**Name:** ..... Sign: .....

P525/1

**CHEMISTRY**

(Theory)

**Paper 1**

July 2024

## UGANDA ADVANCED CERTIFICATE OF EDUCATION

S.5 E.O.T CHEMISTRY

**Paper 1**

2hours 45minutes

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**Instructions to Candidates:**

Answer **ALL** Questions in **Section A** and any **Six** Questions in **Section B. All Questions Must** Be Answered in the spaces provided.

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SECTION A (46 Marks)

**1.** a. $^{239}_{94}Pu + {}^{4}_{2}He \longrightarrow \ldots\ldots\ldots + 2{}^{1}_{0}n$ **[01 mark]**

b. $^{250}_{98}Cf + \ldots\ldots\ldots \longrightarrow {}^{257}_{103}Lw + 4{}^{1}_{0}n$ **[01 mark]**

c. $^{214}_{83}Bi \longrightarrow {}^{206}_{82}Pb + \ldots\ldots\ldots\ldots + 2{}^{4}_{2}He$ **[01 mark]**

d. 5.00g of thorium was left to decay. Calculate the mass of thorium that remained after $2.500 \times 10^{10}$ years. (***the half-life of thorium is $1.400 \times 10^{10}$***)

**[03 marks]**

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**2.** State what would be observed and write equation for the reaction that would take place when;

a. a solution of potassium carbonate is added to aqueous aluminium nitrate.
**[02½ marks]**

**observations:**

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**equation:**

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b. **a** mixture of acidified potassium manganate(VII) is added to hot ethane-1,2-dioic acid. **[02½ marks]**

**observations:**

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**equation:**

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**3.** A hydrocarbon **Q**, with molecular formula $C_xH_y$ reacts with oxygen according to the following equation.

$$C_xH_y + \frac{4x+y}{4}O_2 \longrightarrow xCO_2 + \frac{y}{2}H_2O$$

When $20cm^3$ of **Q** was exploded in $200cm^3$ of an excess amount of oxygen, it burnt completely with a sooty flame. The volume of the residual gas after cooling to room temperature was $160cm^3$. When aqueous potassium hydroxide was added, the gas that finally remained was $30cm^3$.

a. Determine the molecular formula of **Q**. **[02½ marks]**

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b. When **Q** was treated with bromine in the presence of anhydrous iron(III) chloride, the bromine was decolorized.

i. Identify **Q**. **[01 mark]**

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ii. Write the mechanism for the reaction that took place between bromine and compound **Q**. **[03½ marks]**

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**4.** The energy changes that takes place during the formation of barium chloride are shown in the table below:

| Process: | $\Delta H^{\theta}$ /Kj $mol^{-1}$ |
|---|---|
| $Ba(s) \xrightarrow{A} Ba(g)$ | +176.00 |
| $Ba(g) \xrightarrow{B} Ba^{2+}(g)$ | +1480.00 |
| $Cl_2(g) \xrightarrow{C} 2Cl(g)$ | +242.00 |
| $Cl(g) + e^- \xrightarrow{D} Cl^-(g)$ | -364.00 |
| $Ba^{2+}(g) + 2Cl^-(g) \xrightarrow{E} BaCl_2(s)$ | -2018.00 |

a. Name the energy changes for reaction processes: **[02½ marks]**

**A:** ……

**B:** ……

**C:** ……

**D:** ……

**E:** ……

b. Calculate the standard enthalpy of formation of barium chloride. **[02½marks]**

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**5.** Write equation for the reaction between aqueous sodium hydroxide and: -

a. Aluminium oxide. **[01½ marks]**

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b. Beryllium oxide. **[01½ marks]**

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c. Tin(II) oxide. **[01½ marks]**

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**6.** a. Define the term **freezing point constant** of a substance. **[01½ marks]**

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**b.** A solution containing 1.54g of naphthalene, $C_{10}H_8$ in 18.0g of camphor freezes at 148.3°C. Calculate the freezing point constant of camphor. ($K_f$ for camphor is 175°C) **[03 marks]**

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7. 2-bromobutane was treated with sodium ethoxide in ethanol and the mixture heated to form compound **T**.

   **a.** Write the equation and suggest a mechanism for the reaction between 2-bromobutane and ethoxide ion. **[02½ marks]**

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   **b.** The compound **T** formed in(a) can be synthesized from an alcohol. Write the equation and include a mechanism for the reaction leading to the formation of **T** from an alcohol. **[02½ marks]**

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8. **0.89g** of a copper ore was leached with dilute sulphuric acid and the resultant solution diluted to **250cm$^3$**. To 30cm$^3$ of this solution was added 10% potassium iodide solution. The liberated iodine required **23.5cm$^3$** of **0.05M** sodium thiosulphate solution for complete reaction. Calculate the percentage of copper in the ore. The reactions taking place are: - **[04½ marks]**

   $2Cu^{2+}(aq) + 4I^- \rightarrow Cu_2I_2(s) + I_2(aq)$

   $I_2(aq) + 2S_2O_3^{2-}(aq) \rightarrow 2I^-(aq) + S_4O_6^{2-}(aq)$

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**9.** Draw the structure and name the shape of the following anions. In each case, state the **oxidation state** of the chlorine atom. **[04½ marks]**

| Anion | Structure | Shape | Oxidation state of chlorine |
|---|---|---|---|
| $ClO_2^-$ | | | |
| $ClO_3^-$ | | | |
| $ClO_4^-$ | | | |

## SECTION B (54 Marks)

**Attempt ANY SIX Questions from this Section.**
**Additional Questions Shall not be marked.**

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**10.** Complete the following equations of reactions and in each case outline a mechanism for the reaction.

a) $CH_3CHO + NaHSO_3 \longrightarrow$ ..... **[03 marks]**

**Mechanism:**

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b) $CH_3CH{=}CH_2 \xrightarrow[\text{Warm}]{\text{Conc. } H_2SO_4/H_2O}$ ..... **[03 marks]**

**Mechanism:**

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c) $(CH_3)_3CBr \xrightarrow[\text{Heat}]{C_2H_5O^-Na^+/C_2H_5OH}$ ..... **[03 marks]**

**Mechanism:**

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**11. a.** Define the term **Standard enthalpy of formation.** **[01 mark]**

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**b.** Some thermochemical data for calcium, calcium chloride and chlorine are given below:

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|---|---|
| enthalpy of formation of calcium chloride | -763 $kJmol^{-1}$. |
| Enthalpy of atomization of chloride. | +121 $kJmol^{-1}$. |
| Enthalpy of atomization of calcium | +193 $kJmol^{-1}$. |
| First ionization energy of calcium | +590 $kJmol^{-1}$. |
| Second ionization energy of calcium. | +1145 $kJmol^{-1}$. |
| Electron affinity for chlorine. | -348 $kJmol^{-1}$. |

i. Draw an energy diagram for the formation of solid calcium chloride.
**[03 marks]**

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ii. **C**alculate the lattice energy of calcium chloride. **[01½ marks]**

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**c.** Calculate the enthalpy of solution of calcium chloride. **[02½ marks]**

**[Enthalpy of hydration of $Ca^{2+}$ and $Cl^-$ are -1689 and -383.7 $kJmol^{-1}$ respectively]**

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**d.** Comment on the solubility of calcium chloride. **[01 mark]**

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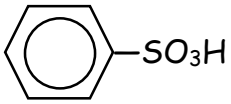
**12.** Write a mechanism to show how each of the following conversion can be effected.

a)  to  **[03 marks]**

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b) $(CH_3)_2C{=}CHCH_3$ to $(CH_3)_2\overset{\overset{OH}{|}}{C}CH_2CH_3$ **[02½ marks]**

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c) $CH_3C\equiv CH$ to $CH_3COCH_3$ **[03½ marks]**

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**13.** Beryllium and magnesium are elements in group (II) of the Periodic Table.

a) Explain the following:

i. The first ionization energy of beryllium is higher than that of magnesium. **[02 marks]**

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ii. **The** polarizing power of magnesium ions is lower than that of beryllium ions. **[01 mark]**

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b) Beryllium reacts with aqueous sodium hydroxide solution. Write equation for the reaction. **[01½ marks]**

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c) State the conditions under which beryllium oxide and magnesium oxide reacts with the following substances and where applicable, write equation(s) for the reaction(s).

i. Water. **[02 marks]**

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ii. Sodium hydroxide. **[02½ marks]**

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**14.** Potassium manganate(VII) is not used a primary standard in volumetric analysis and has to be standardized.

a. Explain why potassium manganate(VII) is not used as a primary standard. **[01 mark]**

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b. Explain why hydrochloric acid is not usually used to acidify solution of potassium manganate(VII) during volumetric analysis. **[01 mark]**

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c. Acidified potassium manganate(VII) reacts with ethane-1,2–dioic acid.

i. the half –reaction equations for the reaction. **[02 mark]**

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ii. the overall equation for the reaction. **[01½ mark]**

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d. 20.00cm$^3$ of a 0.01M manganate(VII) ion solution required exactly 16.55cm$^3$ of a solution containing 5.10g per liter of an ethanedioate, $(COO^-X^+)_2.2H_2O$. Determine the atomic mass of element **X**. **[03½ marks]**

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**15.** During the extraction of aluminum from bauxite, $Al_2O_3.2H_2O$, the ore is first purified.

a) Name **two** major impurities in the ore. **[01 mark]**

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b) Write equations to show how the ore is purified. **[06 marks]**

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c) Describe briefly how aluminium can be obtained after the ore has been purified. **[02 marks]**

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**16.** Name a reagent that can be used to distinguish between each of the following pairs of compounds/ ions. In each case state what would be observed if each member of the pair is treated with the reagent you have named.

a) $CH_3CH_2C\equiv CH$ and $CH_3CH_2CH=CH_2$ **[03 marks]**

i. **Reagent:**

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ii. **Observation:**

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b)  —Cl and $CH_3CH_2CH_2Cl$. **[03 marks]**

i. **Reagent:**

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**Observation:**

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c) $Ca^{2+}$ and $Ba^{2+}$ **[03 marks]**

ii. **Reagent:**

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iii. **Observation:**

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**17.** a. A compound **W** contains 37.3% manganese, 19.1% nitrogen, the rest being oxygen. Calculate the empirical formula of compound **W**. **[02½ marks]**
[Mn=54.9, N=14, O=16]

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b. 10.0g of compound **W** in 1000g of water lowered the freezing point of water by 0.127°C. Determine the molecular formula of **W**. **[02 marks]**

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**c. W**hen a few drops of concentrated nitric acid were added to a solution of **W**, followed by a little lead(IV) oxide and the mixture boiled, a purple coloured solution was formed. Write:

i. formula and name of **W**. **[01 mark]**

**formula:**

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**Name:**

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ii. **e**quation for the reaction leading to the formation of the purple coloured solution. **[01½ marks]**

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**e.** A few drops of aqueous sodium carbonate was added to a solution of **W**.

**i.** State was observed. **[01 mark]**

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**ii.** **W**rite an equation for the reaction that took place. **[01½ marks]**

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**END**

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