

P525/2

CHEMISTRY

PAPER 2

JUNE/JULY 2023

2½ Hours



LITTA JOINT MOCK EXAMINATIONS 2023

Uganda Advanced Certificate of Education

CHEMISTRY

Paper 2

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

- Answer **five** questions including **three** questions from **section A** and only **two** from **section B**.
- Begin each question on a fresh page.
- Mathematical tables and graph papers are provided.
- Non-programmable scientific electronic calculators may be used.
- Illustrate your answers with equations where applicable.

Where required use the following data

- Molar volume of gas at s.t.p. is 22400cm^3
- [Cu = 63.5, O = 16, H = 1, C = 12, Ca = 40, Ag = 108, Cr = 52]

SECTION A: (60MARKS)

Attempt three questions in this section.

1

- a) Distinguish between order and molecularity of a reaction. (03marks)
- b) Describe an experiment that can be carried out to show that the alkaline decomposition of hydrogen peroxide in presence of iron (III) chloride as a catalyst is first order with respect to hydrogen peroxide. (05marks)
- c) A compound Q decomposes according to the following reaction.



The table below shows the concentration of Q at various times.

Time(minutes)	2.0	4.0	7.0	10.0	14.0	20.0
Concentration of Q (mol l ⁻¹), [Q]	0.820	0.670	0.490	0.372	0.240	0.141

Plot a graph of $\log_{10} [Q]$ against time.

(04marks)

- d) Using the graph, determine the;
- i) Original concentration of Q. (01mark)
- ii) Order of reaction. (1½marks)
- iii) Rate constant for the reaction. (1½marks)
- iv) Half-life of the reaction. (01mark)
- d) Using the same axes, draw a labelled diagram for energy reaction coordinate for a catalyzed and an un-catalyzed reaction. (03marks)

2

The elements; carbon, silicon, germanium, tin and lead belong to group (IV) of the periodic table.

- a) i) Write the general outer electronic configuration of group (IV) elements. (01mark)
- ii) State three properties in which carbon differs from the rest of the members of group (IV) elements. (1½marks)
- iii) Give three reasons why carbon differs from the rest of group members. (1½marks)
- b) Describe the reaction of;
- i) Group (IV) elements with water. (04marks)
- ii) Lead (IV) oxide with concentrated hydrochloric acid. (03marks)

c) Explain each of the following observations and write equations where applicable.

i) Carbon tetrachloride is non-polar yet the bonds in carbon tetrachloride are polar. (03marks)

ii) Silicon (IV) chloride is hydrolyzed by water whereas carbon tetrachloride is not. (03marks)

iii) Carbon dioxide is a gas at room temperature while silicon dioxide is a solid at room temperature. (03marks)

3. A compound P contains 59.57% carbon, 3.55% hydrogen, 22.7% oxygen and the rest being calcium. P has a vapour density of $6.259 \times 10^{-3} \text{ g cm}^{-3}$ at s.t.p.

a) i) calculate the empirical formula of P. (03marks)

ii) Determine the molecular formula of P. (02marks)

b). Compound P was separately heated alone and also with lead methanoate to give compound O and N respectively. Both O and N burn with a smoky yellow flame and also form an orange precipitate with Brady's reagent.

i) Identify compound O and N. (01mark)

ii) State the name of the functional group of O and N and give the homologous series to which they belong. (01mark)

c) When compound N was warmed with acidified potassium permanganate solution, compound Q was formed, which when was treated with calcium hydroxide, compound R was formed. Identify compounds Q and R. (01mark)

d) Write equations and a mechanism for the reaction of;

i) Compound N with acidified semi-carbazine. (03marks)

ii) Compound N with hot sodium hydroxide solution. (03marks)

iii) Compound O with hydrogen cyanide. (02marks)

e) Show how the following conversions can be effected;

i) Compound R to 3-bromobenzoic acid. (02marks)

ii) Compound Q to nitrobenzene. (02marks)

4 a) state Raoult's law. (01mark)

b) The vapour pressure of ethanol at 20°C is 43.6mmHg while that of benzene at the same temperature is 75.2mmHg. the mole fraction of benzene is 0.09 for a mixture of benzene and ethanol at 20°C . calculate the; (03marks)

i) The total vapour pressure of mixture. (02marks)

ii) Mole fraction of benzene at the vapour phase.

c) Compound Q boils at 380°C and compound O boils at 410°C . These two components form an ideal solution. (03marks)

i) Sketch a labelled boiling point composition diagram for the mixture. (03marks)

ii) Using the diagram, describe how pure O can be obtained from the mixture containing 50% Q. (03marks)

d) i) what is meant by **distribution coefficient**. (01mark)

ii) State any two limitations of distribution law. (02marks)

e) 50cm^3 of 1.5M ammonia solution were shaken with 50cm^3 of carbon trichloride in a separating funnel. After the layers had settled, 20cm^3 of CHCl_3 layer was pipetted and titrated with 0.05M HCl. If 23.0cm^3 of the acid were required for neutralization. Calculate the KD of ammonia between water and CHCl_3 at that temperature. (05marks)

SECTION B: (40MARKS)

Attempt any two questions from this section.

5 a) Write equations with appropriate conditions to show how the following conversions can be effected.

i) 1, 3, 5-Tribromocyclo hexane from benzene diazonium salt. (03marks)

ii) $\text{HO}-\overset{\text{O}}{\underset{|}{\text{C}}}-\text{CH}_2\text{CH}_2-\overset{\text{O}}{\underset{|}{\text{C}}}-\text{OH}$ from Ethanal (03marks)

iii) Propene from 2-phenylpropane (03marks)

iv) $\text{CH}\equiv\text{CH}$ to 4-hydroxy-4-methyl pentan-2-one (03marks)

v) Ethoxyethane from but-2-ene (02marks)

b) Write the structural formulae of one pair of compounds with two same functional groups which can be distinguished using the following reagents. In each case state what would be observed if each member of the pair was treated with the reagent and write an equation for any reaction that would occur.

i) Iodine solution and sodium hydroxide solution. $\text{CH}_3\text{C}(=\text{O})\text{CH}_3$ or $\text{CH}_3\text{CH}(\text{OH})\text{CH}_3$ (03marks)

ii) Ammoniacal silver nitrate solution. $\rightarrow \text{HCOOH}$ / CH_3COOH (03marks)

a) Explain what is meant by the following terms.

i) Relative lowering of vapour pressure. (01mark)

ii) Ebullioscopic constant. (01mark)

b) i) Describe an experiment to determine the relative molecular mass of a compound by cryoscopy method. [Diagram and treatment of results required] (06marks)

ii) Explain why the method described in b (i) above is not suitable for determination of relative molecular mass of ethanoic acid in aqueous solution. (03marks)

c) When 5.50g of biphenyl ($\text{C}_{12}\text{H}_{10}$) is dissolved in 100.0g of benzene, the boiling point increases by 0.903°C . When 6.3g of an unknown organic compound is dissolved in 150.0g of benzene, the boiling point of the solution increases by 0.597°C . Calculate the molar mass of the unknown compound. (05marks)

d) Explain why the boiling point of a solvent is elevated when a non-volatile solute is added to it. (04marks)

7. a) Explain what is meant by a buffer solution? (02marks)

b) i) Explain how a solution containing a mixture of sodium benzoate and benzoic acid acts as a buffer. (05marks)

ii) Calculate the pH of buffer solution when 50cm^3 of 0.1mol dm^{-3} ethanoic acid is mixed with 150cm^3 of 0.3mol dm^{-3} sodium ethanoate. (K_a of ethanoic acid $= 1.7 \times 10^{-5} \text{mol dm}^{-3}$). (04marks)

c) i) Describe an experiment that can be used to determine the solubility product of silver oxalate. (05marks)

ii) The solubility product of silver chromate at 20°C is $2.5 \times 10^{-12} \text{mol}^3 \text{dm}^{-9}$. What is the solubility of silver chromate at 20°C (03marks)

iii) State two applications of solubility product. (01mark)

8. Soap can be prepared from a vegetable oil or an animal fat.

i) Giving two examples in each case, distinguish between a vegetable oil and an animal fat.

(03 marks)

ii) Describe how solid soap can be prepared in the laboratory starting from a named vegetable oil (equation that leads to formation of soap required)

(06 marks)

b) i) Distinguish between soap and a non-soapy detergent.

(02 mark)

ii) Starting from benzene, describe how you would prepare a non-soapy detergent (equations required)

(04 marks)

c) i) Describe one disadvantage of using non-soapy detergents.

(02marks)

ii) A sample of soap was prepared from 9.5g of a vegetable oil containing the ester of hexadecanoic acid ($C_{15}H_{31}COOH$). Calculate the mass of soap formed.

(03marks)

THE END