

P525/2
CHEMISTRY
Paper 2
July/August 2023
2½ 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, IF = 96500C)

SECTION A

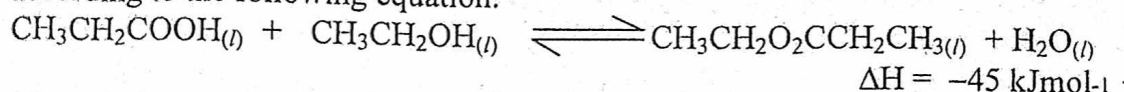
Attempt only three questions from this section.

1.
 - (a) What is meant by the term transition element? (01mark)
 - (b) One of the characteristics of transition elements is that of having variable oxidation states.
 - (i) Explain why transition elements have variable oxidation states. (02marks)
 - (ii) Write the possible stable oxidation states exhibited by chromium and manganese. (04marks)
 - (iii) Write the formulae of the oxides of chromium in the oxidation states in (ii) above. (1½marks)
 - (c) Write the equation for the reaction between the oxides of chromium and manganese in their highest oxidation states with;
 - (i) water. (02marks)
 - (ii) aqueous potassium hydroxide solution. (02marks)
 - (d) State what would be observed and write equation for the reaction when
 - (i) dilute sulphuric acid was added to potassium manganate(VI) solution. (2½marks)
 - (ii) sulphur dioxide was bubbled through acidified potassium dichromate solution (2½marks)
 - (iii) a solid mixture of chromium(III) oxide and sodium peroxide were fused. (2½marks)

2.
 - (a) Concentrated sulphuric acid was added to a mixture of benzene and concentrated nitric acid.
 - (i) State what was observed. (01mark)
 - (ii) Write the equation and suggest a mechanism for the reaction. (05marks)
 - (b) The main organic product in (a) was used in preparation of benzene diazonium chloride. Using equations, write the reaction scheme for the process. (05marks)
 - (c) State what was observed and write the equation for the reaction when benzene diazonium chloride was added to alkaline solution of;
 - (i) phenol (03marks)
 - (ii) naphthalen-2-ol (03marks)
 - (d) Without equations describe how benzene diazonium chloride and potassium cyanide can be used to prepare benzoic acid. (03marks)

3.
 - (a) State Raoult's law as applied to miscible liquids. (01mark)
 - (b)
 - (i) The saturated vapour pressures of pure propanone and pure trichloromethane at 25°C are 38.5 and 26.7 kNm⁻² respectively. Calculate the vapour pressure of the solution made by mixing 203 g of propanone and 179.5 g of trichloromethane at 25°C. (Assuming the solution obeys Raoult's law) (05marks)
 - (ii) If the vapour pressure of the solution in (i) above is 28.5 kNm⁻², state how the solution deviates from Raoult's law. (01mark)
 - (iii) Sketch a labelled boiling point – composition diagram for the mixture of propanone and trichloromethane. (Boiling points of propanone and trichloromethane are 56°C and 61°C respectively) (04marks)
 - (iv) Describe what would happen if a mixture of propanone and trichloromethane is fractionally distilled. (04marks)
 - (c)
 - (i) A hydrocarbon turpentine, C₁₀H₁₆, distills freely in steam at 95°C and at an external pressure of 101325 Pa. Calculate the vapour pressure of turpentine at 95°C if the distillate contained 45% water. (04marks)
 - (ii) Mention two ways by which turpentine in the distillate can be isolated. (02marks)

4. Ethanol and propanoic acid react reversibly and exothermically according to the following equation.



- (a) Write the expression for the equilibrium constant, K_c for the reaction. (01mark)
- (b) Describe an experiment that can be used to determine the equilibrium constant for the esterification reaction between ethanol and propanoic acid. (06marks)
- (c) State and explain how the equilibrium position and equilibrium constant would be affected if;
- temperature of the equilibrium mixture was increased. (03marks)
 - some little calcium carbonate powder was added to the equilibrium mixture. (02marks)
 - some anhydrous copper(II) sulphate powder was added to equilibrium mixture. (02marks)
- (d) 62.1 g of ethanol were mixed with 185 g of propanoic acid and the mixture allowed to reach equilibrium. Calculate the mass of the ethylpropanoate formed at equilibrium. (K_c for the esterification reaction = 4.00) (06marks)

SECTION B

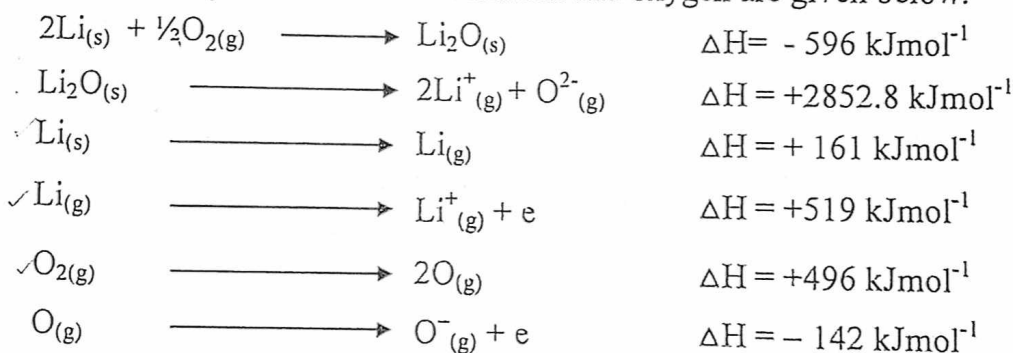
Attempt only two questions from this section.

5. (a) Explain what is meant by the term **first electron affinity**. (02marks)
- (b) The table below shows the first electron affinities of period 2 elements of the Periodic Table.

| Element | Li | Be | B | C | N | O | F |
|---|-----|-----|-----|------|----|------|------|
| Atomic number | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| First electron affinity (kJmol^{-1}) | -52 | +50 | -29 | -120 | -3 | -142 | -348 |

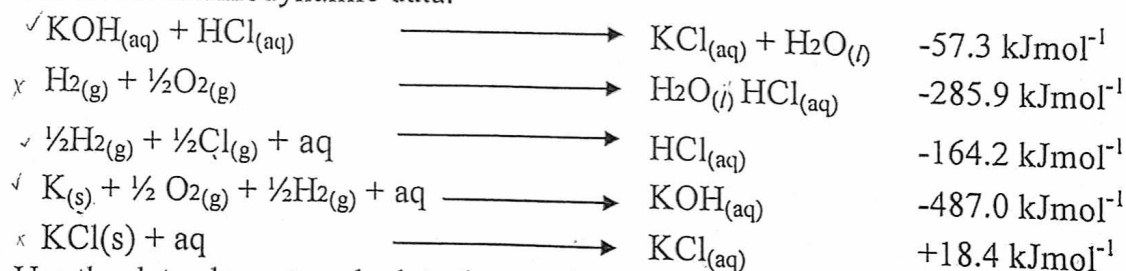
Explain the trend in the electron affinities of period 2 elements. (07marks)

- (c) The thermodynamic data about lithium and oxygen are given below.



- Draw an energy level diagram for the formation of lithium oxide. (04marks)
- Use your diagram in c(i) to calculate the second electron affinity of oxygen. (03marks)

- (d) Given the thermodynamic data.



Use the data above to calculate the standard enthalpy of formation of potassium chloride.

(04marks)
Turn Over

6. Organic compounds **P** and **Q** have the same molecular formula.
- (a) Write the structural formulae of the possible isomers of **P** and **Q**. (02marks)
- (b) When a mixture of sodium nitrite solution and concentrated hydrochloric acid was treated with both **P** and **Q** at 5°C , **P** formed yellow oily compound **R** while **Q** formed a colourless compound **S** together with a neutral gas **T**.
S was found to form two layers within 8 minutes when treated with anhydrous zinc chloride and concentrated hydrochloric acid.
- (i) Identify **P**, **Q**, **R**, **S** and **T**. (2½marks)
- (ii) Write equation for the reaction to show how;
 • **R** was formed (01mark)
 • **S** and **T** were formed. (01marks)
- (c) Write equation and suggest a mechanism for the reaction between;
 (i) **P** and ethanoyl chloride (3½marks)
 (ii) **Q** and bromoethane (03marks)
 (iii) **S** and ethanoic acid in the presence of concentrated sulphuric acid and the mixture heated. (4½marks)
- (d) **S** was warmed with acidified chromium trioxide solution.
 (i) State what was observed. (01mark)
 (ii) Write equation for the reaction and name the main organic product. (1½mark)
7. Explain the following observations.
- (a) Concentrated sulphuric acid cannot be used in the preparation of hydrogen iodide from potassium iodide. (05marks)
- (b) When dilute sulphuric acid was added to copper(I) oxide, the red solid turned brown and a blue solution was formed. (04marks)
- (c) When iron(III) chloride solution was added to sodium ethanoate solution, red-brown solution was formed which turned to reddish brown precipitate on heating. (04marks)
- (d) The boiling points of propylamine ($\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$) and trimethylamine ($(\text{CH}_3)_3\text{N}$) are 48.6 and 3.5°C respectively. (04marks)
- (e) Sulphurous acid is a weaker acid than sulphuric acid. (03marks)
8. (a) Write the formulae of the hydrides of period 3 elements of the Periodic Table. (3½marks)
- (b) Write equation to show how the hydrides of following elements are prepared in the laboratory.
 (i) sodium
 (ii) silicon
 (iii) sulphur. (4½marks)
- (c) Discuss the reactions of the hydrides in (b) with;
 (i) sodium hydroxide solution.
 (ii) concentrated sulphuric acid. (05marks)
- (d) State what would be observed and write equation for the reaction when the hydride of sulphur is burnt in;
 (i) limited air.
 (ii) excess air. (04marks)
- (e) Briefly describe a simple chemical test that can be carried out to show that sodium hydride is an ionic compound. (03marks)

END