SCHOOL CATEGORY:
GIRLS { }
BOYS { }
MIXED { }

# KENYA HIGH SCHOOL

## THE NATIONAL CHEMISTRY CONTEST 1ST EDITION

## FORM 4

## 233 Chemistry

## 8TH June, 2024 Time: 1 1/2 Hours

NAME: …… CODE ……

**Instructions to Candidates**

a) Write your Name and the Code in the spaces provided above.

b) Indicate the School category in the space provided above

c) Answer ALL the questions in the Answer Sheet provided.

d) Mathematical tables and silent electronic calculators may be used.

e) This paper consists of 10 printed pages

**For Examiner's Use Only**

| Questions | Max. Score | Candidate's Score |
|---|---|---|
| 1 – 23 | 55 | |

## SECTION A

**1.** Tri-Iron tetra oxide is an oxide of iron which can be produced in the laboratory.

(a) Write an equation for the reaction which can be used to produce the oxide. (1mks)

(b) Write an equation for the reaction between the oxide and hydrochloric acid. (1 mks)

**2.** State the advantage of using a boiling tube while heating compared to a test tube. ($^1/_2$ mks)

**3.** When preparing a gas in the laboratory, explain why the following is done.

(a) Heating is not required when using a flat-bottomed flask, ($^1/_2$ mks)

(b) The delivery tube must always be well above the level of the reacting chemicals. If the tube to supply a liquid or solution reagent is a dropping funnel, the tap must be closed. ($^1/_2$ mks)

(c) If a thistle funnel is used, it must be dipped below the surface of the reacting chemicals. ($^1/_2$ mks)

**4.** Complete the **Table 1** below;

| **Volume ($cm^3$)** | **360** | **27** | |
|---|---|---|---|
| **Temperature (°C)** | **27** | | **360** |

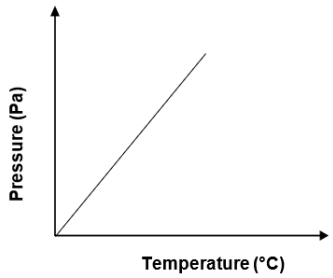
**Table 1**

**5.** Element X reacts with dilute acids but not with cold water. Element Y does not react with dilute acids. Elements Z displaces element W from its oxide. W reacts with cold water. Name the element that is likely to have the largest atomic radius. (1 mk)

**6.** Starting with 2M sodium hydroxide solution, describe how you can prepare crystals of an acid salt formed when sodium hydroxide reacts with 2M sulphuric (VI) acid. (3 mks)

**7.** Determine the molecular mass of the gas B which diffuses ½ times faster than Oxygen. (1 mks)

**8.** The graph below shows the relationship between pressure and the temperature of a gas in a fixed volume container.




State the relationship between pressure and temperature that can be drawn from the graph. ($^1/_2$ mks)

**9.** **$RCOO^-Na^+$** and **$ROSO_3^-Na^+$** are types of cleansing agents;

(a) Name the class of cleansing agents to which each belongs. (1 mks)

(b) Which one of these agents in (a) above would be more suitable when washing with water from the Indian Ocean. Explain. (1 mks)

**10.** The molecular mass of gas F is 28 and its empirical formula is $CH_2$.

(a) Determine the molecular formula of F. (1 mks)

(b) (i) Write the structural formula of F. ($^1/_2$ mks)

(ii) Write equation for the reaction between F and bromine water. (1 mks)

(c) (i) Name one other reagent that can be used to identify F. (1 mks)

(ii) State what would be observed if the reagent is used on F. (1 mks)

**11.** Under suitable laboratory conditions ethene can be converted to a compound with a general formula $(-H_2C-CH_2-)$. Name one other compound of the category $(-H_2C-CH_2-)$ which is:

(i) Man made. ($^1/_2$ mks)

(ii) Not manmade. ($^1/_2$ mks)

**12.** Substances **G** and **H** are represented by the formulae **ROH** and **RCOOH** respectively. They belong to two different homologous series of organic compounds. If both G and H react with potassium metal: State the observation made when each of the samples **G** and **H** are reacted with a sodium hydrogen carbonate. (1 mks)

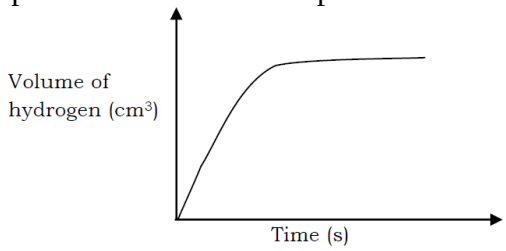
**13.** Explain why dilute Sulphuric acid is a strong acid than concentrated Sulphuric acid.(1 mks)

**14.** Explain why particles collide and products are formed during a chemical reaction. (1 mks)

**15.** Explain what would happen to the position of equilibrium in the following reaction if the pressure is increased. (2 mks)

$$\mathbf{CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)} \quad \Delta H = +ve\ kJmol^{-1}}$$

**16.** The graph below shows the variation of volume of hydrogen with time when excess magnesium was added to 100cm$^3$ of 1.0M sulphuric acid at room temperature.




*Sketch* on the same axes of the graph in the figure and *label*, the graph that would be obtained if the following were used at room temperature: (1 mks)

(i) 100cm$^3$ of 0.5M sulphuric acid. (ii) 200cm$^3$ of 2.0M sulphuric acid.

## SECTION B

**17.** Carbon burns in oxygen according to the following equation

$$\mathbf{C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \qquad \Delta H = -393\ kJmol^{-1}}$$

(a) Calculate the

(i) Amount of heat evolved when 5.6 g carbon is burnt completely in oxygen. (1 mks)

(ii) Volume of oxygen at s.t.p that would be required to produce 78.6 kJ of heat. (*1mole of gas occupies 22.4 dm$^3$ at s.t.p*) (1 mks)

(b) Calculate the enthalpy of hydration of bromide ions given the following.

Enthalpy of hydration of magnesium ions **– 1,891kJ/mol**

Lattice energy of $MgBr_2$ **- 2,421kJ/mol**

Enthalpy of solution of $MgBr_2$ **– 186kJ/mol** (1 mks)

(c) Explain why the molar heat of neutralization of KOH and ethanoic acid of equal volume and molarity would be less than the value obtained in the molar heat of neutralization of KOH and sulphuric (VI) acid. (1 mks)

**18.** (a) A piece of iron wire of mass 2.225g was put into a conical flask containing dilute sulphuric (VI) acid. The flask was fitted with a bung carrying a Bunsen valve, to allow the hydrogen gas generated to escape but prevent air from entering. The mixture was warmed. When the effervescence stopped, the

solution was cooled to room temperature and made up to 250cm$^3$ in a graduated flask. 25cm$^3$ of the solution were acidified and titrated against a 0.0185moldm$^{-3}$ solution of potassium dichromate (VI) the volume required was 31cm$^3$. Calculate the percentage of iron in the iron wire. (1 mks)

(b) A sample containing ammonium sulphate was warmed with 250cm$^3$ of 0.8moldm$^{-3}$ sodium hydroxide solution. After the evolution of ammonia had ceased, the solution was neutralized by 85cm$^3$ of hydrochloric acid of concentration 0.5moldm$^{-3}$. What mass of ammonium sulphate did the sample contain? (1 mks)

**19.** (a) 5.125g of washing soda crystals are dissolved and made up to 250cm$^3$ of solution. A 25cm$^3$ portion requires 35.8cm$^3$ of 0.05moldm$^{-3}$ sulphuric (VI) acid for neutralization. Calculate the percentage of sodium carbonate in the crystals. (1 mks)

(b) From 23g of ethanol, 36g of ethyl ethanoate are obtained by esterification with ethanoic acid in the presence of concentrated sulphuric (VI) acid. What is the percentage yield of the reaction? (1 mks)

**20.** The following **Figure 1** shows the steps in the manufacture of sulphuric acid by the contact process

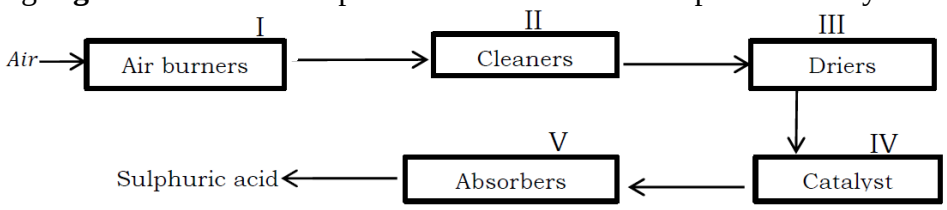



**Figure 1**

(a) Write an equation for the reaction that takes place in step I. (1 mks)

(b) Why is step II necessary? (1 mks

(c) Name the:

(i) Drying agent in step III. (1 mks) (ii) Catalyst in step IV. ($^1/_2$ mks)

(d) Describe the process that takes place in step V in order to produce sulphuric acid. (1 mks)

(e) Sulphur (IV) oxide combines with air to form sulphur (VI) oxide.

(i) Write equation for the reaction. (1 mks)

(ii) State the conditions for the maximum yield of sulphur (VI) oxide. (1 mks)

**21.** In an experiment, dry chlorine gas was reacted with aluminium as shown in the **Figure 2** below.

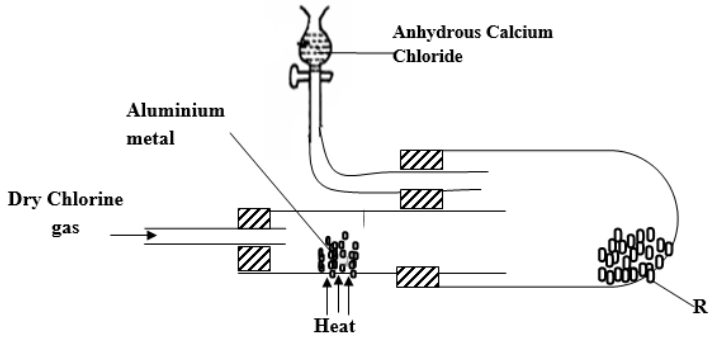



**Figure 2**

a) Name substance R. ($^1/_2$ mks)

b) Write an equation for the reaction that took place in the combustion tube. (1mks)

c) State the function of the anhydrous calcium chloride in the set-up above. (1 mks)

d) Name another substance that can be used instead of anhydrous calcium chloride.($^1/_2$ mks)

e) Why is the substance named above in (d) more suitable than anhydrous calcium chloride? ($^1/_2$ mks)

f) Name another metal that can be used instead of aluminium. ($^1/_2$ mks)

g) What property makes substance R to be collected in the flask? ($^1/_2$ mks)

h) Write the equation for the reaction between excess phosphorus and chlorine.(1 mks)

**22.** Use the data in the **table 2** below to answer the questions that follow.

| Substance | M.P. °C | B.P. °C | Solubility in water | Electrical conductance | | Density |
|---|---|---|---|---|---|---|
| | | | | Solid form | Molten form | |
| **J** | 714 | 1418 | V | None | Good | 2.3 g/cm³ |
| **K** | -95 | 56 | V | None | None | 0.8 g/cm³ |
| **L** | 1083 | 2580 | I | Good | Good | 8.9 g/cm³ |
| **M** | -101 | -34 | V | None | None | 2.55 g/l |
| **N** | -23 | 77 | I | None | None | 1.6 g/cm³ |
| **S** | -219 | -183 | S | None | None | 1.33 g/l |

**Key**;

***V= Very soluble***

***S= Slightly soluble***

***I=Insoluble***

**Table2**

(a) (i) Name two substances that are liquid at room temperature. ($^1/_2$ mks)

(ii) Which of the two is more volatile? ($^1/_2$ mks)

(b) Which substances would dissolve in water and could be separated from the solution by:

(i) Fractional distillation. ($^1/_2$ mks) By evaporation of the water? ($^1/_2$ mks)

(c) Which of the substances:

(i) Has the structure consisting of ions? ($^1/_2$ mks)

(ii) Is a metal? ($^1/_2$ mks)

(iii) Is a liquid which would form separate layer with water? ($^1/_2$ mks)

(iv) Would the water be above or below? ($^1/_2$ mks)

(d) Which substance is a gas which:

(i) Would not be collected efficiently over water. ($^1/_2$ mks)

(ii) Would be collected efficiently over water. ($^1/_2$ mks)

## SECTION C

**23.** You are given solid T (***aluminium sulphate***). Carry out the tests below writing observations and infer accordingly. Take a spatula endful of T and put in a boiling tube. Add about 10cm$^3$ of water and shake. Keep the mixture for the tests below.

a) To about 2cm$^3$ of solution T, add about 5 drops of Nitric Acid ($HNO_{3(aq)}$) followed by 2 drops of Barium nitrate.

| **Observations** | **Inference** |
|---|---|
| | |

b) To about 2cm$^3$ of solution of T add Sodium Hydroxide (2M NaOH) drop wise till in excess.

| **Observations** | **Inference** |
|---|---|
| | |

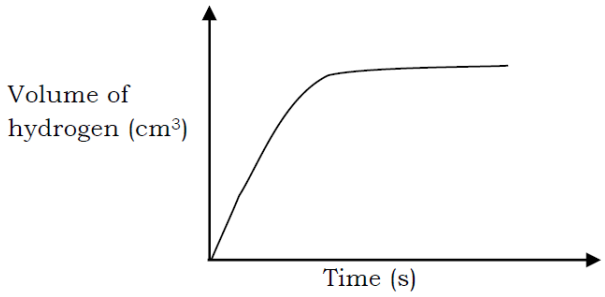
c) To about 2cm$^3$ of solution T, add Ammonia solution (2M $NH_{3(aq)}$) drop wise till in excess.

| **Observations** | **Inference** |
|---|---|
| | |

# WORKING AREA

# 233 Chemistry Answer Sheet

| QUESTION | | ANSWER | MARKS | TOTAL |
|---|---|---|---|---|
| **1.** | (a) | | (1 mks) | |
| | (b) | | (1 mks) | |
| **2.** | | | ($^1/_2$ mks) | |
| **3.** | (a) | | ($^1/_2$ mks) | |
| | (b) | | ($^1/_2$ mks) | |
| | (c) | | ($^1/_2$ mks) | |
| **4.** | | | (1 mks) | |
| **5.** | | | (1 mks) | |
| **6.** | | | (3 mks) | |
| **7.** | | | (1 mks) | |
| **8.** | | | ($^1/_2$ mks) | |
| **9.** | (a) | | (1 mks) | |
| | (b) | | (1 mks) | |
| **10.** | (a) | | (1 mks) | |
| | (b)(i) | | ($^1/_2$ mks) | |

| | | | | |
|---|---|---|---|---|
| | | | | |
| | (ii) | | (1 mks) | |
| | (c)(i) | | (1 mks) | |
| | (ii) | | (1 mks) | |
| **11.** | (i) | | ($^1/_2$ mks) | |
| | (ii) | | ($^1/_2$ mks) | |
| **12.** | | | (1 mks) | |
| **13.** | | | (1 mks) | |
| **14.** | | | (1 mks) | |
| **15.** | | | (2 mks) | |
| **16.** | (i) | **ON THE GRAPH** | ($^1/_2$ mks) | |
| | (ii) |   | ($^1/_2$ mks) | |
| **17.** | (a)(i) | | (1 mks) | |
| | (ii) | | (1 mks) | |
| | (b) | | (1 mks) | |
| | (c) | | (1 mks) | |
| **18.** | (a) | | (1 mks) | |

| | | | | |
|---|---|---|---|---|
| | (b) | | (1 mks) | |
| **19.** | (a) | | (1 mks) | |
| | (b) | | (1 mks) | |
| **20.** | (a) | | (1 mks) | |
| | (b) | | (1 mks) | |
| | (c) (i) | | (1 mks) | |
| | (ii) | | ($^1/_2$ mks) | |
| | (d) | | (1 mks) | |
| | (e)(i) | | (1 mks) | |
| | (ii) | | (1 mks) | |
| **21.** | (a) | | ($^1/_2$ mks) | |
| | (b) | | (1 mks) | |
| | (c) | | (1 mks) | |
| | (d) | | ($^1/_2$ mks) | |
| | (e) | | ($^1/_2$ mks) | |
| | (f) | | ($^1/_2$ mks) | |
| | (g) | | ($^1/_2$ mks) | |
| | (h) | | (1 mks) | |
| **22.** | (a) (i) | | ($^1/_2$ mks) | |
| | (ii) | | ($^1/_2$ mks) | |
| | (b) (i) | | ($^1/_2$ mks) | |
| | (ii) | | ($^1/_2$ mks) | |
| | (c)(i) | | ($^1/_2$ mks) | |

| | | | | | |
|---|---|---|---|---|---|
| | (ii) | | | ($^1/_2$ mks) | |
| | (iii) | | | ($^1/_2$ mks) | |
| | (iv) | | | ($^1/_2$ mks) | |
| | (d) (i) | | | ($^1/_2$ mks) | |
| | (ii) | | | ($^1/_2$ mks) | |
| **23.** | (a) | **Observation** | **Inference** | (2 mks) | |
| | | | | | |
| | | | | | |
| | (b) | **Observation** | **Inference** | (2 mks) | |
| | | | | | |
| | (c) | **Observation** | **Inference** | (2 mks) | |
| | | | | | |
| | | | | | |
| **TOTAL** | | | | **55** | |

*BELIEVE THAT CHEMISTRY IS EASY AND YOU CAN PASS. SUCCESS*

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