P525/2
CHEMISTRY
Paper 2
April./May. 2024 **S.5**
2 ½ hours.

THE CHEMISTRY DEPARTMENT

2024

CHEMISTRY

END OF TERM I, Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt all questions in this paper.
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.

1. The lowering in vapour pressure of a volatile solvent is a colligative property.

(a) (i) Define the term **colligative property** *(01 mark)*

(ii) State **two** other examples of colligative properties. *(02 marks)*

(iii) State **Raoult's law of vapour pressure lowering**. *(01 mark)*

(b) The vapour pressure of carbon disulphide at a certain temperature is $400\ mmHg$. At the same temperature, a solution of 5g of sulphur in $63\ cm^3$of carbon disulphide has a vapour pressure of $392.58\ mmHg$. If the density of carbon disulphide at this temperature is $1.27 gcm^{-3}$.

(i) Explain why a solution of sulphur in carbon disulphide has a lower vapour pressure than pure carbon disulphide.

(02 marks)

(ii) Calculate the relative molecular mass of sulphur. *(03 marks)*

(iii) Deduce the molecular formula of sulphur in carbon disulphide.

$(C = 12, S = 32)$ *(02 marks)*

(c) The vapour pressure of different solutions of solute ***Y*** dissolved in solvent ***X*** at 40°C are shown in the table below.

Concentration of Y$(moldm^{-3})$	0.00	0.10	0.20	0.30	0.40	0.50
Vapour pressure of solution(kNm^{-2})	16.000	15.971	15.942	15.914	15.880	15.860

(i) Plot a graph of lowering in vapour pressure(ΔP) against concentration of ***Y***. *(04 marks)*

(ii) Use your graph in b(i) above to determine the relative molecular mass of solvent ***X*** if its density is $1.0 gcm^{-3}$.

(03 marks)

(iii) State **two** assumptions made in b(ii) above. *(02 marks)*

2. (a) State what is meant by the following terms;
   (i) Atomic radius *(01 mark)*
   (ii) Ionisation energy *(01 mark)*

   (b) Write equation to illustrate;
   (i) first ionization energy of magnesium. *(01 mark)*
   (ii) third ionization energy of aluminium. *(01 mark)*

   (c) Briefly explain how atomic radius affects first ionisation energy. *(04 marks)*

   (d) The table below shows some information about group VII elements and some period 3 elements .

Group VII			**Period 3**		
Element	**Atomic radius**	**Ionic radius**	**Element**	**Atomic number**	**First ionization energy ($kJmol^{-1}$)**
F	0.072	0.136	**Na**	11	496
Cl	0.099	0.181	**Mg**	12	738
Br	0.114	0.195	**Al**	13	578
I	0.133	0.216	**Si**	14	786

   (i) Explain why the ionic radius is larger than the atomic radius of the corresponding neutral atom for each element. *(03 marks)*

   (ii) Plot a graph of first ionization energy against atomic number of the period 3 elements. *(03 marks)*

   (iii) Explain the shape of the graph in b(ii) above. *(06 marks)*

3. (a) Define the terms;
   (i) Functional group *(01 mark)*
   (ii) Unsaturated hydrocarbon *(01 mark)*
   (iii) Homologous series *(01 mark)*
   (iv) Structural isomerism *(01 mark)*

(b) Describe the **three** types of structural isomerism, giving a suitable example in each case. *(06 marks)*

(c) A hydrocarbon **Z**, on complete combustion gave 0.63g of carbon dioxide and 0.26g of water. When 0.716g of **Z** was vapourised, it occupied a volume of 0.25 litres at s.t.p. Determine the;

(i) empirical formula of **Z**. *(03 marks)*

(ii) molecular formula of **Z** *(03 marks)*

(iii) Deduce the structural formulae and IUPAC names of any **four** possible isomers of **Z**. *(04 marks)*

4. (a) Define the terms;

(i) Radioactivity *(02 marks)*

(ii) Nuclear stability *(02 marks)*

(iii) Half-life *(02 marks)*

(b) State;

(i) **Graham's law of gaseous diffusion**. *(01 mark)*

(ii) **Dalton's law of partial pressure**. *(01 mark)*

(b) 250 cm^3 of an alkene diffuse through a porous medium in 10 seconds and 716 cm^3 of oxygen diffuse through the same medium in 25 seconds under the same conditions. Calculate the molecular mass of the alkene and deduce its structural formula. *(3 $\frac{1}{2}$ marks)*

(c) (i) Explain why a mixture of ammonia and hydrogen chloride does not hold for Dalton's law of partial pressures. *(2 $\frac{1}{2}$ marks)*

(ii) A mixture of 20% ammonia, 55% hydrogen and 25% nitrogen by volume has a pressure of $9.80 \times 10^4 Nm^{-2}$. Calculate the partial pressure of each gas. *(03 marks)*

(d) The half life of a radioactive element is 150 seconds. What percentage of the isotope will remain after 600 seconds? *(03 marks)*

END