

P525/2

CHEMISTRY

Paper 2



2 ½ hours

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 any **two** questions 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.

[C = 12, H = 1, 1 mol of a gas occupies 22.4 dm³ at s.t.p.]

SECTION A:

Answer **THREE** questions from this section

1. (a) 0.98g of a cyclic organic compound **Q** on complete combustion yielded 2.64g of carbon dioxide and 0.90g of water. Determine the empirical formula of **Q**. (03 marks)
- (b) When **Q** was distilled in steam, the distillation took place at 98.5°C and standard pressure. The distillate was found to contain 0.60g water and 14.88g of **Q**. [The vapour pressure of water at 98.5°C is 0.18 atm].
- (i) Determine the molecular formula of **Q**. (04 marks)
- (ii) **Q** had no effect on ammoniacal silver nitrate solution. Identify **Q**. (01 mark)
- (c) Write equation for the reaction between **Q** and semicarbazone in aqueous acidic medium. (05 marks)
- (d) Write equations to show how nylon 6,6 can be prepared from **Q**. (07 marks)
2. (a) Describe how you would determine the standard enthalpy of combustion of copper. (07 marks)
- (b) Some thermo chemical data for copper, copper(I)oxide and oxygen is given below:
- Sublimation of copper = $339.3 \text{ kJ mol}^{-1}$
- Enthalpy of formation of copper(I)oxide = $-166.7 \text{ kJ mol}^{-1}$
- Bond dissociation energy of oxygen = $498.4 \text{ kJ mol}^{-1}$
- First ionization energy of copper = 750 kJ mol^{-1}
- First electron affinity of oxygen = $-141.4 \text{ kJ mol}^{-1}$
- Second ionization energy of copper = 1958 kJ mol^{-1}
- Second electron affinity of oxygen = $+790.8 \text{ kJ mol}^{-1}$
- (i) Draw an energy level diagram for the combustion of copper to copper(I)oxide using the enthalpy data given. (03 marks)

- (ii) Calculate the lattice energy for copper(I)oxide.
(02 marks)
- (iii) Determine the lattice energy for copper(II)oxide and comment on the stability of copper(I)oxide and copper(II)oxide. (04 marks)
- (c) (i) Define the term bond energy.
(01 mark)
- (ii) The standard enthalpies of atomization of hydrogen, chlorine and graphite are 434.7, 246.6 and 714.8KJmol⁻¹ respectively. Calculate the standard enthalpy of chloromethane if the C - Cl and C - H bond energies are 334.4 and 412.6 KJmol⁻¹ respectively. (03 marks)

3. Carbon, silicon, tin and lead belong to group IV of the periodic table.

- (a) (i) Write the formulae of the oxides of the elements in the +4 oxidation state.
(02 marks)
- (ii) State the trend in the acidic nature of the oxides you have written in
(01 mark)
- (b) Discuss the reaction of the oxides in (a) (i) with;
 - (i) Sodium hydroxide
(05 marks)
 - (ii) Mineral acids
(05 marks)
- (c) Write equation for the reaction to show how lead (IV)oxide can be prepared from;
 - (i) Lead(II) nitrate solution. (1½ marks)
 - (ii) Trilead tetraoxide. (1½ marks)
- (d) Sulphur dioxide gas was passed over heated lead(IV)oxide.
 - (i) State what was observed. (1½ marks)
 - (ii) Explain your observation (1½ marks)

4. (a) Explain the following observations:

- (i) When few drops of sodium hydroxide solution were added to calcium nitrate solution, a white precipitate was formed but when few drops of ammonia solution are added no precipitate was formed. *(04 marks)*
- (ii) During the titration of ammonia solution with hydrochloric acid methyl orange indicator was used instead of phenolphthalein indicator. *(03 marks)*
- (iii) A mixture of water and carbon tetrachloride boils at a temperature considerably below the boiling point of either liquid. *(04 marks)*
- (b) Chromium sulphate was dissolved in water to form an aqueous solution. To the solution was added sodium hydroxide solution drop wise until in excess followed by hydrogen peroxide.
 - (i) State what was observed. *(1½ marks)*
 - (ii) Write equations(s) for the reactions that took place. *(3½ marks)*
- (c) The resultant solution (b) was gently warmed and then acidified with dilute sulphuric acid.
 - (i) State what was observed. *(01 mark)*
 - (ii) Write equation(s) for the reaction that took place. *(03 marks)*

SECTION B:

*Answer **TWO** questions from this section*

5. Explain the following observations; write equations where necessary.
 - (a) An aqueous solution of ammonium sulphate turns blue litmus red where as an aqueous solution of potassium sulphite turns red litmus blue. *(04 marks)*
 - (b) When excess sodium hydroxide solution is added to chromium(III) sulphate solution, a green gelatinous precipitate is formed which dissolves to form a green solution. The green solution turn yellow when hydrogen peroxide is added to it, the yellow solution forms a yellow

precipitate with lead nitrate solution.

(06 marks)

- (c) Methanoic acid reacts with ammoniacal silver nitrate whereas ethanoic acid does not.

(04 marks)

- (d) When pure hydrogen chloride is analyzed in a mass spectrometer, peaks corresponding to molecular ion with masses 36, 37, 38 and 39 are obtained.

(04 marks)

- (e) Alcohols have higher boiling points than alkanes of approximately the same molecular mass.

(02 marks)

6. (a) Explain what is meant by the term **order of a reaction**.

(03 marks)

- (b) Describe an experiment that can be carried out to show that the decomposition of hydrogen peroxide solution follows first order kinetics. *(08 marks)*

- (c) The iodination of propanone in acidic solution takes place according to the equation;



The rate of the reaction was followed by withdrawing 10 cm³ samples from the reaction mixture, quenching and titrating against standard sodium thiosulphate solution. The following results were obtained.

Time (min)	0	10	20	30	40
Vol. of Na ₂ S ₂ O ₃ (aq) (cm ³)	8.0	6.5	5.0	3.5	2.0

- (i) Plot a graph of volume of sodium thiosulphate used against time.

(03 marks)

- (ii) What is the order of the reaction with respect to iodine? Explain your answer.

(03 marks)

- (iii) Write an expression for the rate of the reaction if the reaction is first order over all.

(01 mark)

- (iv) What would be the effect on the gradient of your graph of doubling the initial concentration of iodine. Give a reason for your answer.

(02
marks)

7. (a) When small quantities of sodium hydroxide solution or hydrochloric acid were added to a solution containing ethylamine and ethylamine hydrochloride, the pH of the solution remained almost constant. Explain this observation.

(07 marks)

- (b) 20.0 cm³ of 0.1M hydrochloric acid were added to aqueous ethylamine and the pH of the resultant solution measured at intervals. The following results were obtained.

pH	11.68	11.33	10.73	9.14	6.02	2.23	1.95	1.70
Volume of HCl _(aq) added (cm ³)	2	4	10	19.5	20	22.5	25	30

- (i) Plot a graph of pH against volume of hydrochloric acid added.

(03
marks)

- (ii) Explain the shape of the graph.

(07 marks)

- (c) Use your graph to determine the ionization constant K_b for ethylamine.

(03
marks)

8. (a) 1.57 g of an organic compound **W** containing carbon, hydrogen and nitrogen only; on complete combustion yielded 3.64 g of carbon dioxide gas and

308.80 cm³ of nitrogen gas measured at s.t.p. Determine the empirical formula of **W**.

(04 marks)

- (b) When vapourized, 0.2 g of **W** occupied 87.52 cm³ measured at 100 kPa and 27°C.

- (i) Determine the molecular formula of **W**.

(03 marks)

- (ii) Write the structural formula and IUPAC names of all the possible isomers of **W**. (02 marks)
- (c) When **W** was reacted with sodium nitrite and dilute sulphuric acid, a yellow oil was formed.
- (i) Identify **W**. (01 mark)
- (ii) Write an equation for the reaction. (01 mark)
- (iii) Write equations to show how **W** can be synthesized from propan -1-ol. Indicate reagents and conditions for the reactions. (06 marks)

END