

P525/ 2
CHEMISTRY
(Theory)
Paper 2
August,2023
2½ hours

END OF TERM TWO EXAMINATIONS, 2023

Uganda Advanced Certificate of Education

S.5 CHEMISTRY

PAPER 2

2 hours 30 minutes

INSTRUCTIONS TO CANDIDATES

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

Write the answers on the answer sheets provided.

Mathematical tables and graph papers are provided.

Begin each question on a fresh page.

Non-programmable scientific electronic calculators may be used.

Illustrate your answers with relevant equations where applicable.

Where necessary use

Molar gas constant, $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$.

Standard pressure = 101325 N m^{-2}

$C = 12, O = 16, H = 1, S = 32, F = 19$

SECTION A

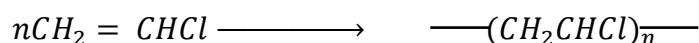
(Answer any three questions from this section)

Question One

- (a) State **Graham's law**. (01 mark)
- (b) Oxygen diffused through a porous partition in 1.87 minutes. Under similar conditions, the same volume of an alkene, **T** diffused in 2.15 minutes.
- (i) Determine the molecular formula of **T**. (2 ½ marks)
- (ii) Write all the possible isomers of **T** and their IUPAC names. (02 marks)
- (c) **T** decolourises cold alkaline potassium manganate (VII) solution.
- (i) Identify **T** (01 mark)
- (ii) Write equation for the reaction. (01 ½ marks)
- (d) Write equation and outline the mechanism for the reaction of **T** with;
- (i) acidified water. (03 ½ marks)
- (ii) hydrogen bromide solution (04½ marks)
- (ii) bromine in tetrachloromethane. (04 marks)

Question Two

- (a) State the;
- (i) laws of osmotic pressure. (02 marks)
- (ii) conditions under which the laws in (a)(i) are invalid. (02 marks)
- (b) (i) Describe an experiment that can be used to determine the relative molecular mass of soluble starch, **P**, (**C₆H₁₀O₅**)_{**n**} using osmotic pressure measurements. (06 marks)
- (ii) The osmotic pressure of an aqueous solution of **P** containing 2.56gdm⁻³ at 23°C is 0.146mmHg. Calculate the number of monomer units in **P** (02 marks)
- (c) (i) Calculate the freezing point of 2% aqueous solution of **P** at atmospheric pressure. (*K_f* for water = 1.86°Cmol⁻¹kg⁻¹) (02 marks)
- (ii) Comment on your answer in c(i) above. (02 marks)
- (a) Vinyl chloride polymerizes according to the following to the equation



Concentration (gl^{-1})	1.25	4.40	6.25	10.65		12.50	15.65
Osmotic pressure (Nm^{-2})	48.7	171.3	243.7	414.2		487.4	609.2

(i) Plot a graph of osmotic pressure against concentration, use your graph to determine the value of n . (04 marks)

Question Three

(a) The table below shows the first ionization energies of the elements in third short period of the Periodic Table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
First ionization energy (kJmol^{-1})	494	736	577	786	1060	1000	1260	1520
Atomic number	11	12	13	14	15	16	17	18

- (i) What is meant by the term **first ionization energy**? (01 mark)
- (ii) Write an equation for the first ionization energy of phosphorus. (01 mark)
- (iii) Plot a graph of $\log_{10}(\text{first ionisation energy})$ against atomic number. (05 marks)
- (iv) Explain the shape of the graph. (07 marks)
- (b) State and explain how the first ionization energies of group(I) elements vary down the group. (04 marks)
- (c) Explain the application of ionisation energy in chemistry. (02 marks)

Question Four

- (a) Distinguish between **empirical formula** and **molecular formula**. (03 marks)
- (b) A compound **W** contains carbon, hydrogen and oxygen. Elemental analysis shows that 54.5% is carbon, 9.09% is hydrogen and the rest is oxygen.
 - (i) Calculate the empirical formula of **W**. (03 marks)
 - (ii) 0.542g of **W** occupies 148cm^3 at 20°C and 740 mmHg. Calculate the molecular formula of **W** hence state its name given that it forms effervescence with sodium hydrogen carbonate. (05 marks)
- (c) A compound **Y** contains carbon, hydrogen and nitrogen only. On complete combustion, 2.325g of **Y** yielded 6.6g of carbon dioxide and 295.4cm^3 of nitrogen gas measured at 15°C and at 760mmHg. Calculate the empirical formula of **Y**. (05 marks)

- (d) The empirical formula of a fluoride of sulphur **M**, is SF_4 . 0.1g of **M** occupied 22.10 cm^3 when vaporized at 20°C and 766 mmHg. Determine the molecular formula of **M**.

(04 marks)

SECTION B

(Answer any two questions from this section)

Question Five

- (a) State **Raoult's law** and the conditions under which the law holds. (03 marks)
- (b) Benzene and methylbenzene form a liquid mixture that is ideal. A liquid mixture of the two compounds was made by adding 23.4g of benzene to 46g of methylbenzene at 25°C . The vapour pressures of benzene and methylbenzene are 203 Nm^{-2} and 76 Nm^{-2} respectively at 25°C . Calculate the:
- (i) vapour pressure of the mixture. (04 marks)
- (ii) composition of each component in the vapour. (03 marks)
- (c) Explain why the mixture of benzene and methylbenzene is ideal. (04 marks)
- (d) (i) Sketch a boiling point-composition diagram for the mixture of benzene and methylbenzene. (Boiling points of benzene and methylbenzene are 80°C and 111°C respectively)
- (ii) Using the diagram, describe what will happen when a liquid mixture containing 50% of each component is distilled. (05 marks)
- (e) State **one** similarity between an azeotropic mixture and a compound. (01 mark)

Question Six

- (a) State what is meant by the following terms;
- (i) **First electron affinity** (01 mark)
- (ii) **Enthalpy of displacement** (01 mark)
- (b) The thermochemical data of copper (II) oxide is shown below;

	$\Delta H^\theta (\text{kJmol}^{-1})$
Enthalpy of sublimation of copper	+339.3
Standard enthalpy of formation of copper (II) oxide	-155.9
First electron affinity of oxygen	-140.9
Second electron affinity of oxygen	+770
First ionization energy of copper	+750.0

Second ionization energy of copper +1958.0

Lattice dissociation energy of copper (II) oxide +4081.5

Using the data above:

- (i) Explain the observed difference in the first and second electron affinity values of oxygen.
(03 ½ marks)
- (ii) Draw an energy level diagram and use it to determine the bond dissociation energy of oxygen.
(04 ½ marks)
- (b) Write equation to show how copper (II) oxide can be converted to copper (II) sulphate.
(01 ½ marks)
- (c) The reaction between copper (II) sulphate solution and zinc is an exothermic reaction.
- (i) State what would be observed when zinc dust is added to an aqueous solution containing copper (II) ions and the mixture allowed to stand.
(1 ½ marks)
- (ii) Describe an experiment to determine the standard enthalpy change for the reaction in d(i) above.
(07 marks)

Question Seven

- (a) Write the name and the formula of the chief ore from which aluminium is extracted.
(02 marks)
- (b) Describe how;
- (i) the ore in (a) above is purified.
(05 marks)
- (ii) aluminium is obtained from the purified ore in (b)(i) above.
(Your answer should include equations) (03 marks)
- (c) Write equations and state the conditions under which aluminium reacts with.
- (i) air (02 ½ marks)
- (ii) sodium hydroxide (02 ½ marks)
- (iii) hydrochloric acid (02 ½ marks)
- (d) Explain why aluminium utensils should not be washed using soap solutions.
(02 ½ marks)

Question Eight

Explain the following observations:

- (a) The first ionisation energy of aluminium is less than that of magnesium. (Al = 13, Mg= 12)
(05 marks)
- (b) Alkenes undergo electrophilic addition reactions whereas alkanes do not. *(04 marks)*
- (c) When magnesium metal is heated in air, a white solid is formed which when dissolved in water forms a colorless solution with evolution of a colorless gas both of which turn litmus blue.
(05 marks)
- (d) Aluminium fluoride has a higher melting point than aluminium chloride.
(03 marks)
- (e) Pentane has a higher boiling point than 2,2-dimethylpropane yet both have the same molecular mass.
(03 marks)

END