INTERNAL MOCK EXAMINATIONS

THE CHEMISTRY DEPARTMENT

2024

CHEMISTRY

Paper 2

2 hours 30 minutes

INSTRUCTIONS:

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 graph papers are provided.

Non-programmable scientific calculators may be used.

Use equations where necessary to illustrate your answers.

SECTION A : (60 MARKS)
Answer **three** *questions from this section.*

1. (a) (i)Sketch a graph of first electron affinity against atomic number of group VII elements. *(3½ mark)*

   (ii) Explain the shape of the graph. *(6 ½ marks)*

   (b) State **two** reasons why fluorine differs in some reactions from other group VII elements. *(02 marks)*

   (c) State **three** properties in which fluorine differs from other group VII elements. *(03 marks)*

   (d) (i) Describe the reaction of sulphuric acid with hydrogen bromide. Write the equation for the reaction that takes place. *(03 marks)*

   (ii) Briefly explain why hydrogen chloride cannot react with sulphuric acid the same way as hydrogen bromide does in (d)(i) above. *(02 marks)*

2. Ethylamine, dimethylamine and ammonia are weak bases in aqueous solution.

   (a)(i) Arrange the compounds in order of increasing basic strength. *(01 mark)*

   (ii) Suggest why the basic strength is in that order. *(04 marks)*

   (b)   (i) Name a reagent that can be used to identify the functional group of the bases. *(01 mark)*

   (ii) State what is observed when each of the bases is separately treated with the named reagent. *(01 mark)*

   (c)Using equations and showing the necessary conditions, show how:

   (i)   dimethylamine could be prepared from ethanol. *(04 marks)*

   (ii)   ethylamine could be converted to propanoic acid. *(04 marks)*

(d)   (i) Name the reagent that could be used to distinguish between the bases.   *(01 mark)*

(ii)   State what is observed when each of the bases is separately treated with the named reagent.   *(02 marks)*

(iii)   Write the equation for the reaction that took place in each case.   *(02 marks)*

3. Water and nitric acid (boiling point, $86°C$) when mixed form a liquid mixture that deviates negatively from Raoult's law.

(a) (i) Explain why the mixture deviates negatively from Raoult's law.   *(02 marks)*

(ii) Draw a well labelled temperature-composition diagram for the mixture. (Azeotropic mixture composition and boiling point are 68% nitric acid at $120.5°C$)   *(04 marks)*

(iii)   Describe the shape of the diagram.   *(05 marks)*

(b)   Describe what happens when a solution containing 80% nitric acid is fractionally distilled.   *(04 marks)*

(c) (i) Calculate the molarity of nitric acid in the azeotropic mixture.

(04 marks)

(ii)   Name **one** method that could be used to increase the percentage of nitric acid in the azeotropic mixture.

(01 mark)

3. (a) (i) Distinguish between **electrolytic conductivity** and **molar conductivity** of a solution.   *(02 marks)*

(ii)   Write the equation to show the relationship between electrolytic conductivity and molar conductivity of a solution.   *(01 mark)*

(b) (i) Sketch a graph to show how the molar conductivity of sodium ethanoate varies with dilution.   *(1 ½ marks)*

(i)   Explain the shape of the graph   *(04 marks)*

(c) The table below gives the molar conductivity of a solution of ethanoic acid at 298K.

$[CH_3CO_2H](mol\,dm^{-3})$	0.001	0.01	0.1
Molar conductivity ($\Omega^{-1}cm^2mol^{-1}$)	50	16	5

(i) Explain the trend in molar conductivity. (02 marks)

(ii) Calculate the pH and ionization constant, K_a of 0.01M ethanoic acid. (04 marks)

(The molar conductivity of ethanoic acid at infinite dilution is $390\Omega^{-1}cm^2mol^{-1}$)

(d) (i) Distinguish the terms **resistivity** and **conductance**. (02 marks)

(ii) Using the same conductivity cell, the resistance of potassium chloride solution and 0.1M chloroethanoic acid solution were found to be 24.9 and 66.5 ohms respectively at 25°C. The conductivity of potassium chloride at 25°C is $0.01164\Omega^{-1}cm^{-1}$. Calculate the cell constant hence the conductivity of 0.1M chloroethanoic acid. (03 marks)

SECTION B : (40 MARKS)

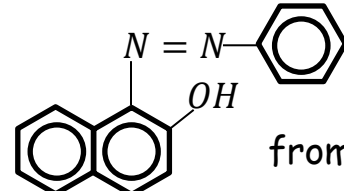*Answer any* **two** *questions from this section*

4. Write equations to show how the following compounds can be synthesised. Indicate the reagents and conditions.

(a) CH_3COOH from propan-1-ol (04 marks)

(b) $CH_3\overset{\displaystyle Cl}{\underset{\displaystyle Cl}{C}}CH_2CH_3$ from ethanol (04 marks)

(c) CH_3CH_2—⬡—SO_3Na from benzene (04 marks)

(d) ⬡—$CH = N\text{–}NH$—⬡ from benzene (04 marks)

(e) [naphthalene with $N = N$—⬡ and OH groups] from benzene (04 marks)

5. (a) (i) State the partition law and state the conditions under which it is valid. (03 marks)

(ii) Briefly describe how the partition coefficient for the distribution of ammonia between water and trichloromethane can be determined. (05 marks)

(b) 18g of a compound **X** distributes itself between an immiscible solvent **Y** and an equal volume of water such that 2g of **X** are left in water. Calculate the percentage of **X** left in water if 1000 cm^3 of water containing 1 g of **X** are extracted by:

(i) one litre of **Y**

(ii) half a litre of **Y** two times successively. (05 marks)

(c) State **three** applications of partition coefficient. (03 marks)

(d) Some substances can be effectively purified by steam distillation.

(i) Explain the principle of separation of substances by steam distillation. (03 marks)

(ii) State **one** advantage of separation of substances by steam distillation over fractional distillation. (01 mark)

6. (a) (i) Define the term an **ore**. (01 mark)

(ii) Iron can be extracted from iron pyrites. Write the formula of iron pyrites. (01 mark)

(b) Describe how iron is extracted from the ore in (a) (ii) above. (08 marks)

(c) Describe the reaction of iron with:

(i) water (03 marks)

(ii) chlorine (02 marks)

(iii) sulphuric acid (05 marks)

7. Explain each of the following observations. Use relevant equations where necessary.

(a) The atomic radius of the group IIA metals increases down the group. *(03 marks)*

(b) An aqueous solution of aluminium chloride is acidic. *(03 marks)*

(c) The boiling point of a solution containing 0.3075g of nitrobenzene in 100g of benzene is the same as that of a solution containing 0.38g of camphor in 100g of benzene.
(04 marks)

(d) When concentrated hydrochloric acid was added to an aqueous solution cobalt(II) chloride, the colour of the solution changed from pink to blue and back to pink on when diluted with water.
(04 marks)

(e) The solubility of lead(II) nitrate decreases on addition of dilute hydrochloric acid but increases on addition of concentrated hydrochloric acid. *(04 marks)*

(f) The boiling point of ethanol is higher than that of ethylamine.
(02 marks)

END