

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)



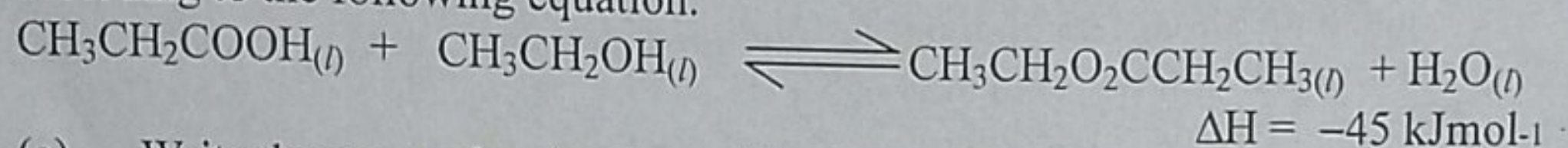
## SECTION A

*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<sup>-2</sup> 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<sup>-2</sup>, 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, C<sub>10</sub>H<sub>16</sub>, 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

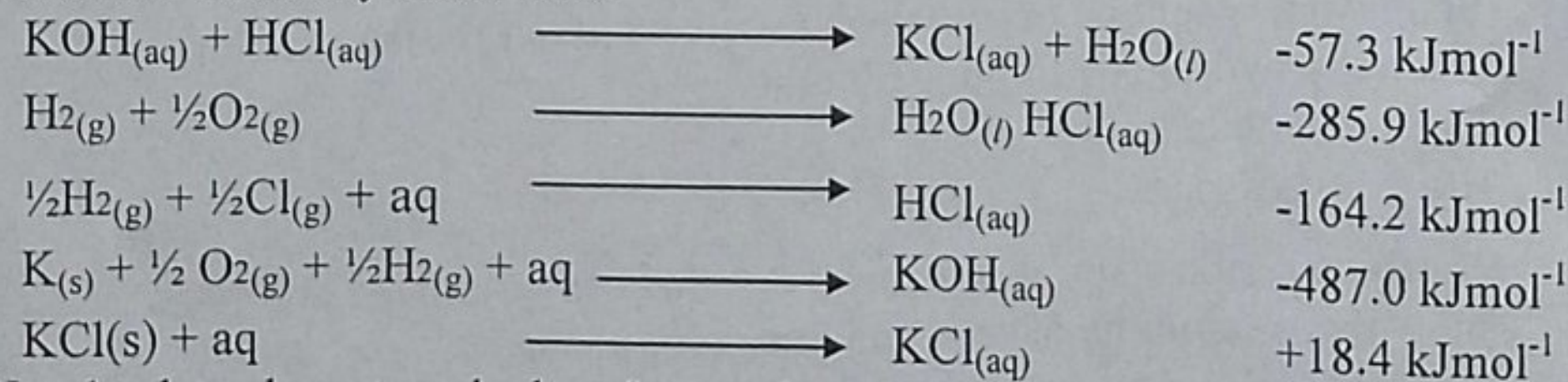
Attempt only *two* questions from this section.

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 ( $\text{kJmol}^{-1}$ )	-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.
- $$2\text{Li}_{(s)} + \frac{1}{2}\text{O}_{2(g)} \longrightarrow \text{Li}_2\text{O}_{(s)} \quad \Delta H = -596 \text{ kJmol}^{-1}$$
- $$\text{Li}_2\text{O}_{(s)} \longrightarrow 2\text{Li}^+_{(g)} + \text{O}^{2-}_{(g)} \quad \Delta H = +2852.8 \text{ kJmol}^{-1}$$
- $$\text{Li}_{(s)} \longrightarrow \text{Li}_{(g)} \quad \Delta H = +161 \text{ kJmol}^{-1}$$
- $$\text{Li}_{(g)} \longrightarrow \text{Li}^+_{(g)} + e \quad \Delta H = +519 \text{ kJmol}^{-1}$$
- $$\text{O}_{2(g)} \longrightarrow 2\text{O}_{(g)} \quad \Delta H = +496 \text{ kJmol}^{-1}$$
- $$\text{O}_{(g)} \longrightarrow \text{O}^-_{(g)} + e \quad \Delta H = -142 \text{ kJmol}^{-1}$$
- 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.
- Write the structural formulae of the possible isomers of **P** and **Q**. (02marks)
  - 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.
    - Identify **P**, **Q**, **R**, **S** and **T**. (2½marks)
    - Write equation for the reaction to show how;
      - R** was formed (01mark)
      - S** and **T** were formed. (01marks)
  - Write equation and suggest a mechanism for the reaction between;
    - P** and ethanoyl chloride (3½marks)
    - Q** and bromoethane (03marks)
    - S** and ethanoic acid in the presence of concentrated sulphuric acid and the mixture heated. (4½marks)
  - S** was warmed with acidified chromium trioxide solution.
    - State what was observed. (01mark)
    - Write equation for the reaction and name the main organic product. (1½mark)
7. Explain the following observations.
- Concentrated sulphuric acid cannot be used in the preparation of hydrogen iodide from potassium iodide. (05marks)
  - When dilute sulphuric acid was added to copper(I) oxide, the red solid turned brown and a blue solution was formed. (04marks)
  - 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)
  - 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)
  - Sulphurous acid is a weaker acid than sulphuric acid. (03marks)
8.
  - Write the formulae of the hydrides of period 3 elements of the Periodic Table. (3½marks)
  - Write equation to show how the hydrides of following elements are prepared in the laboratory.
    - sodium
    - silicon
    - sulphur. (4½marks)
  - Discuss the reactions of the hydrides in (b) with;
    - sodium hydroxide solution.
    - concentrated sulphuric acid. (05marks)
  - State what would be observed and write equation for the reaction when the hydride of sulphur is burnt in;
    - limited air.
    - excess air. (04marks)
  - Briefly describe a simple chemical test that can be carried out to show that sodium hydride is an ionic compound. (03marks)

END