P525/2
CHEMISTRY
PAPER 2
JULY/AUGUST 2024
2½ Hours

KYENJOJO JOINT EXAMINATIONS BOARD
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ASSHU – KYENJOJO JOINT MOCK EXAMINATIONS 2024

Uganda Advanced Certificate of Education

CHEMISTRY

(Theory)

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, N = 14]

SECTION A (60 MARKS))

Answer **three** *questions from this section.*

Extra question(s) will **not** *be marked.*

1. a) i) State and briefly explain **three** factors that affect equilibrium vapour pressure when a liquid is heated. (4½ marks)

ii) Explain the effect on vapour pressure above a liquid when a non-volatile solute is added to the liquid. (4½ marks)

iii) Without using a diagram, describe an experiment that can be carried out to determine relative molecular mass of a substance, **Q**, by boiling point elevation method. (6½ marks)

iv) A solution of 14g of **Q** in 100g of water boiled at 100.2^0C at normal pressure. Calculate the relative molecular mass of **Q**. (The boiling point elevation constant for water is 0.52^0C per mole per 1000g). (4 marks)

b) Apart from boiling point elevation method, state any other method that can be used to determine relative molecular mass of a substance. (½ mark)

2. An organic compound, **W**, contains 2.868g of carbon, 0.281g of hydrogen and 0.56g of nitrogen. 0.0076g of **W** at 27^0C and $1.02 \times 10^5 Nm^{-2}$ pressure occupies $2cm^3$.

a) i) Determine the empirical formula of **W**. (2½ marks)

ii) Calculate the molecular mass of **W** and determine its molecular formula. (4 marks)

b) Sodium nitrite in dilute nitrous acid was added to **W** at 3^0C to form compound **X**. Alkaline phenol was added to cold **X** to form compound **Y**.

i) Show the steps leading to formation of **Y** from **W** (Use actual structural formulae of organic compounds involved). (2 marks)

ii) Show the steps leading to formation of **Y** from **W**. (Use actual structural formulae of organic compounds involved) (1 mark)

iii) State what is observed when **Y** is obtained from **X**. (1 mark)

c) i) Outline a mechanism for the reaction between **W** and propanal. (3½ marks)

ii) State and explain the order of basicity of **W**, ammonia and methylamine. (5 marks)

d) Write equation for reaction between **W** and water. (1½ mark)

3. An aqueous solution containing 68% by mass of nitric acid boils at 120.5^0C. At the same atmospheric pressure, pure water boils at 100^0C while pure nitric acid boils at 86^0C.

a) i) Sketch a boiling point composition diagram for the water-nitric acid system.

(2½ marks)

ii) Describe what happens when an aqueous solution containing 50% nitric acid is fractionally distilled. (4 marks)

iii) Explain why a mixture of nitric acid and water shows this behavior. (6 marks)

b) Using equations only, show how nitric acid can be obtained on industrial scale.

(4½ marks)

c) Concentrated nitric acid contains 69% by mass of the acid. Calculate the molarity of concentrated nitric acid. (Density of concentrated nitric acid = $1.41 gcm^{-3}$). (3 marks)

4. a) i) What is meant by the term *first ionisation energy?* (2½ marks)

ii) The first ionisation energies of period 3 elements are given in the table below.

Element	**Na**	**Mg**	**Al**	**Si**	**P**	**S**	**Cl**
First ionization energy ($kJmol^{-1}$)	496	738	578	789	1012	1000	1251
Atomic number	11	12	13	14	15	16	17

Plot a graph of first ionisation energy of the elements against atomic number **and** explain the shape of the graph. (8½ marks)

iii) State and explain **three** factors that influence ionization energy of an atom. (4½ marks)

b) Write equation for the reaction between water and:

i) silicon (IV) chloride. (1½ mark)

ii) phosphorus trichloride. (1½ mark)

c) Write equation for the reaction that occurs when zinc powder is added to the resultant mixture in (b)(i) above. (1½ mark)

SECTION B (40 MARKS)

Answer **two** *questions in this section.*

Extra question(s) will **not** *be marked.*

5. Hydrogen iodide gas decomposes to form an equilibrium mixture of hydrogen gas and iodine gas at 440^0C. At this temperature, equilibrium constant, $\mathbf{K_c}$, for the reaction is 0.02.

a) i) Write equation for the reaction and expression for the equilibrium constant, $\mathbf{K_c}$.

(2½ marks)

ii) 2 moles of hydrogen and 1 mole of iodine were mixed together in a 1.0dm^3 vessel at 440^0C. Calculate the number of moles of iodine that reacted. (3 marks)

iii) Describe how equilibrium constant, Kc, for formation of hydrogen iodide gas from iodine and hydrogen can be determined by a titrimetric method. (5 marks)

b) What is the significance of each of the following in rates of reactions?

i) Rate constant (2 marks)

ii) Activated state (2 marks)

c) Rate constant (k) for the decomposition of hydrogen iodide at different temperatures is given in the table below.

Rate constant, k (mol^{-1}dm^3 s^{-1})	**Temperature (K)**
3.75 x 10^{-9}	500
6.65 x 10^{-6}	600
1.15 x 10^{-3}	700
7.75 x 10^{-2}	800

i) Plot a graph of $\boldsymbol{ln}$ **k** against $\frac{\mathbf{1}}{\boldsymbol{T}}$. (3 marks)

ii) Use your graph to obtain the value of activation energy (Ea) for the decomposition of hydrogen iodide. (The gas constant, R = 8.3Jmol^{-1}K^{-1}) (2½ marks)

6. a) State and explain what is observed when:

i) Sodium sulphite solution is added so a solution of acidified potassium manganate(VII).

(4½ marks)

ii) Sodium hydroxide solution is added drop wise until in excess to a solution of chromium(III) chloride. (6½ marks)

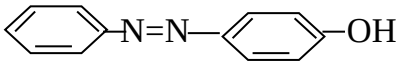
b) Describe an experiment that can be carried out to determine solubility product of chromium (III) hydroxide. (6½ marks)

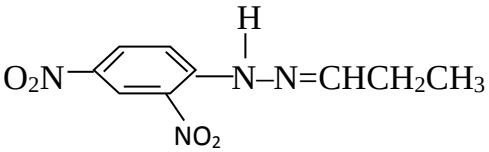
c) State what is observed and write equation for the reaction that occurs when warm hydrogen peroxide solution is added to a solution of chromium (III) ions to which sodium hydroxide solution has been added in excess. (2½ marks)

7. Write equations to show how each of the following compounds can be synthesised. In each case, indicate the reagents and conditions for the reaction.

a) $CH_3C(CH_3)=NOH$ from ethanol (5 marks)

b) But-2-yne from butan-2-ol (3½ marks)

c) Nitrobenzene to  (5½ marks)

d) $CH_3CH_2CH_2Br$ to  (4 marks)

e) Butane from ethanol (2 marks)

8. a) Explain the following observations:

i) Electrical conductivity of liquid magnesium oxide is good while that of solid magnesium oxide is poor. (3 marks)

ii) Melting point of magnesium oxide is considerably higher than that of sodium chloride. (3 marks)

iii) Melting point of Silicon(IV) oxide is much higher than that of carbon dioxide yet both are in group (IV) of the Periodic Table. (2½ marks)

b) Explain how atomic radii of group II elements vary down the group. (4 marks)

c) Explain how the reactions of magnesium oxide and barium oxide with dilute sulphuric are different. (6 marks)

d) Write equation for the reaction that occurs when sodium chromate(VI) solution is added to a solution of barium nitrate. (1½ mark)

END