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)

Turn Over

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 25^0C 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 25^0C. (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 $56\,^{o}C$ and $61\,^{o}C$ respectively)
      (iv) Describe what would happen if a mixture of propanone and trichloromethane is fractionally distilled. (04marks)
   (c) (i) A hydrocarbon turpentine , $C_{10}H_{16}$, distills freely in steam at $95^{o}C$ and at an external pressure of 101325 Pa. Calculate the vapour pressure of turpentine at $95^{o}C$ 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.

$$CH_3CH_2COOH_{(l)} + CH_3CH_2OH_{(l)} \rightleftharpoons CH_3CH_2O_2CCH_2CH_{3(l)} + H_2O_{(l)}$$
$$\Delta H = -45 \text{ kJmol}^{-1}$$

(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;

   (i) temperature of the equilibrium mixture was increased. (03marks)

   (ii) some little calcium carbonate powder was added to the equilibrium mixture. (02marks)

   (iii) 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.

$$2Li_{(s)} + \tfrac{1}{2}O_{2(g)} \longrightarrow Li_2O_{(s)} \qquad \Delta H = -596 \text{ kJmol}^{-1}$$
$$Li_2O_{(s)} \longrightarrow 2Li^+_{(g)} + O^{2-}_{(g)} \qquad \Delta H = +2852.8 \text{ kJmol}^{-1}$$
$$Li_{(s)} \longrightarrow Li_{(g)} \qquad \Delta H = +161 \text{ kJmol}^{-1}$$
$$Li_{(g)} \longrightarrow Li^+_{(g)} + e \qquad \Delta H = +519 \text{ kJmol}^{-1}$$
$$O_{2(g)} \longrightarrow 2O_{(g)} \qquad \Delta H = +496 \text{ kJmol}^{-1}$$
$$O_{(g)} \longrightarrow O^-_{(g)} + e \qquad \Delta H = -142 \text{ kJmol}^{-1}$$

   (i) Draw an energy level diagram for the formation of lithium oxide. (04marks)

   (ii) Use your diagram in c(i) to calculate the second electron affinity of oxygen. (03marks)

(d) Given the thermodynamic data.

$$KOH_{(aq)} + HCl_{(aq)} \longrightarrow KCl_{(aq)} + H_2O_{(l)} \qquad -57.3 \text{ kJmol}^{-1}$$
$$H_{2(g)} + \tfrac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)} HCl_{(aq)} \qquad -285.9 \text{ kJmol}^{-1}$$
$$\tfrac{1}{2}H_{2(g)} + \tfrac{1}{2}Cl_{(g)} + aq \longrightarrow HCl_{(aq)} \qquad -164.2 \text{ kJmol}^{-1}$$
$$K_{(s)} + \tfrac{1}{2}O_{2(g)} + \tfrac{1}{2}H_{2(g)} + aq \longrightarrow KOH_{(aq)} \qquad -487.0 \text{ kJmol}^{-1}$$
$$KCl(s) + aq \longrightarrow KCl_{(aq)} \qquad +18.4 \text{ kJmol}^{-1}$$

Use the data above to calculate the standard enthalpy of formation of potassium chloride. (04marks)

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 5^0C,
   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
   (ii) **Q** and bromoethane (3½marks)
   (iii) **S** and ethanoic acid in the presence of concentrated sulphuric acid and the mixture heated. (03marks)
   (d) **S** was warmed with acidified chromium trioxide solution. (4½marks)
   (i) State what was observed.
   (ii) Write equation for the reaction and name the main organic product. (01mark)

7. Explain the following observations. (1½mark)
   (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 ($CH_3CH_2CH_2NH_2$) and trimethylamine ((CH_3)$_3N$) are 48.6 and 3.5^0C 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