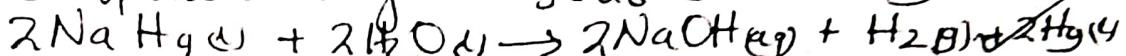
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5 (a) Concentrated sodium chloride (Brine) is electrolysed using Mercury Cathode and Carbon anode.

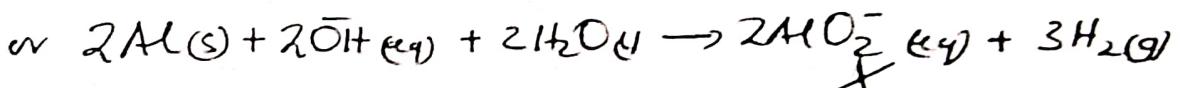
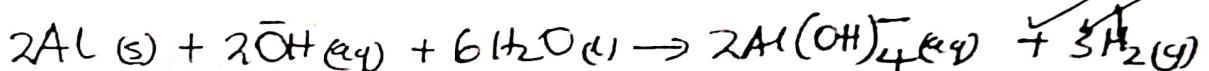
Sodium ions are discharged at the Cathode to form sodium which forms an alloy sodium amalgam.



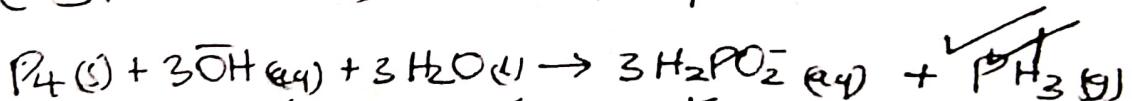
The Sodium amalgam reacts with water to form sodium hydroxide solution which is evaporated to form solid sodium hydroxide



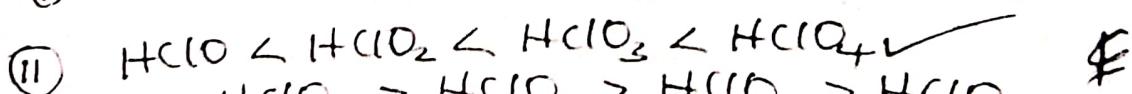
(b) (i) Aluminium reacts with hot concentrated sodium hydroxide solution to form sodium 3 aluminate and hydrogen gas



(ii) Phosphorous reacts with hot concentrated sodium hydroxide to form sodium phosphinate (hypophosphite) and phosphine



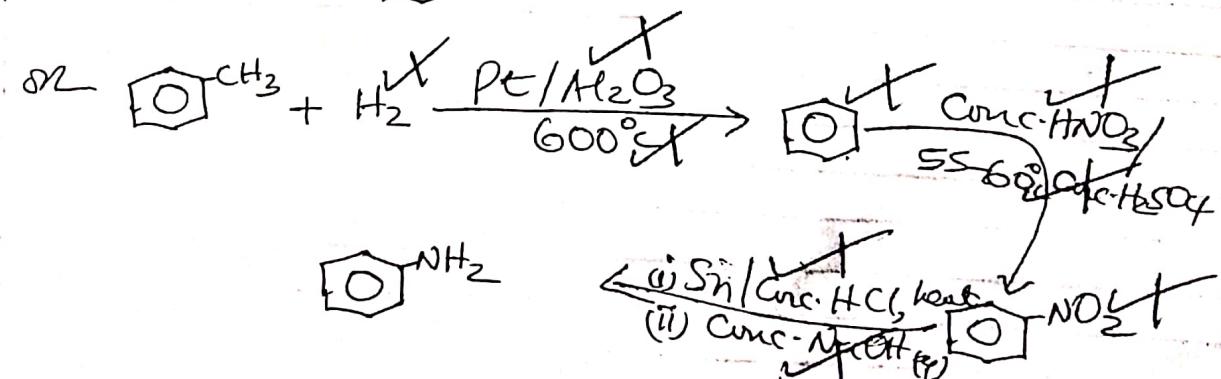
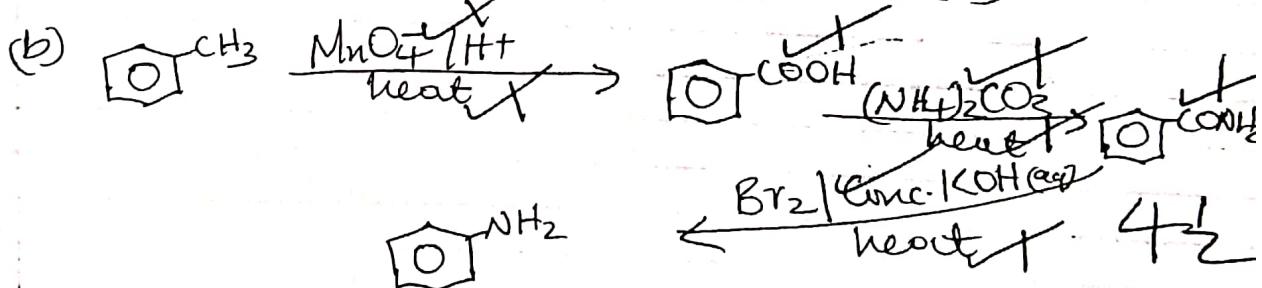
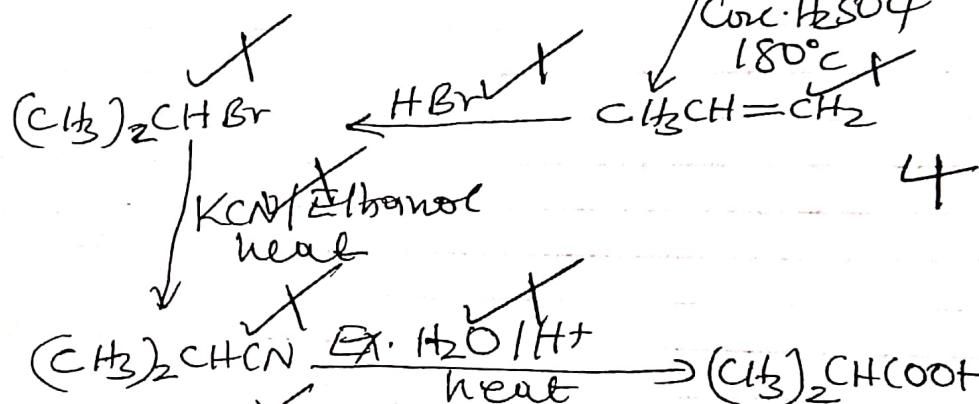
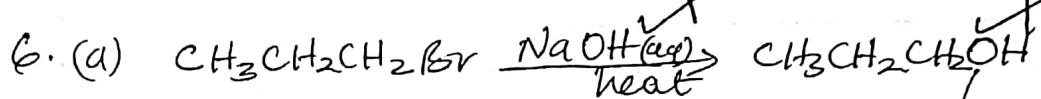
(c) (i)  $\text{HClO}$ ,  $\text{HClO}_2$ ,  $\text{HClO}_3$  and  $\text{HClO}_4$

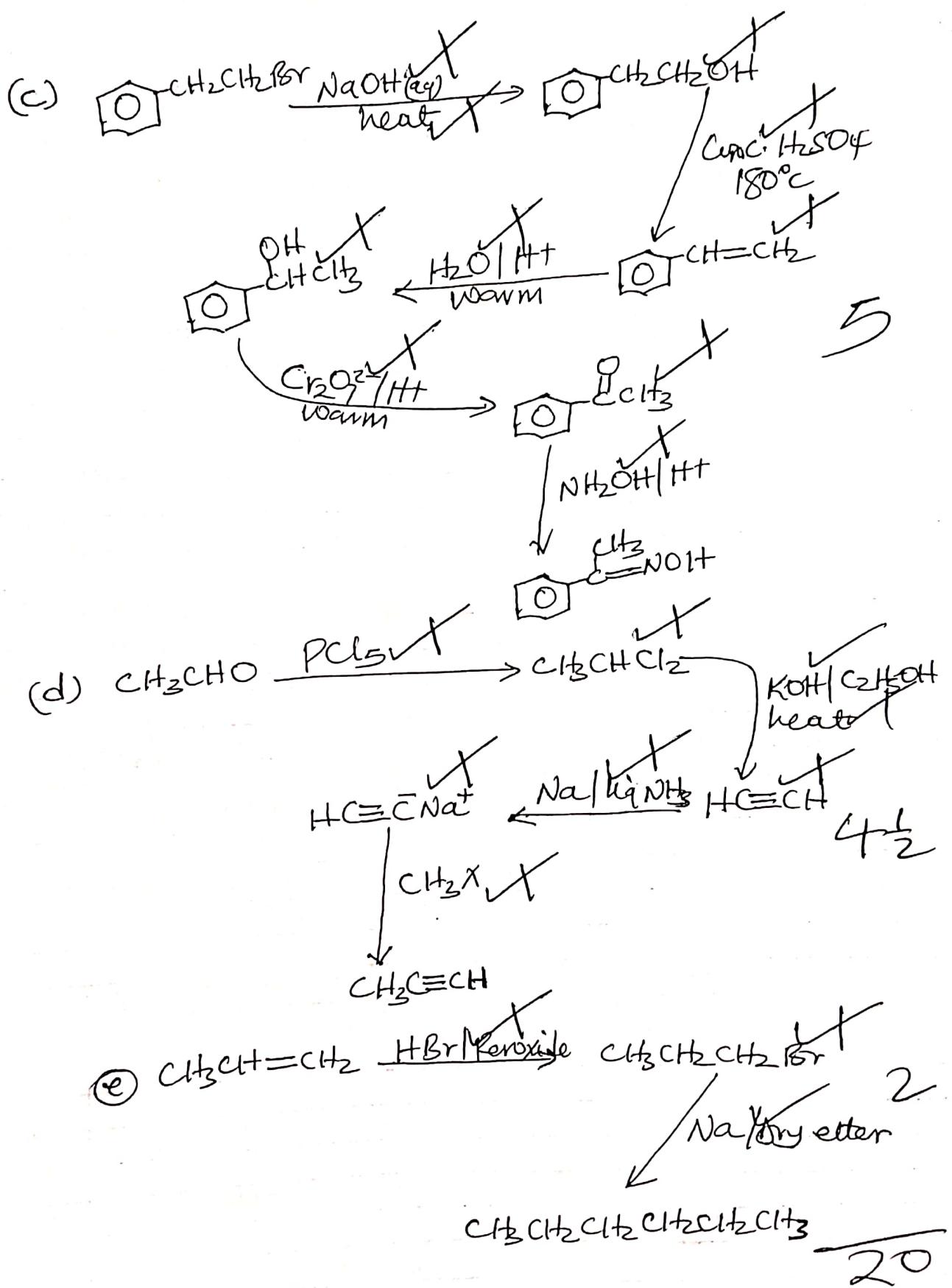


The acid strength of the oxo acids increase with increase in number of Oxygen atoms. This is because Oxygen atom is more electronegative than Chlorine atom in the oxoacid. They withdraw electrons.

from Oxygen-hydrogen bond through the chlorine. This weakens the oxygen-hydrogen bond increasing the ease with which a proton is lost increasing the acid strength.

(d) (i)  $\text{HClO}$  or chloric(I) acid

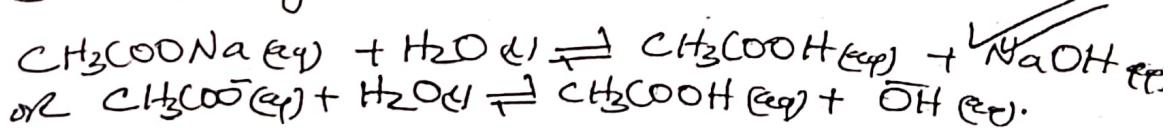




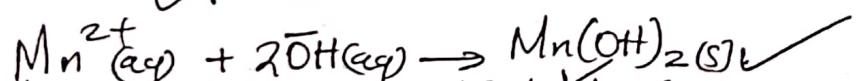
7(a) 1-bromobutane easily undergoes nucleophilic substitution because carbon-bromine bond is polar since bromine is more electronegative than carbon atom, the carbon atom is having a partial positive charge and so is easily attacked by the nucleophile. 4  
 Bromobenzene does not easily undergo nucleophilic substitution because the lone pair of electrons on the bromine atom interacts with the delocalised electrons of the benzene ring. This strengthens carbon-bromine bond and is not easily broken.

(b) Phenol is slightly soluble in water because of the presence of the non-polar group which is hydrophobic.  
 $\text{C}_6\text{H}_5\text{OH}(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{C}_6\text{H}_5\text{O}^-(aq) + \text{H}_3\text{O}^+(aq)$ .  
 It's more soluble in sodium hydroxide because it reacts with sodium hydroxide to form sodium phenoxide which is more soluble.  
 $\text{C}_6\text{H}_5\text{OH}(aq) + \text{NaOH}(aq) \rightarrow \text{C}_6\text{H}_5\text{ONa}(aq) + \text{H}_2\text{O}(l)$ .

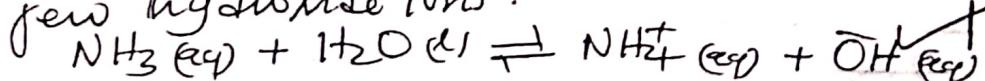
(c) Sodium ethanoate is a salt formed from weak acid and strong base. It undergoes hydrolysis to form alkaline solution. 4



(d) A precipitate is formed because of formation of insoluble manganese(II) hydroxide

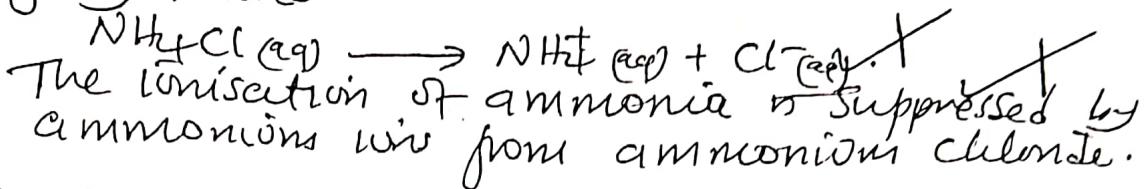


Ammonia is a weak base and provides few hydroxide ions.

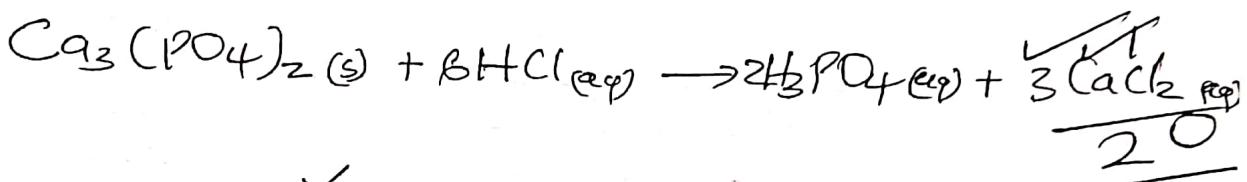


Manganese(II) hydroxide is precipitated if the ionic product exceeds the solubility product.

Ammonium chloride is a strong electrolyte and fully ionises



- (e) Calcium phosphate is insoluble in water because its lattice energy is greater than hydration energy. It dissolves in hydrochloric acid because it forms calcium chloride and phosphoric acid which are both soluble



- (g) A known volume of a standard solution of oxalate ions is mixed with dilute sulphuric acid.

A known volume of a standard solution of manganese(VII) is mixed with dilute sulphuric acid. Oxalate ions is heated to about  $80^\circ\text{C}$ .

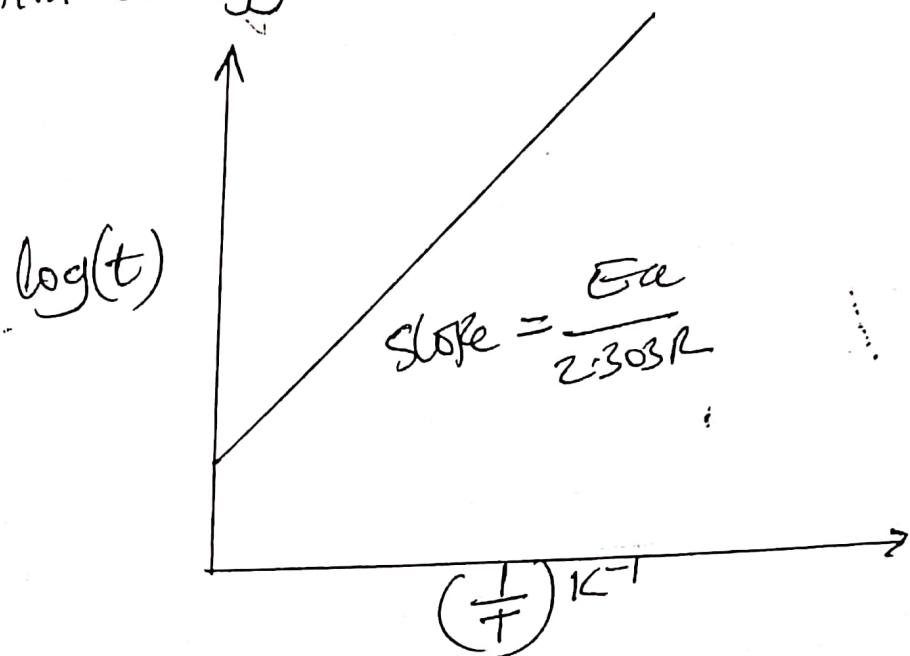
The manganese(VII) solution is then rapidly added to the hot solution of oxalate ions and a stop clock immediately started.

The mixture is shaken and left to settle.

The time taken for the solution to turn to colourless is recorded. The experiment is repeated several times at different temperatures and at room temperature.

A graph of logarithm of time ( $t$ ) against reciprocal of temperature ( $\frac{1}{T}$ ) is plotted. The slope of the graph is then used to obtain the

activation energy



b) i)	$(\frac{1}{T})$	0.002	0.0018	0.0016	0.0015	<del>0.0014</del>
	$\log(\text{Rate})$	-3.167	-1.578	-0.252	0.864	<del>1.824</del>

$$\text{(ii) Slope} = \frac{-3.55 - 1.95}{2.01 \times 10^3 - 8.0 \times 10^5} \checkmark$$

$$= \frac{-5.5}{1.93 \times 10^3} = -2849.74 \text{ K}$$

$$\text{Slope} = -\frac{E_a}{2.303R} \checkmark$$

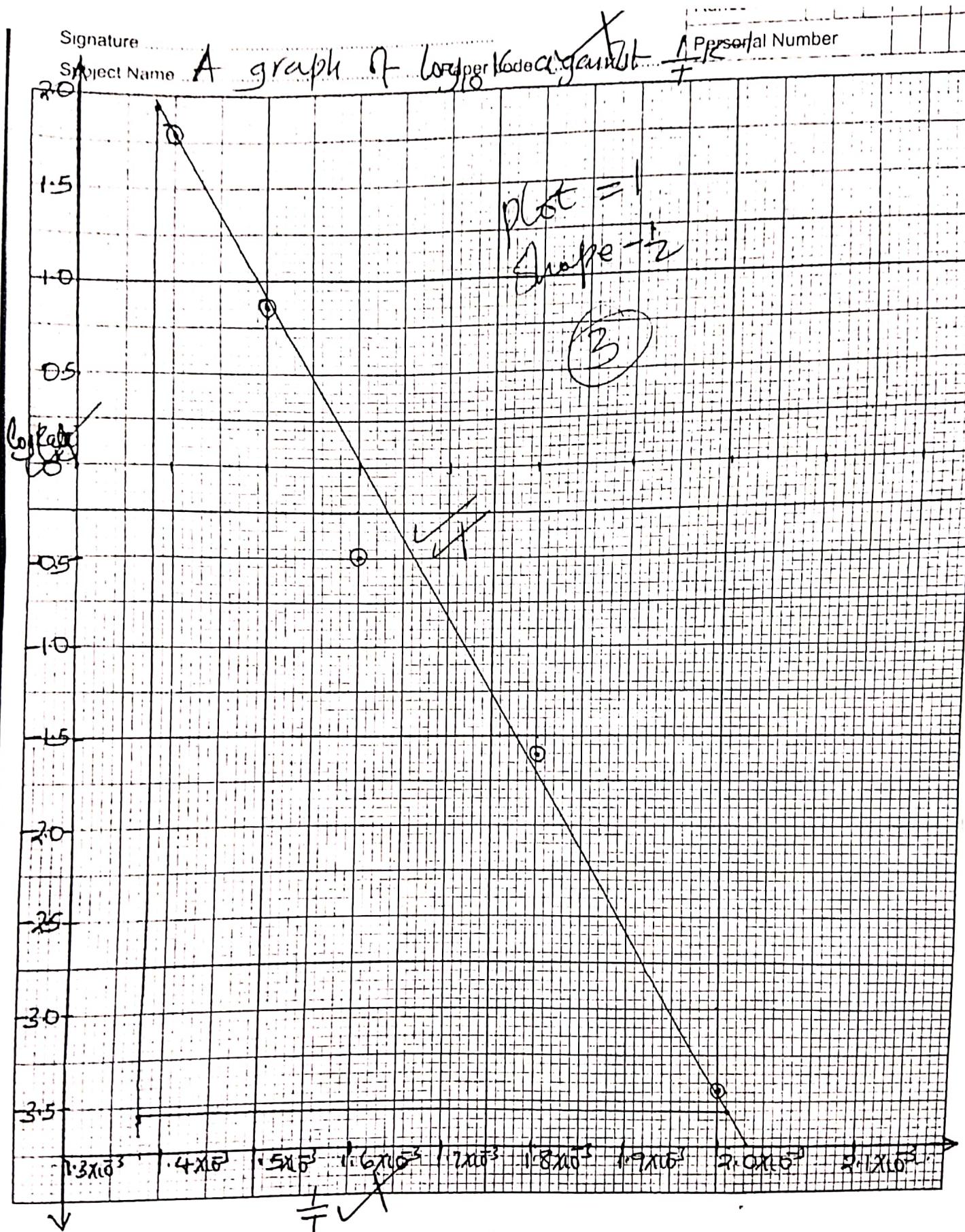
$$E_a = \frac{-2849.74 \text{ K} \times 8.315 \text{ J mol}^{-1} \text{ K}^{-1}}{4} \checkmark$$

$$\underline{\underline{E_a = +23.68 \text{ kJ mol}^{-1}}}$$

Signature

Subject Name

Personal Number



Signature .....

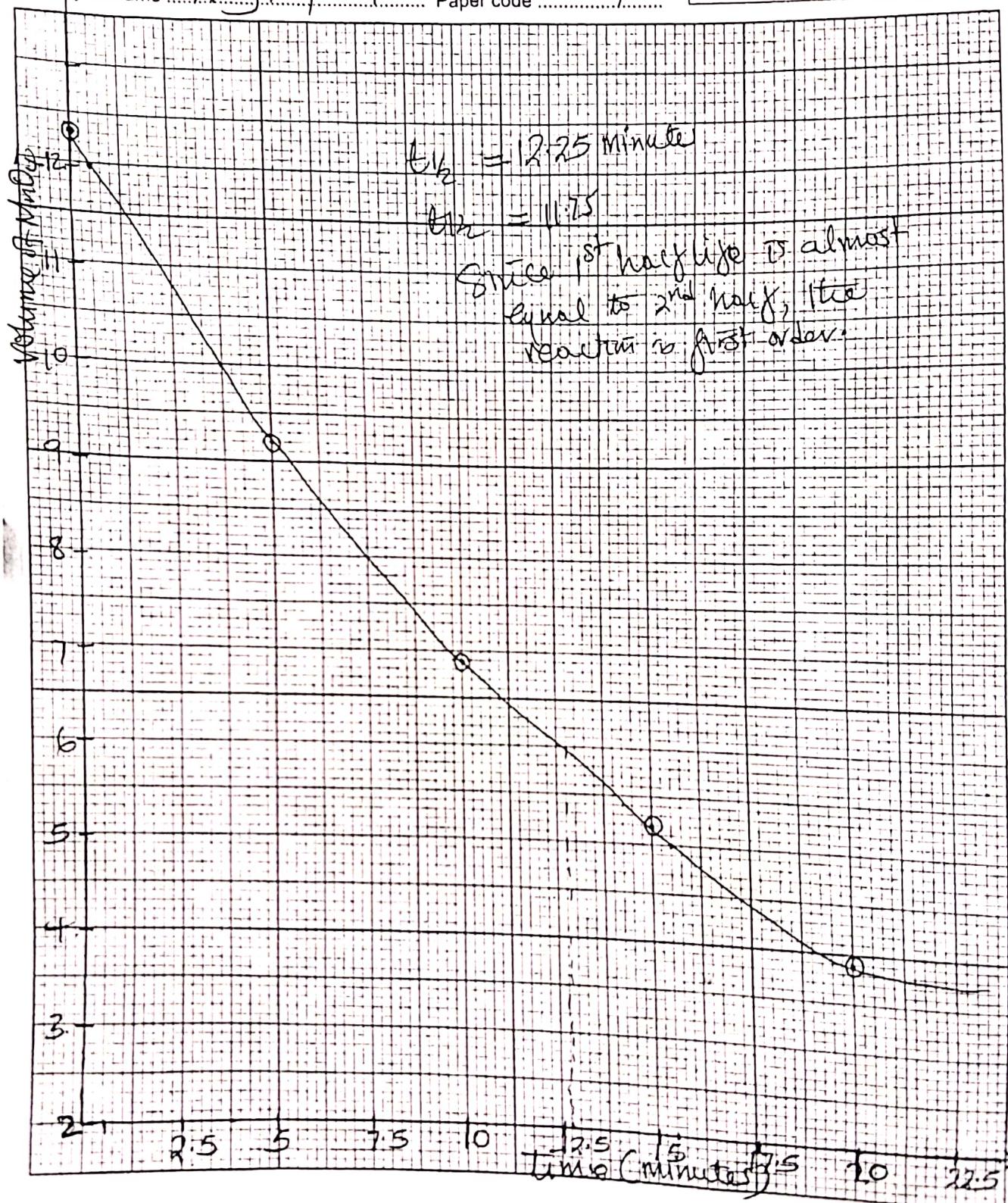
Subject Name .....

A graph of volume of KMnO<sub>4</sub> against time

Random No.

Personal Number

Paper code .....



$$\textcircled{c} \quad 2.303 \log\left(\frac{V_0}{V_t}\right) = K_1 t \checkmark$$

$$V_0 = 12.30 \text{ cm}^3.$$

$$K_1 = \frac{2.303 \log\left(\frac{12.3}{9.20}\right)}{5} \checkmark 0.058 \text{ min}^{-1}$$

$$K_2 = \frac{2.303 \log\left(\frac{12.3}{6.90}\right)}{10} \checkmark 0.058 \text{ min}^{-1}$$

Since using the integrated rate expression for first order reaction,  $K_1 = K_2$ .  
 The decomposition of hydrogen peroxide is a first order reaction.

or Plot a graph of volume of  $\text{KMnO}_4$  against time. If the half life is constant, the reaction is first order.

20

END