Candidates' Name: ……..... Signature: ……..

School: ……

P525/2
CHEMISTRY
Paper 2
July / Aug, 2024
2 ½ hours

EDUCAN EXAMINATIONS BOARD

Uganda Advanced Certificate of Education

CHEMISTRY

(THEORY)

Paper 2

2 Hours 30 Minutes

INSTRUCTIONS TO CANDIDATES:

*Attempt **five** questions including **three** from section **A** and any **two** questions from section **B**.*

Answers to the question must on the answer sheets provided

Begin each question on a fresh page. Extra questions attempt will not be marked.

Mathematical tables and graph papers are provided.

Non- programmable scientific electronic calculators may be used.

Use equations where necessary to illustrate your answers.

[H= 1 , C= 12 , O = 16 , F= 19.0]

SECTION A

*Answer any **three** questions from this section.*

1. (a) When 6.1g of an organic compound **P** was burnt completely in oxygen, 15.4g of carbon dioxide and 2.7g of water were formed. 0.252g of P when vaporized at 273°C and 2.15atmospheres, 43.04cm^3 of vapour was formed.

   (i) Calculate the empirical formula of **P.** *(3½ marks)*

   (ii) Determine the molecular formula of **P**. *(3½ marks)*

   (b) **P** burns with a sooty flame. Identify **P.** *(0½ mark)*

   (c) When **P** was treated with lithium tetrahydrido aluminate(III) in dry ethoxyethane, compound **Q** was formed. When **Q** was warmed with acidified solution of chromium trioxide, compound **R** was formed.

   (i) Identify **Q** and **R.** *(01mark)*

   (ii) Write equations leading to the formation of **Q** and **R.** *(02 marks)*

   (d) Write equation and suggest a mechanism for the reaction between

   (i) **Q** and propanoyl bromide. *(3½ marks)*

   (ii) **R** and 2,4-dinitrophenylhydrazine in acidic medium. *(4½ marks)*

   (e) Without using equations describe how **P** can be synthesized from benzene. *(2½ marks)*

2. Carbon, silicon, germanium, tin and lead are elements in group (IV) of the Periodic Table.

   (a) (i) State the oxidation states exhibited by the elements. *(01mark)*

   (ii) State how the oxidation states vary down the group. *(02 marks)*

   (b) Describe how these elements reaction with

   (i) bromine. *(04 marks)*

   (ii) concentrated nitric acid. *(05 marks)*

   (iii) cold soft water. *(2½ marks)*

(c) One of the oxides of lead is trileadtetraoxide, Pb_3O_4.

(i) Give the name of this type oxide of lead. *(0½ mark)*

(ii) State the reason why it is given such a name. *(01 mark)*

(iii) describe how this oxide of lead reacts with nitric acid and hydrochloric acid. *(04 marks)*

3. (a) State Raoult's law as applies to miscible liquids. *(01 mark)*

(b) The saturated vapour pressures of pure water and pure hydrofluoric acid at 20°C are $2.3kNm^{-2}$ and $10.90kNm^{-2}$ respectively. A liquid mixture was made by mixing 45g of water and 110g hydrofluoric acid at 20°C.

Calculate

(i) the vapour pressure of the solution at 20°C. *(05 marks)*

(ii) the composition of the vapour at 20°C. *(02 marks)*

(assuming the mixture obeys Raoult's law)

(c) The actual vapour pressure of the mixture in (b) above is $7.5kNm^{-2}$. State how the mixture deviates from Raoult's law. Explain your answer. *(03 marks)*

(d) (i) Sketch a well labelled boiling point – composition curve for the mixture in (b). *(03 marks)*

(ii) Explain the shape of the graph curve with reference to Raoult's law. *(05 marks)*

(e) Name **two** mixtures that behave in the same way as that in (b) above. *(01 mark)*

4. (a) Define the following terms

(i) Standard enthalpy change for the reaction. *(01mark)*

(ii) Standard enthalpy of formation . *(01mark)*

(iii) Standard enthalpy of combustion. *(01 mark)*

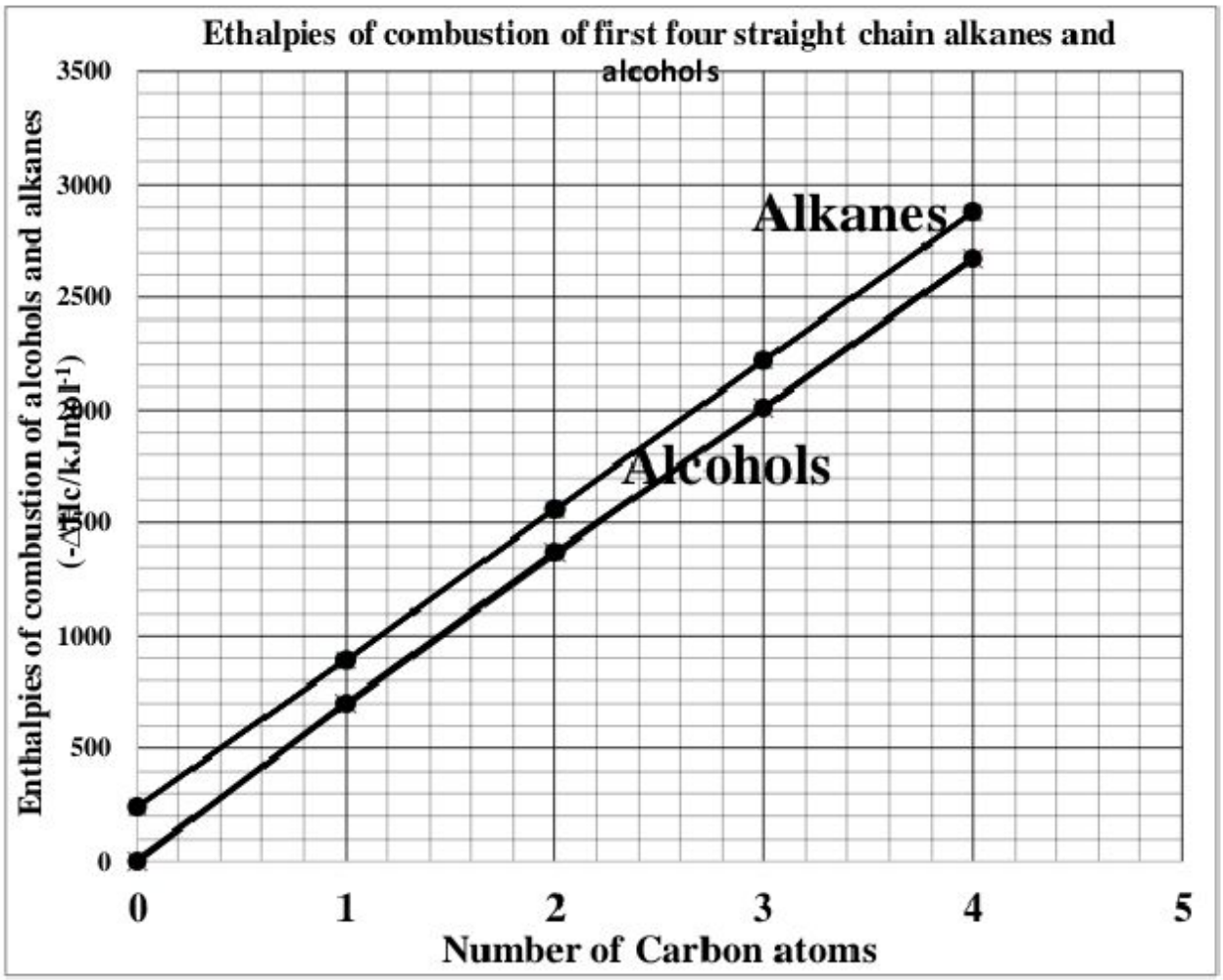
(b) (i) Describe an experiment that can be used to determine the enthalpy of combustion of sugar(sucrose) by a method of Bomb calorimeter. (Diagram **not** required). *(06 marks)*

(ii) When 48.36g of sucrose was burnt completely in oxygen, the heat liberated raised the temperature of 2.35kg of water from 24.5°C to 97.5°C. Calculate the molar heat of combustion of sucrose. ($C_{12}H_{22}O_{11}$). *(03 marks)*

(Density of water = $1gcm^{-3}$, Specific heat capacity of water = $4.2Jg^{-1}K^{-1}$)

(iii) Explain why the value of the molar heat of combustion of sucrose is lower than the theoretical value. *(01mark)*

(c) The graph below shows the enthalpies of combustion of the first four straight chain alkanes and alcohols.



Explain why

(i) the two graphs are parallel. *(02 marks)*

(ii) the graph for alkane has an intercept while the of alcohols pass through the origin. *(03 marks)*

(iii) the graph for alkanes is above that of alcohols. *(02 marks)*

SECTION B

*(Attempt any **two** questions from this section)*

5. An organic compound **Q** has the structure, $HOCH_2CH_2Br$.

(a) Give the IUPAC name of **Q.** *(01mark)*

(b) Name the reagents that can be used to identify the functional groups in **Q**. In each case state what would be observed when each reagent is treated with **Q.** *(04 marks)*

(c) Write equation and suggest a mechanism for the reaction to show how **Q** can be synthesized in the laboratory. *(4½ marks)*

(d) Using equations only, show how **Q** can be converted to;

(i) ethyne. *(3½ marks)*

(ii) ethane–1,2–dioic acid. *(3½ marks)*

(iii) 3–hydroxypropanoic acid. *(3½ marks)*

6. Phosphorus(V) chloride decomposes at high temperature according to the following equation.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$$

(a) Write an expression for the equilibrium constant, Kc for the reaction. *(01mark)*

(b) The bond energies of P — Cl and Cl—Cl bonds are -276.6 and -242kJmol^{-1} respectively. Calculate the enthalpy change for the decomposition reaction. *(03 marks)*

(c) State and explain the effect on the equilibrium position and value of the equilibrium constant for the equilibrium when

(i) pressure was increased. *(03 marks)*

(ii) temperature was increased. *(03 marks)*

(iii) inert gas was added at constant volume. *(02 marks)*

(d) When 83.4g of phosphorus(V) chloride was sealed in a9.23dm^3 glass tube and heated up to 450°C until equilibrium was attained. The tube was quickly broken into ice - cold excess potassium iodide solution. 25.0cm^3 of this solution required 38.50cm^3 of 0.022M sodium thiosulphate solution using starch indicator.

(i) State why the tube was quickly broken into ice - cold potassium iodide solution. *(01 marks)*

(ii) Write equations for the reactions that took place. *(03 marks)*

(iii) Calculate the equilibrium constant Kc for the reaction at 450°C. *(04 marks)*

7. Explain the following observations

(a) The pH of 0.1M hydrochloric acid is 1 whereas that of 0.1M hydrofluoric acid is 2.8. *(04 marks)*

(b) Hydrochloric acid is **not** usually used to acidify potassium manganate (VII) during redo titrations. *(03 marks)*

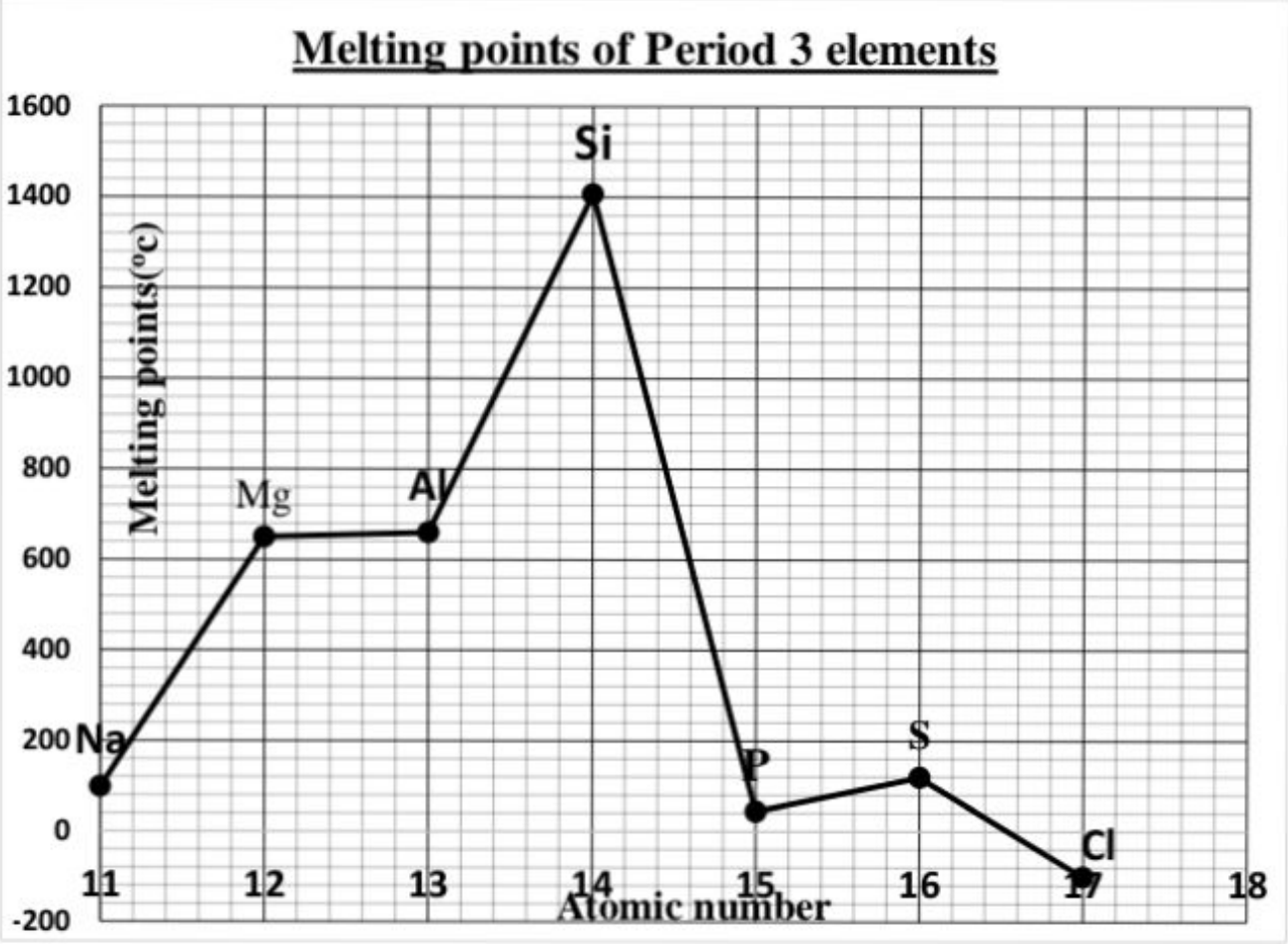
(c) Sauce pans made of aluminium are **not** usually washed using soap.

(04 marks)

(d) Methoxymethane is a gas at room temperature whereas ethanol is a liquid at room temperature although both compounds have the same relative molecular mass. *(04 marks)*

(e) Ethene undergoes electrophilic addition reactions whereas ethanal undergoes nucleophilic addition reaction. *(05 marks)*

8. (a) The graph below shows the melting points of period 3 elements



(i) Explain the shape of the graph. *(06 marks)*

(b) Describe the reaction of

(i) aluminium, silicon, phosphorus and chlorine with sodium hydroxide. *(08 marks)*

(ii) the chlorides of aluminum and silicon with water. *(03 marks)*

(c) Write equation for the reaction between

(i) sodium peroxide and water. *(1½ marks)*

(ii) Sulphur dioxide and sodium hydroxide solution. *(1½ marks)*

END