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

P525/1

CHEMISTRY

(Theory)

Paper 1

July 2024

UGANDA ADVANCED CERTIFICATE OF EDUCATION

S.5 MID TERM CHEMISTRY

Paper 1

2hours 45minutes

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.

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 2.500×10^{10} years. (***the half-life of thorium is 1.400×10^{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:	ΔH^{θ} /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:

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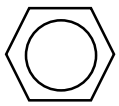
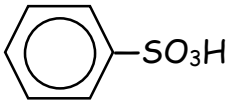
12. Write a mechanism to show how each of the following conversion can be effected.

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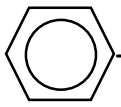
b)  —Cl and $CH_3CH_2CH_2Cl$. **[03 marks]**

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. When 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