

P525/2  
Chemistry  
Paper 2  
July - August 2024  
2 ½ hours



UGANDA MUSLIM TEACHERS' ASSOCIATION

UMTA JOINT MOCK EXAMINATIONS 2024

UGANDA ADVANCED CERTIFICATE OF EDUCATION

Chemistry

Paper 2

2 hours 30 minutes

### INSTRUCTIONS TO THE CANDIDATES

- *This paper consists of two Sections A and B.*
- *Attempt five questions including three from Section A and any two from Section B.*
- *Answers to the question must be on the answer sheets provided.*
- *Begin each question on a fresh page*
- *Extra question(s) attempted will not be marked*
- *Mathematical tables and graph papers are provided.*
- *Non-programmable scientific electronic calculators may be used.*
- *Use equations where necessary to illustrate your answers.*

$$(H = 1; C = 12; O = 16)$$

$$\text{Molar gas volume} = 22.4 \text{ dm}^3 \text{ at s.t.p}$$

$$1 \text{ atmosphere} = 101325 \text{ Nm}^{-2}$$

For Examiners Use Only						
Question						Total
Marks						

## SECTION A

*Answer three questions from this section.*

1. (a) Define the terms;

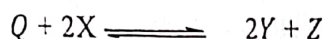
(i) activation energy

(01 mark)

(ii) molecularity

(01 mark)

(b) Q and X react to form Y and Z according to the equation;



The enthalpy change for the above reaction is  $-50\text{kJmol}^{-1}$  and activation energy of forward reaction is  $+250\text{kJmol}^{-1}$ .

(i) Draw a well labelled energy diagram for the reaction.

(03 marks)

(ii) Calculate the activation energy for the backward reaction.

(01 mark)

(c) For the reaction in (b) above, draw a sketch graph to show the change in concentration of Y with time at two temperatures  $T_1$  and  $T_2$  where  $T_1 > T_2$

(2 ½ marks)

(d) Propanone reacts with iodine in the presence of an acid catalyst according to the equation;



Describe an experiment to show that the order of reaction with respect to iodine is zero.

(06 marks)

(e) The following experimental data was obtained about the rate of the reaction in (c) above.

Experiment No.	$[\text{CH}_3\text{COCH}_3]$	$[\text{H}^+]$	$[\text{I}_2]$	Rate ( $\text{mol}^{-1}\text{s}^{-1}$ )
1	0.60	0.50	0.02	$9.0 \times 10^{-5}$
2	0.80	0.50	0.04	$1.2 \times 10^{-4}$
3	0.60	1.00	0.02	$1.8 \times 10^{-4}$
4	0.80	1.00	0.02	$2.4 \times 10^{-4}$

(i) Determine the order of reaction. Explain your answer.

(3 ½ marks)

(ii) Write the rate equation.

(½ mark)

(iii) Calculate the rate constant.

(1 ½ marks)



2. The elements aluminium, silicon, phosphorus, sulphur and chlorine belong to Period 3 of the Periodic Table. The table below shows the melting points of the above elements and the values of their first electron affinities.

Element	Al	Si	P	S	Cl
Atomic number	13	14	15	16	17
Melting point ( $^{\circ}\text{C}$ )	660.3	1414	44.2	115.2	-101.5
First electron affinity ( $\text{kJmol}^{-1}$ )	-44	-135	-72	-200	-364

- (a) State and explain the trend in melting points of the elements. (05 marks)
- (b) (i) Plot a graph of first electron affinity of the elements against atomic number. (03 marks)  
(ii) Explain the general trend in first electron affinity using the graph in b (i) above. (2½ marks)
- (c) Describe the reactions of the elements with hot concentrated sodiumhydroxide. (05 marks)
- (d) Write the ;  
(i) formula of the hydride formed by each of the elements above. (2½ marks)  
(ii) equations for the reaction for each of the hydrides in d (i) above with water. (02 marks)
3. An organic compound G, contains 31.4% oxygen and 9.8% hydrogen. When  $29.58\text{cm}^3$  of G was dissolved in  $520\text{cm}^3$  of ether, the solution boiled at  $307.849\text{K}$ .
- (a) Determine the;  
(i) empirical formula of G. (02 marks)  
(ii) molecular formula of G. (4 ½ marks)
- (Assume that the density of G= density of water =  $1\text{gcm}^{-3}$ , Ebullioscopic constant for ether =  $2.02\text{Kmol}^{-1}\text{kg}^{-1}$ , boiling point of pure ether =  $34.6^{\circ}\text{C}$ )
- (b) G gives no bubbles of gas with an aqueous solution of sodium hydrogen carbonate but can react with dilute sulphuric acid on heating to form a mixture of products.
- (i) Write the structural formula and names of possible isomers of G. (04 marks)  
(ii) If the products of the reaction in (b) above are 2-methylpropan-1-ol and methanoic acid, identify G, hence outline mechanism for the reaction of G with dilute sulphuric acid. (4 ½ marks)

(c) Using equations only, show how G;

(4 ½ marks)

(i) can be synthesized from 2 – methylpropan -2 -ol.

(01 mark)

(ii) reacts with an ethereal solution of lithium tetrahydridoaluminate.

4. (a) The table below shows the pH of the solution when measured volumes of hydrochloric acid is added to 25cm<sup>3</sup> of 0.1M ammonia solution.

Volume of hydrochloric acid (cm <sup>3</sup> )	0	10.0	15.0	16.5	17.0	20.0	25.0
pH of solution	10.25	9.08	8.30	6.70	2.97	1.96	1.60

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

(03 marks)

(ii) Explain the shape of the graph.

(04 marks)

(b) Using the graph in (a) above, calculate the:

(i) molarity of hydrochloric acid.

(1 ½ marks)

(ii) ionisation constant,  $K_b$  of ammonia.

(2 ½ marks)

(iii) Concentration of ammonium chloride formed.

(02 marks)

(iv) hydrolysis constant of ammonium chloride.

(03 marks)

(c) Calculate the pH of the solution formed when 5cm<sup>3</sup> of 0.1M hydrochloric acid is added to 25cm<sup>3</sup> of 0.1M ammonia solution.

( $K_b = 1.8 \times 10^{-5}$  and  $K_w = 1 \times 10^{-14}$  at 25°C) .

(04 marks)

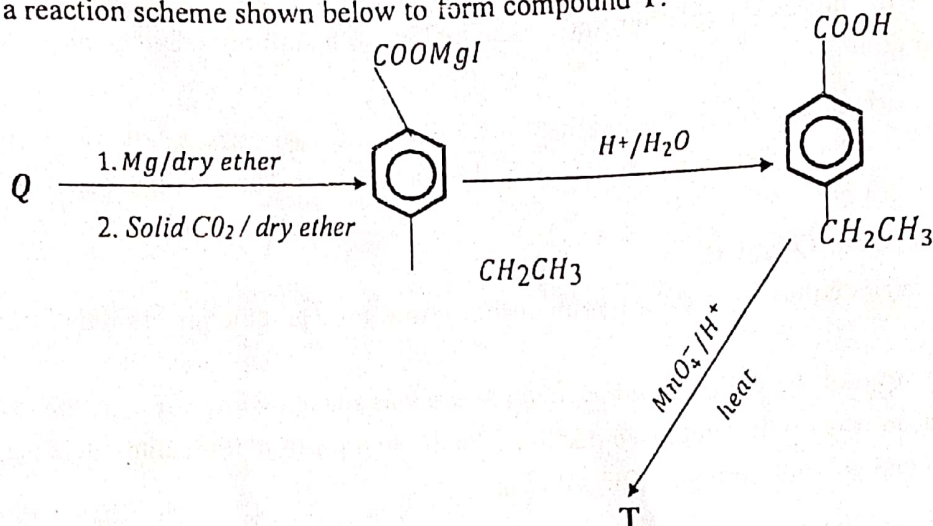
## SECTION B

*Answer two questions from this section.*

5. (a) Chromium ( $\text{Cr} = 24$ ) and manganese ( $\text{Mn} = 25$ ) are both d-block and transition elements. Explain this statement. (2 ½ marks)
- (b) State the possible oxidation states exhibited by both chromium and manganese in their compounds. (1 ½ marks)
- (c) An oxide of chromium Q, and that of manganese, R, were separately fused with potassium hydroxide in presence of oxygen to form a yellow solid and a green solid respectively.
- (i) Identify Q and R. (01 mark)
- (ii) Write equations for formation of the yellow solid and the green solid respectively. (02 marks)
- (d) A sample of the yellow solid in (c) (i) above was shaken with water and the resultant solution was divided into two portions. To the first portion dilute nitric acid was added followed by sodium hydroxide solution.
- (i) State what was observed and write equation(s) for the reaction(s) that took place on treatment of the first portion as stated above. (2½ marks)
- (ii) To the second portion barium nitrate solution was added followed by dilute nitric acid. Write equation(s) for the reaction(s) that took place. (02 marks)
- (e) R was dissolved in carbonated water, the mixture boiled and filtered. The residue was dried.
- (i) State what was observed after dissolution and boiling the mixture. (1½ marks)
- (ii) Write equation for the reaction that took place. (1½ marks)
- (f) State one application of the residue from (e) above as;
- (i) a reagent in organic synthesis. (01 mark)
- (ii) a catalyst (01 mark)
- (g) State one reagent that can be used to distinguish the following pairs of ions in aqueous solution. State what is observed in each case.
- (i)  $\text{Cr}^{3+}$  and  $\text{Mn}^{2+}$  (1½ marks)
- (ii)  $\text{MnO}_4^-$  and  $\text{MnO}_4^{2-}$  (1½ marks)



6. An organic compound with molecular formula;  $C_8H_{10}$ , has three isomers P, Q and R which all burn with a sooty flame. When each of the isomers was separately treated with hot aqueous sodium hydroxide solution followed by dilute nitric acid and then silver nitrate solution, P and Q gave no observable change whereas R formed a yellow precipitate. Q can undergo a reaction scheme shown below to form compound T.



- (a) Identify P, Q, R and T. (04 marks)
- (b) Explain the differences in reactivity of the isomers in P, Q and R above with the reagent used. (4½ marks)
- (c) Write equation(s) to show how;
- R can be converted to 3-phenylpropene. (3½ marks)
  - T can be converted to Dacron. (01 mark)
  - P can be converted to phenylethane. (04 marks)
- (d) Outline mechanism for the reaction between R and an aqueous solution of phenol in sodium hydroxide. (03 marks)

7. Explain each of the following observations.

- (a) Hydrogen fluoride is a liquid at room temperature while hydrogen chloride is a gas at room temperature. (03 marks)
- (b) Pure hydrogen bromide is not readily obtained by action of concentrated Sulphuric acid on sodium bromide. (04 marks)
- (c) When aqueous ammonia was added to Nickel (II) sulphate solution, a pale green precipitate was formed which dissolved in excess to form a blue solution. (04 marks)

(d) Diethyl ether boils at  $35^{\circ}\text{C}$  whereas butan-1-ol boils at  $124^{\circ}\text{C}$  yet the two compounds have the same molecular mass. (04 marks)

(e) Ethene undergoes electrophilic addition reactions whereas ethanal undergoes nucleophilic addition reactions. (05 marks)

8. (a) Define the terms:

(i) molar conductivity

(ii) electrolytic conductivity

(iii) conductance

(03 marks)

(b) The table below shows the molar conductivities of aqueous potassium hydroxide at given dilutions.

Dilution( $\text{mol}^{-1}\text{dm}^3$ )	100	25	11.11	6.25	4.0	2.8
Molar conductivity( $\text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$ )	239	228	224	215	210	201

(i) Plot a graph of molar conductivity against dilution. (03 marks)

(ii) Use the graph to determine the molar conductivity of potassium hydroxide at infinite dilution. (01 mark)

(iii) Explain the shape of the graph. (04 marks)

(c) (i) Draw a sketch graph to show the change in the conductivity with volume of aqueous sodium hydroxide when  $25\text{cm}^3$  of a  $0.1\text{M}$  propanoic acid is titrated with  $0.1\text{M}$  sodium hydroxide solution. (02 marks)

(ii) Explain the shape of the graph. (03 marks)

(d) The conductivity of a saturated solution of silver phosphate at  $25^{\circ}\text{C}$  is  $2.65 \times 10^{-6}\text{ohm}^{-1}\text{cm}^{-1}$  and that of pure water is  $1.52 \times 10^{-6}\text{ohm}^{-1}\text{cm}^{-1}$ . If the molar ionic conductivities of phosphate ions and silver ions are  $240$  and  $62\text{ohm}^{-1}\text{cm}^2\text{mol}^{-1}$  at infinite dilution at  $25^{\circ}\text{C}$  respectively, calculate the:

(i) solubility of silver phosphate at  $25^{\circ}\text{C}$ .

(ii) solubility product of silver phosphate at  $25^{\circ}\text{C}$  and give its units.

END

# CORRIGENDUM

## P525/2 Chemistry

### Question 3

An organic compound **G**, contains 31.4% oxygen and 9.8% hydrogen. When  $29.58\text{cm}^3$  of **G** was dissolved in  $520\text{cm}^3$  of ether, the solution boiled at  $307.849\text{K}$ .

(a) Determine the;

(i) empirical formula of **G**. (02 marks)

(ii) molecular formula of **G**. (4 ½ marks)

(Assume that the density of **G** = density of water =  $1\text{gcm}^{-3}$ , Ebullioscopic constant for ether =  $0.446\text{Kmol}^{-1}\text{kg}^{-1}$ , boiling point of pure ether =  $34.6^\circ\text{C}$ )

(b) **G** gives no bubbles of gas with an aqueous solution of sodium hydrogen carbonate but can react with dilute sulphuric acid on heating to form a mixture of products.

(i) Write the structural formula and names of possible isomers of **G**. (04 marks)

(ii) If the products of the reaction in (b) above are 2-methylpropan-1-ol and methanoic acid, identify **G**, hence outline mechanism for the reaction of **G** with dilute sulphuric acid (4 ½ marks)

(c) Using equations only, show how **G**;

(i) can be synthesized from 2-methylpropan-2-ol. (4 ½ marks)

(ii) reacts with an ethereal solution of lithium tetrahydridoaluminate. (01 mark)

END