

# Chemistry I

002

17/11/ 2015 08.30AM - 11.30AM



## ORDINARY LEVEL NATIONAL EXAMINATIONS, 2015

**SUBJECT: CHEMISTRY I**

**DURATION: 3 HOURS**

### INSTRUCTIONS:

- 1) Write your names and index number on the answer booklet as they appear on your registration form, and **DO NOT** write your names and index number on additional answer sheets of paper if provided.
- 2) Do not open this question paper until you are told to do so.
- 3) This paper consists of three sections: **A**, **B** and **C**.
  - **Section A:** Attempt all questions. (55marks)
  - **Section B:** Attempt any **THREE** questions. (30marks)
  - **Section C:** Attempt **ONLY ONE** question. (15marks)
- 4) You do not need the Periodic Table.
- 5) Silent non-programmable calculator may be used.

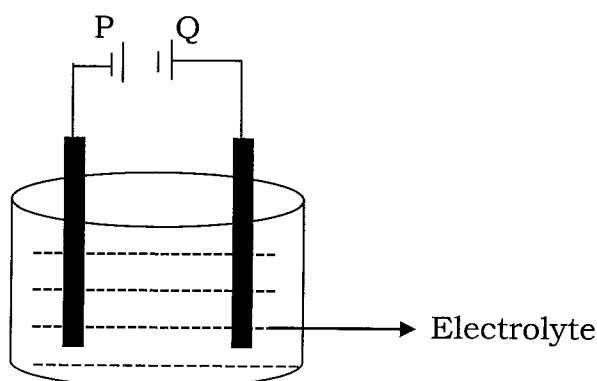
**SECTION A: ATTEMPT ALL THE QUESTIONS. (55MARKS)**

- 1) An atom of an element has the structure  ${}^4_ZX$ . This atom belongs to group VI and period III of the periodic table.
- (a) Give the electronic configuration of atom X. (1mark)
  - (b) Find Z. (1mark)
  - (c) How many protons does this atom have? (0.5marks)
  - (d) How many electrons does the ion  $X^{2-}$  have? (1mark)
- 2) Some elements of the periodic table are called noble or inert gases.
- (a) In which group are these gases in the periodic table? (1mark)
  - (b) What is meant by the term 'inert'? (1mark)
  - (c) Explain in terms of electronic structure why these gases are inert. (1mark)
- 3) Name the process by which the components of the following mixtures can be separated:
- (a) Water and methanol. (0.5marks)
  - (b) Pigments of leaves. (0.5marks)
  - (c) Sand in water. (0.5marks)
  - (d) Ammonium chloride and sodium chloride. (0.5marks)
- 4) (a) A solution containing calcium ions was added to a solution of potassium carbonate.
- (i) State what was observed. (0.5marks)
  - (ii) Write the equation for the reaction that took place. (1mark)
- (b) To the mixture prepared in (a) above, dilute hydrochloric acid was added.
- (i) State what was observed. (0.5marks)
  - (ii) Write the equation for the reaction. (1mark)
- 5) Hydrochloric acid reacts with magnesium according to the equation:
- $$\text{Mg(s)} + 2\text{HCl(aq)} \longrightarrow \text{MgCl}_2\text{(aq)} + \text{H}_2\text{(g)}$$
- (a) Calculate the number of moles of magnesium that will react with excess hydrochloric acid to produce 720 cm<sup>3</sup> of hydrogen at room temperature and pressure. (1 mole of a gas occupies 24 dm<sup>3</sup> at room temperature and pressure, Mg (Ar = 24)). (3marks)
  - (b) Why is it necessary to use excess of hydrochloric acid? (1mark)
- 6) (a) Calculate the molar mass of Fe<sub>2</sub>O<sub>3</sub>. (Atomic mass of: Fe= 56, O= 16) (1mark)
- (b) How many atoms of oxygen are contained in 4.8 g Fe<sub>2</sub>O<sub>3</sub>? (1 mole contains 6.02×10<sup>23</sup> atoms.) (2marks)
- 7) State one reagent that can be used to distinguish between each of the following pairs of ions and in each case state what would be observed if each ion is treated with the reagent.
- (a) SO<sub>4</sub><sup>2-</sup>(aq) and CO<sub>3</sub><sup>2-</sup>(aq) (2.5marks)
  - (b) Fe<sup>2+</sup> (aq) and Fe<sup>3+</sup>(aq) (2.5marks)

- 8) The boiling and the melting points of substances W, X, Y and Z are given in the table below:

| Substance | Melting point (°C) | Boiling point (°C) |
|-----------|--------------------|--------------------|
| W         | +29                | +40                |
| X         | -5                 | +20                |
| Y         | 0                  | 100                |
| Z         | 15                 | 85                 |

- (a) Give the physical state (gas, solid or liquid) of the substances W, X, Y and Z at room temperature (25°C). (2marks)
- (b) Which of these substances is water? (1mark)
- 9) (a) The oxides of some elements are listed below:  
Sulfur dioxide, Aluminium oxide, Sodium oxide.  
State the oxide which reacts with:
- (i) Acids only (0.5marks)
- (ii) Alkalis only (0.5marks)
- (iii) Both acids and alkalis. (0.5marks)
- (b) When excess oxygen was passed over 6.20g of a strongly heated metal W, 14.20g of oxide was formed. Find the empirical formula of the oxide W. (Atomic mass: W = 31, O = 16) (4marks)
- 10) The diagram below shows the arrangement apparatuses used for the purification of copper.



- (a) Indicate which part is the anode and which part is the cathode on the diagram above. (1mark)
- (b) Name the substance used as:
- (i) Anode (0.5marks)
- (ii) Cathode (0.5marks)
- (c) Name the electrolyte (0.5marks)
- (d) Write the equation of the reaction that takes place at:
- (i) Anode (0.5marks)
- (ii) Cathode (0.5marks)

- 11) The molecular formula of an organic compound is  $C_4H_{10}O$ .  
This compound is an alcohol. Give the structural formula and names of all possible isomers (alcohols) of  $C_4H_{10}O$ . **(4marks)**

- 12) Using the table below that shows the pH of different aqueous solutions, answer the questions that follow:

| Solution | A  | B   | C | D | E |
|----------|----|-----|---|---|---|
| pH       | 12 | 5.5 | 3 | 7 | 9 |

Which of the solutions is :

- (a) Most acidic? **(0.5marks)**  
 (b) Most alkaline? **(0.5marks)**  
 (c) Distilled water? **(0.5marks)**  
 (d) Likely to be rain water? **(0.5marks)**  
 (e) Which two of the solutions above would give a neutral solution when mixed? **(0.5marks)**  
 (i) A + E; (ii) C + D; (iii) B + C; (iv) B + E

- 13) When 14.2g of hydrated sodium carbonate,  $Na_2CO_3 \cdot nH_2O$  was heated, the mass of the residue was 10.6g.  
 (a) Complete this equation:  $Na_2CO_3 \cdot nH_2O \xrightarrow{\text{heat}} \dots + \dots$  **(1 mark)**  
 (b) Calculate the number of moles of water of crystallization (n). **(4.5marks)**  
 (c) Write the molecular formula of hydrated sodium carbonate. **(0.5marks)**
- 14) Complete and balance the equations below: **(3marks)**  
 (a)  $CH_3COOH + CH_3CH_2OH \rightarrow$   
 (b)  $CH_3CH=CH_2 + Br_2 \rightarrow$   
 (c)  $CH_2=CH_2 + HCl \rightarrow$
- 15) (a) Describe how you would prepare pure crystals of lead (II) nitrate in the laboratory starting from lead (II) oxide. **(3marks)**  
 (b) Write the equation for the reaction that takes place. **(1mark)**

### SECTION B: ATTEMPT ANY THREE QUESTIONS. (30MARKS)

- 16) (a) Copper (II) carbonate was heated strongly until there was no further observable change. During the reaction, a colourless gas was given off and a black solid was observed.  
 (i) Give the name of the black solid. **(1mark)**  
 (ii) Write the equation for the reaction. **(2marks)**  
 (iii) State the name of one reagent which can be used to identify the gaseous product and write an equation for the reaction. **(2marks)**
- (b) Excess dilute sulphuric acid was added to the residue in 16) (a) (ii) and the mixture warmed.  
 (i) State what was observed. **(1mark)**  
 (ii) Write the equation for the reaction. **(1mark)**

(c) To the product in (b) dilute sodium hydroxide solution was added drop wise until in excess.

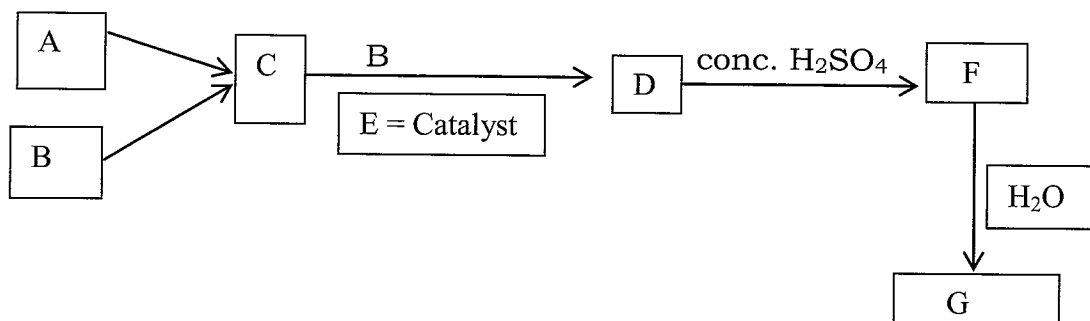
(i) State what was observed.

**(1mark)**

(ii) Write an ionic equation for the reaction.

**(2marks)**

17) The diagram below represents the flow chart for the manufacture of sulphuric acid by the contact process.



(a) Write the molecular formula of the substance: A, B, C, D, E and F.

**(3marks)**

(b) Write the equation of the reaction that gives substance:

(i) C; (ii) D; (iii) F; (iv) G.

**(4marks)**

(c) The purity of sulphuric acid prepared in the contact process is 98% by mass; which means 98g of pure sulphuric acid in 100g of the solution.

(i) What mass of the acid is present in 1 litre of prepared sulphuric acid?  
(1 millilitre of prepared sulphuric acid weighs 1.84g.)

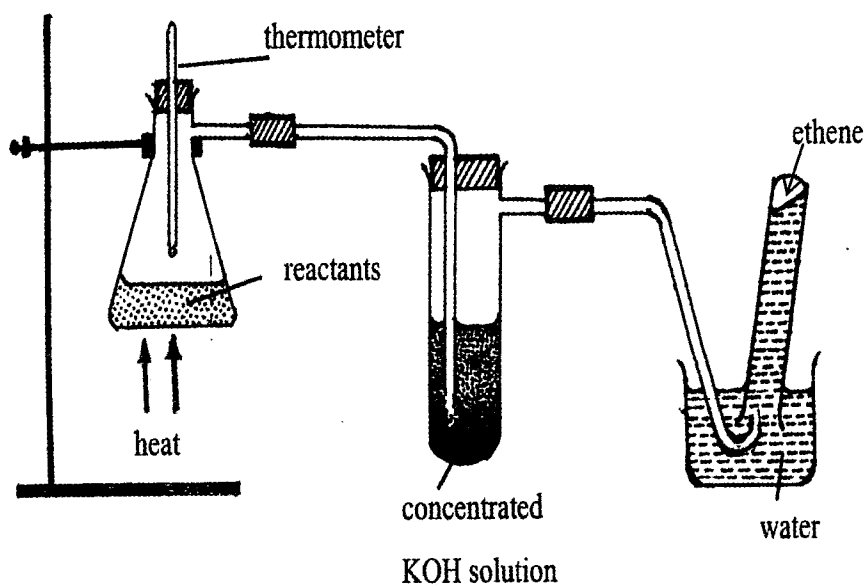
**(2marks)**

(ii) What is the molar concentration of this solution?

**(1mark)**

(S = 32, H = 1, O = 16)

18) Study the diagram below that shows the preparation of ethene in the laboratory and answer questions that follow:



(a) Name the reactants.

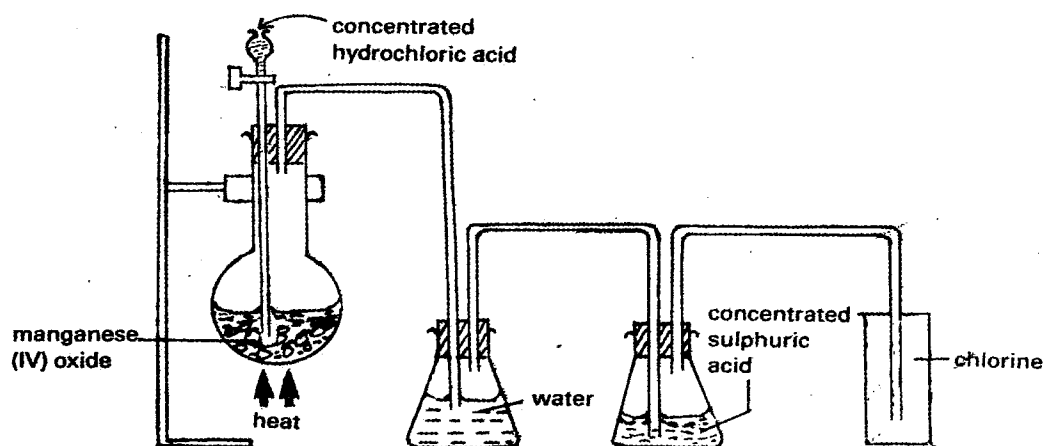
**(1mark)**

- (b) Write the equation of the reaction between the reactants. (1mark)
- (c) At which maximum temperature are the reactants heated? (1mark)
- (d) Why is it possible to collect ethene over water? (1mark)
- (e) In this experiment, what is the use of:
- (i) Concentrated potassium hydroxide? (1mark)
- (ii) the thermometer? (1mark)
- (f) Write the equation of the reaction in the tube containing KOH. (1mark)
- (g) If the empirical formula of compound W is  $C_2H_3O$  and its molecular mass is 258. Find the molecular formula of W. (3marks)
- (Atomic mass: H=1, C=12, O=16)

19) In an experiment to titrate the solution of hydrochloric acid, 15.9 g of pure anhydrous sodium carbonate ( $Na_2CO_3$ ) was dissolved in distilled water to make  $500\text{ cm}^3$  of the solution.  $20\text{ cm}^3$  of this solution neutralized  $15\text{ cm}^3$  of HCl acid using methyl orange. (Atomic masses: H=1, Cl=35.5, Na=23, C=12, O=16)

- (a) What was observed during the titration? (1mark)
- (b) Write the equation of the reaction during the titration. (1mark)
- (c) What was the role of methylorange in this experiment? (1mark)
- (d) Calculate the concentration of  $Na_2CO_3$  in  $\text{g/dm}^3$ . (1mark)
- (e) Find the molarity of  $Na_2CO_3$  solution. (1.5marks)
- (f) Calculate the moles of  $Na_2CO_3$  that reacted with HCl. (1mark)
- (g) Find the moles of HCl that reacted with  $Na_2CO_3$ . (1mark)
- (h) Calculate the molarity of the solution of HCl. (1mark)
- (i) Find the concentration of hydrochloric acid in  $\text{g/dm}^3$ . (1.5marks)

20) Dry chlorine can be prepared by the reaction between manganese (IV) oxide with concentrated sulphuric acid. Below is a diagram of this preparation:



- (a) Write the chemical equation of the reaction between manganese (IV) oxide

and concentrated hydrochloric acid.

(1mark)

(b) What are the roles of water and concentrated sulphuric acid in this experiment?

(2marks)

(c) When chlorine reacts with iron:

(i) Why is iron (II) chloride not formed?

(1mark)

(ii) State the compound that is formed instead of iron (II) chloride?

(1mark)

(d) With the aid of ionic equation, state what would be observed if chlorine was bubbled through the solution of:

(i) iron (II) sulphate

(2marks)

(ii) potassium iodide

(2marks)

(e) Chlorine is a bleaching agent when in the presence of cold water.

Write an equation for the reaction between chlorine and cold water.

(1mark)

**SECTION C: ATTEMPT ONLY ONE QUESTION. (15 MARKS)**

21) The figure below shows a part of the periodic table. The letter is not a correct symbol of the elements.

| I | II | III | IV | V | VI | VII | VIII |
|---|----|-----|----|---|----|-----|------|
| J |    |     |    |   |    |     |      |
|   |    |     | G  |   | E  |     |      |
| A |    |     |    |   |    | R   | D    |
|   | X  |     |    |   |    |     |      |

(a) Which of the elements are metals?

(2marks)

(b) Write the formula of the compounds formed between :

(i) X and R.

(1mark)

(ii) J and G.

(1mark)

(c) Which element is least reactive? Explain your answer.

(2marks)

(d) Which of the compounds (aqueous solution) formed between A and R, or between G and J would conduct electricity. Explain your answer.

(2marks)

(e) State which formula of the following :  $R_2$ ,  $E_2$ ,  $D_2$ ,  $A_2$  is written correctly.

(2marks)

(f) X is in period IV and group II of the periodic table.  
Give its electronic structure.

(1mark)

(g) State the type of bond that exists in the chloride of X and write the formula of the ion formed by X.

(2marks)

(h) The nitrate of X was strongly heated.

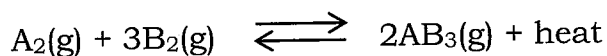
(i) State what was observed.

**(1mark)**

(ii) Write the equation of the reaction.

**(1mark)**

22) Substance A<sub>2</sub> reacts with B<sub>2</sub> to produce AB<sub>3</sub> according to the following equation (the letters A and B are not correct symbols of elements):



(a) Is this reaction exothermic or endothermic? Explain.

**(2marks)**

The table below shows percentage yield of AB<sub>3</sub> at various temperatures and pressure

| Temperature | Pressure (atmosphere) |      |      |
|-------------|-----------------------|------|------|
|             | 10                    | 200  | 1000 |
| 250         | 30%                   | 75%  | 96%  |
| 500         | 1%                    | 18%  | 60%  |
| 1000        | 0%                    | 0.1% | 60%  |

(b) Draw a graph showing the percentage yield of AB<sub>3</sub> at different pressures and 250 °C. (%: x-axis, Pressure: y-axis)

**(6.5marks)**

(c) Using the graph, find the percentage yield of AB<sub>3</sub> at 700 atm. and 250°C.

**(2.5marks)**

(d) State :

(i) How the percentage yield of AB<sub>3</sub> varies with the temperature at constant pressure.

**(1mark)**

(ii) How the percentage yield of AB<sub>3</sub> varies with pressure at constant temperature.

**(1mark)**

(e) At which temperature and pressure is the production of AB<sub>3</sub> maximum?

**(2marks)**