

P525/2
CHEMISTRY
Paper 2
June./July. 2024
2 $\frac{1}{2}$ hours.

S.5

THE CHEMISTRY DEPARTMENT

2024

CHEMISTRY

MID TERM II, Paper 2

2 hours 30 minutes

INSTRUCTIONS:

Attempt only 5 questions out of the 8 questions.

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.

Answer any **five** questions from this paper.

All questions carry equal marks.

1. (a) State what is meant by the terms;
- (i) **first electron affinity** (02 marks)
 - (ii) **atomic radius.** (02 marks)
- (b) Briefly explain how atomic radius and screening effect affect first electron affinity. (04 marks)
- (c) Write equations for;
- (i) first electron affinity of chlorine (01 mark)
 - (ii) second electron affinity of oxygen (01 mark)
- (d) The elements fluorine, chlorine, bromine and iodine belong to group VII of the Periodic Table. The table below shows the values of first electron affinity of the elements.

Element	Fluorine	Chlorine	Bromine	Iodine
Atomic number	9	17	35	53
First electron affinity(kJmol ⁻¹)	-354	-370	-348	-320

- (i) Plot a graph first electron affinity against atomic numbers of the elements. (03 marks)
 - (ii) Explain the shape of the graph. (07 marks)
2. (a) (i) State **Graham's law** of gaseous diffusion. (01 mark)
- (ii) 20 cm³ of a vapourised hydrocarbon **Q** diffuses through a small aperture in 45 seconds while the same volume of carbon dioxide diffuses through the same aperture in 35.18 seconds. Deduce the molecular formula of the alkane. (05 marks)
 - (iii) Write the structural formulae and IUPAC names of all the possible isomers of **Q**. (4 $\frac{1}{2}$ marks)
- (b) State the trend in variation of the boiling points of the isomers in (a)(iii) above. Explain your answer. (4 $\frac{1}{2}$ marks)
- (c) **Q** can be prepared by passing a mixture of 2-methylbut-2-ene and hydrogen over finely divided nickel catalyst at 150°C.

- (i) Identify **Q**. (01 mark)
 - (ii) Write equation for the reaction. (01 mark)
 - (d) Write equation(s) to show how **Q**; (03 marks)
 - (i) can be formed from 2-bromo-2-methylbutane
 - (ii) burns in excess air
 - (iii) can be prepared from any monocarboxylic acid.
3. (a) (i) What is meant by the term **structural isomerism**? (02 marks)
- (ii) Describe the **three** types of structural isomerism, giving a suitable example in each case. (06 marks)
- (b) Explain what is meant by the following terms;
- (i) Nucleophilic addition reaction (03 marks)
 - (ii) Nucleophilic substitution reaction (03 marks)
 - (iii) Electrophilic substitution reaction (03 marks)
 - (iv) Electrophilic addition reaction (03 marks)
- In each of cases, state one reaction example and write an equation to illustrate your answer.***
4. (a) Define the terms;
- (i) **relative atomic mass**. (02 marks)
 - (ii) **relative abundance** (02 marks)
- (b) Briefly describe how the relative atomic mass of an element is determined by spectrometry with the aid of a well labeled diagram. (10 marks)
- (c) The mass spectrum of element **Y** shows four peaks of heights in a ratio 2.1 : 4 : 2.2 : 1.6 with isotopic masses 10.692, 11.291, 10.928 and 12.029 a.m.u respectively. Determine the;
- (i) relative abundances of the isotopes of **Y**. (04 marks)
 - (ii) relative atomic mass of **Y**. (02 marks)

5. (a) Define the terms

- (i) **Radioactivity** (02 marks)
- (ii) **Radioisotopes** (02 marks)
- (iii) **Nuclear stability** (02 marks)

(b) State;

- (i) any **two** differences between chemical and nuclear reactions. (02 marks)
- (ii) the effect of emission of a positron on the nucleus of an atom. (02 marks)

(c) (i) Determine the number of beta particles and alpha particles that must be emitted for ${}^{234}_{90}\text{Th}$ to transform to ${}^{218}_{84}\text{Po}$. (03 marks)

(ii) The half-life of Radium is 1590 years. Calculate the percentage of an original sample of Radium that could have decayed after 3180 years. (03 marks)

(c) State ;

- (i) any **two** applications of radioactive isotopes.(02 marks)
- (ii) how half-life affects the stability of a nucleus. (02 marks)

6. Sodium, magnesium, aluminium, silicon, phosphorus, sulphur and chlorine are some of the elements in period 3 of the Periodic Table. The table below shows their melting points.

Element	Na	Mg	Al	Si	P	S	Cl
Atomic number	11	12	13	14	15	16	17
Melting point(K)	370.8	923	933.3	1687	317.2	388.2	171.5

- (a) (i) State what is meant by the term **melting point**. (01 mark)
- (ii) Plot a graph of melting point against atomic number of the elements. (03 marks)
- (iii) Explain the shape of the graph. (08 marks)
- (b) Describe the reactions of the elements above with concentrated sulphuric acid. (08 marks)

7. Explain the following observations

(a) Carbonic acid (H_2CO_3) and sulphurous acid (H_2SO_3) are both weak acids but their molecules exhibit different bond angles.

(04 marks)

(b) The melting point of aluminium chloride is lower than that of aluminium fluoride.

(04 marks)

(c) Both 2-nitrophenol and 4-nitrophenol exhibit hydrogen bonding and yet the boiling points of the two compounds differ greatly.

(04 marks)

(d) Hexane boils at 68°C whereas 2-methylpentane boils at 60.3°C yet the two compounds have the same molecular mass.

(04 marks)

(e) The ionic radius of the potassium ion is smaller than that of potassium atom yet ionic radius of chloride ion is larger than that of chlorine atom.

(04 marks)

8. (a) Explain what is meant by the terms:

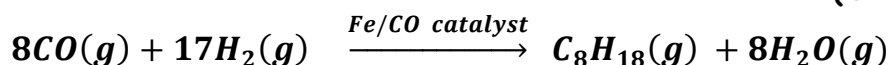
(i) **Standard enthalpy of reaction** (02 marks)

(ii) **Standard enthalpy of formation** (02 marks)

(iii) **Standard enthalpy of combustion** (02 marks)

(b) Describe an experiment to determine the enthalpy of combustion of propanol. (No diagram required) (10 marks)

(c) The standard enthalpies of formation of steam, carbon monoxide and gaseous octane (C_8H_{18}) are -242 , -111 and -169 respectively. Calculate the enthalpy change for the reaction below; (04 marks)



END