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

P525/1

CHEMISTRY

(Theory)

Paper 1

July 2024

Uganda Advanced Certificate of Education

S.5 END OF TERM II CHEMISTRY EXAMINATION

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. $^{27}_{13}Al + {}^{4}_{2}He \longrightarrow$ ..... $+ {}^{1}_{0}n$ **[01 mark]**

b. $^{113}_{48}Cd + {}^{1}_{0}n \longrightarrow$ ..... $+ \gamma$ **[01 mark]**

c. $^{214}_{83}Bi \longrightarrow 3\beta +$ ..... $+ 2\alpha$ **[01 mark]**

d. When a radioactive isotope was stored for 420 days, it retained a eighth, ($\frac{1}{8}$) of its original activity. Calculate the half-life of the isotope. **[03½ marks]**

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2. a. State what would be observed and write equation for the reaction that would take place if a solution of potassium iodide was added to aqueous copper(II) sulphate. **[02½ marks]**

Observations:

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Equation:

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b. A few drops sodium thiosulphate solution was added to the mixture in(a) above. State what would be observed and write equation of reaction that took place. **[02½ marks]**

observations:

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equation:

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3. When a compound **W** was steam distilled at 86°C and 760mmHg pressure, the distillate was found to contain 85% of water by mass. Calculate the relative molecular mass of **W**. **(*the vapour pressure of water at 86°C is 740mmHg*)**

[04 marks]

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4. a. Write equation for the complete combustion of ethanal, CH_3CHO.

[01½ marks]

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b. The enthalpies of combustion of carbon, hydrogen and ethanal are -394, -286 and -1187 $kMol^{-1}$ respectively. Calculate the enthalpy of formation of ethanol **[04 marks]**

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5. Write equation for the reaction between: -

a. acidified potassium dichromate(VI) and sodium sulphite. **[01½ marks]**

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b. aqueous sodium hydroxide and beryllium **[01½ marks]**

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c. potassium chromate(VI) solution and barium chloride solution. **[01½ marks]**

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6. 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 $10cm^3$ of **Q** was exploded in $90cm^3$ of an excess amount of oxygen, it burnt completely. The volume of the residual gas after cooling to room temperature was $70cm^3$. When the residual gases were passed through potassium hydroxide solution, the volume reduced to $40cm^3$.

a. Determine the molecular formula of **Q**. **[03½ marks]**

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b. Write equations to show how **Q** can be synthesis from an alcohol.

[02½ marks]

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7. a. Define the term **Osmotic pressure** of a solution **[01 mark]**

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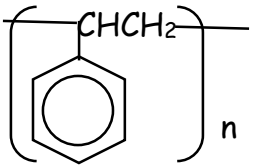
b. Polystyrene,  is formed by polymerization of phenylethene.

The osmotic pressure of a solution containing 5.5.g of polystyrene in 1.0dm^3 of benzene is 1.05 x 10^{-3} atmospheres at 20°C. (Given that R = 0.082atmK^{-1}mol^{-1})

i. Determine the molecular mass of polystyrene. **[03 marks]**

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ii. Determine the number of monomers that formed the polystyrene. **[01½ marks]**

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8. Write equations to show how the following compounds can be synthesized.

a. $CH_3C{\equiv}CH$ from 2-bromopropane. **[03½ marks]**

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b.  —CH_3 from benzene **[01marks]**

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9. **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 **23.50cm^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]**

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

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

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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) $CH_3CH_2Cl + HC\equiv C^-Na^+ \xrightarrow[\text{Dry ether}]{\text{Liq. } NH_3}$ ..... **[02 marks]**

Mechanism:

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b) $CH_3CH=CH_2 \xrightarrow[\text{Warm}]{\text{Bromine } /H_2O}$ ..... **[04 marks]**

Mechanism:

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c) $CH_3\underset{\underset{Br}{|}}{CH}-\overset{\overset{Br}{|}}{C}HCH_3 \xrightarrow[\text{Heat}]{C_2H_5O^-Na^+/C_2H_5OH}$ ..... **[03 marks]**

Mechanism:

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11. a. Draw the structure and name the shape of the following oxyanions. In each case, state the **oxidation state** of the sulphur atom. **[04½ marks]**

Oxyanion	Structure;	Shape	Oxidation state of sulphur
SO_3^{2-}			
SO_4^{2-}			

b. Explain the structure of the SO_3^{2-} ion. **[01½ marks]**

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c. Name the reagent(s) that can be used to distinguish between the oxyanions in(a) above. **[01 mark]**

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c. State what would be observed if each of the oxyanion is treated with the reagent(s) you have named in(b) above **01 mark]**

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d. Write the equation(s) for any reaction that would take place when a solution of each of the oxyanions is treated separately with the reagent(s) you have named in(c) above. **[01 marks]**

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12. A hydrocarbon **M** contains 85.7% carbon and has a density of $2.5gl^{-1}$ at s.t.p.

a) Calculate the empirical formula of **M.** **[02 marks]**

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b) Determine the molecular formula of **M.** **[02 marks]**

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c) Write the structural formulae of all the possible open chain isomers of **M.** **[01½ marks]**

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d) Ozonolysis of **M** and subsequent work-up gave one compound. Identify **M**. **[0½ mark]**

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d. Write an equation to show how **M** can be synthesized from butan-2-ol and indicate the mechanism for the reaction. **[03 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. Ammonium ferrous sulphate-hexahydrate, $(NH_4)_2SO_4FeSO_4.6H_2O$ is normally used to standardize a solution of potassium manganate(VII) solution acidified with using sulphuric acid.

a. Write equation for the reaction between potassium manganate(VII) and the iron(II) salt solution. **[01½ marks]**

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b. State why hydrochloric acid is not usually used to acidify solution of potassium manganate(VII) during volumetric analysis. **[02½ marks]**

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c. 25.00cm^3 of an acidified solution of a 0.02M manganate(VII) ion solution required exactly 26.55cm^3 of a solution containing 5.10g per liter of an impure sodium nitrite, **($NaNO_2$)**. Determine the percentage the nitrite in salt. [Na=23, N=14, O=16] **[05 marks]**

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15. a Write the formula and the name of **one** ore from which aluminium can be extracted. **[01 mark]**

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b. Name **two** main impurities in the ore you have named in(a) above. **[01 mark]**

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c. In the extraction of aluminium, after the removal of the impurities, the ore is mixed with cryolite and then electrolyzed to extract aluminium.

i. State the purpose of adding cryolite. **[01 mark]**

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ii. Name the electrode used in the electrolysis. **[0½ mark]**

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iii. Write equation for the reaction that took place when an electric current was passed through the molten electrolyte. **[01½ marks]**

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d. Aluminium powder was added to dilute sodium hydroxide solution.

i. State what was observed. **[01 marks]**

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ii. Write **equation** for the reaction that took place. **[01½ marks]**

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e. **A**luminium powder was mixed with trimanganese tetra oxide, Mn_3O_4 and the mixture heated. Write equation for the reaction that took place. **[01½ marks]**

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16. a. Define the term **Isotopes**. **[01 mark]**

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b. The table below shows the information from the mass spectrum of a lead sample.

Isotope	Detector current/mA
204	0.16
206	2.72
207	2.50
208	5.92

Calculate: -

i. relative abundance of the different isotopes of lead in the sample **[03 marks]**

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ii. **the** relative atomic mass of lead. **[01½ marks]**

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d. The initial counts of a radioactive nucleus was 680 per second. After 350 seconds, the count rate was 125 per second. Calculate the: -

i. Decay constant. **[02 marks]**

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ii. Half-life of the nucleus. **[01½marks]**

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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]**
[Kf for water =1.86°Cmol^{-1}kg^{-1}]

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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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