P525/2
CHEMISTRY
Paper 2
July/August 2024
$2^{1}/_{2}$ hours

WAKISSHA JOINT MOCK EXAMINATIONS

Uganda Advanced Certificate of Education

CHEMISTRY

(Principal Subject)

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**.
- Write the answers in the answer booklet/sheets provided.
- **Begin each question on a fresh page.**
- Mathematical tables and graph papers are provided.
- Non programmable, silent scientific electronic calculators may be used.
- Illustrate your answers with equations where applicable.
- Where necessary use (C = 12, O = 16, H = 1, N = 14, Br = 80, Cl = 35.5, Sr. 87.6 Cr = 52, IF = 96500C)
- 1 mole of a gas at room temperature occupies 24 dm^3.

Turn Over

SECTION A

*Attempt only **three** questions from this section.*

*Any additional question answered will **not** be marked.*

1. (a) An organic compound **W** contains 70.59% by mass carbon, 5.88% by mass hydrogen and the rest being oxygen. The vapour density of **W** is 68.04 gcm^{-3} at room temperature.

(i) Calculate the empirical formula of **W** (03marks)

(ii) Determine the molecular formula of **W**. (02marks)

(b) When **W** was refluxed with dilute sodium hydroxide followed by acidification it yielded compound **X** , C_6H_6O and compound **Y** , $C_2H_4O_2$. Both **X** and **Y** liberate hydrogen gas when reacted with sodium metal. **Y** liberated carbon dioxide when treated with sodium carbonate while **X** did not. When **X** was completely hydrogenated in presence of nickel catalyst at 200 °C , compound **Z** , $C_6H_{12}O$ was formed.

(i) Identify **W** , **X** , **Y** and **Z** (02marks)

(ii) Write equation and suggest a mechanism for the reaction to show how **W** can be prepared in the laboratory. (04marks)

(c) Write the mechanism for the reaction between;

(i) X and 1-bromopropane in presence of sodium hydroxide solution. (2½marks)

(ii) **Z** and hot concentrated orthophosphoric acid. (3½marks)

(d) Name a **reagent** that can be used to distinguish between **X** and **Z** and state what would be observed when each compound was treated with the reagent.(03marks)

2. (a) Define the following terms:

(i) solubility product

(ii) common ion effect (02marks)

(b) Describe an experiment to determine the solubility product of strontium chromate by titrimetric method. (06marks)

(c) The solubility product of strontium chromate at 25 °C is $3.6x10^{-5}$ mol^2dm^{-6}. Calculate the solubility of strontium chromate in grams per dm^3;

(i) in pure water (02 marks)

(ii) in 0.15M sodium chromate solution. (03 marks)

(d) (i) Define the term **molar conductivity** (01 mark)

(ii) The molar conductivities at infinite dilution of silver ions and phosphate ions at 25 °C are 61.9 and 240 $\Omega^{-1}cm^2mol^{-1}$ respectively. The electrolytic conductivity of a saturated solution of silver phosphate is $2.7336 x10^{-6}$ $\Omega^{-1}cm^{-1}$ and that of pure water is $1.5916 x10^{-6}$ $\Omega^{-1}cm^{-1}$. Calculate the solubility product of silver phosphate at 25 °C and state its units. (4½marks)

(e) State **two** applications of common ion effect. (01mark)

3. Chromium, manganese, copper and zinc are d – block elements in the Periodic Table.

(a) (i) What is meant by the term **d- block element**? (01mark)

(ii) Write the electronic configuration of the elements. (Atomic numbers of chromium, manganese, copper and zinc are 24, 25, 29 and 30 respectively). (02marks)

(b) Zinc is a d- block element but it is **not** a typical transition element. State **two** properties in which zinc shows;

(i) similarity to the rest of d- block elements (01mark)

(ii) differences from the rest of the d- block elements. (01mark)

(c) Explain the following observations,

(i) when zinc metal was added to copper (II) sulphate solution, the blue solution turns colourless and reddish brown solid formed. (03marks)

(ii) when few drops of concentrated sodium carbonate solution were added to aqueous chromium (III) sulphate solution, grey green precipitate was formed and bubbles of a colourless gas were produced. (04marks)

(iii) When a mixture of hydrogen peroxide and hexahydroxo chromate(III) ions was warmed, the green solution turns to yellow. (03marks)

(d) State what would be observed and write equation for the reaction when;

(i) barium chloride solution was added to potassium chromate solution. (02marks)

(ii) dilute sulphuric acid was added to potassium manganate(VI) solution. (03marks)

4. (a) What is meant by the term **weak base**? (01mark)

(b) The base ionisation constant , K_b for dimethylamine , $(CH_3)_2NH$ is 5.9×10^{-4} moldm^{-3} at 25^{0}C and K_w for water is 1.0×10^{-14} mol^{2}dm^{-6}. at the same temperature

(i) Calculate the degree of ionisation of 0.025M dimethyl amine at 25 ^{0}C. (03marks)

(ii) Determine the pH of the solution in (b)(i) above. (02marks)

(c) 500 cm^3 of 0.1M dimethylammonium chloride $(CH_3)_2N^+H_2Cl^-$ was added to 500 cm^3 of solution in (b) above.

(i) Calculate the pH of the resultant mixture. (04marks)

(ii) Comment on the pH values in (b)(ii) and (c)(i). (04marks)

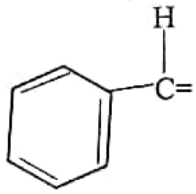
(d) (i) Sketch a graph of pH against volume of hydrochloric acid when 50 cm^3 of 0.025M dimethyl amine was titrated with 0.1M hydrochloric acid. (02marks)

(ii) Explain the shape of the graph in (d)(i) above. (04marks)

SECTION B (40marks)

Answer any two questions from this section

5. Using equations only show how the following conversions can be effected.

(a)  from benzoic acid. (05marks)

(b) 2,2- dichloropropane from propan- 1- ol. (05marks)

(c) cyclohexanone from benzene. (05marks)

(d) 2,2-diphenylpropane-1,3- dioic acid from benzoyl chloride. (05marks)

6. (a) What is meant by the term **standard enthalpy of displacement**? (01mark)

(b) The table shows the results of an investigation of the reaction of copper(II) sulphate solution with two divalent metals **X** and **Y**.

Time (minutes)	0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
Temperature of mixture of **X** and 50 cm^3 of 0.5M $CuSO_4$ (°C)	26.5	38.0	42.5	43.0	44.0	43.0	42.0	41.0
Temperature of mixture of **Y** and 50 cm^3 of 0.5M $CuSO_4$ (°C)	26.5	29.0	35.0	36.0	37.0	38.0	38.0	38.0

Turn Over

(i) On the same axes plot graphs of temperature against time for the two separate mixtures. (04marks)

(ii) From the graphs determine the maximum temperature attained by each mixture. (02marks)

(iii) Calculate the molar heat of displacement for each metal. (04marks)

(iv) Write equation for the reaction in each mixture. (02marks)

(v) What does 26.5 °C in the table represent? (0½mark)

(vi) Which of the metals is more reactive? Give a reason for your answer. (02marks)

(d) Calculate the Gibbs free energy for the cell formed between each metal and copper(II) sulphate solution. Given that the standard reduction potentials for the half cells are; X is -0.76V, Y is -0.44V and copper is +0.34V. (4½marks)

7. Explain the following observations

(a) Chlorine has two isotopes of mass numbers 35 and 37. However the mass spectrum of chlorine gas consists of three peaks at $\frac{m}{e}$ of 70, 72 and 74 (03marks)

(b) Benzene is inert towards bromine water whereas phenol readily reacts with it. (03marks)

(c) When sodium hydroxide solution was added to lead(II) nitrate solution, a white precipitate was formed which dissolved to form a colourless solution. (05marks)

(d) The Ka value of chloroethanoic acid is 1.4×10^{-3} moldm^{-3} whereas that of ethanoic acid is 1.74×10^{-5} moldm^{-3} at 25 °C. (04marks)

(e) When aqueous bromine was added to sodium thiosulphate solution, sodium sulphate was formed, however when aqueous iodine solution was used, sodium tetrathionate was formed. (05marks)

8. Siderite ore is one of the ores from which iron is extracted. It is roasted in air before it is fed into the blast furnace.

(a) Explain why siderite has to be roasted. Write equation for the reaction if any that takes place. (03marks)

(b) Name **two** major impurities in this ore and describe briefly how they are removed. Write equation(s) for the reactions leading to the removal of the impurities. (4½marks)

(c) Coke is one of the raw materials for the extraction of iron. It is allowed to react with hot air. The reaction liberates a lot of heat and this makes the temperature of the furnace to reach 170 °C.

(i) Briefly explain how this temperature is maintained in the blast furnace. (02marks)

(ii) Write equations leading to the formation of iron from the roasted ore. (4½marks)

(d) What name is given to the iron from the blast furnace and state why it has limited uses. (01mark)

(e) Discuss the reaction of iron with;

(i) dry oxygen

(ii) sulphuric acid

(iii) dry chlorine (05marks)

END