Chemistry I

002

17/11/ 2015   08.30AM - 11.30AM

REB
Rwanda Education Board

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 ${}^{4}_{z}X$. 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:
   $$Mg(s) + 2HCl\,(aq) \longrightarrow MgCl_2(aq) + H_2(g)$$

   (a) Calculate the number of moles of magnesium that will react with excess hydrochloric acid to produce 720 cm³ of hydrogen at room temperature and pressure. (1 mole of a gas occupies 24 dm³ 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_2O_3. (Atomic mass of: Fe= 56, O= 16) **(1mark)**
   (b) How many atoms of oxygen are contained in 4.8 g Fe_2O_3? (1 mole contains 6.02×10^{23} 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_4^{2-}(aq) and CO_3^{2-}(aq) **(2.5marks)**
   (b) Fe^{2+} (aq) and Fe^{3+}(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.
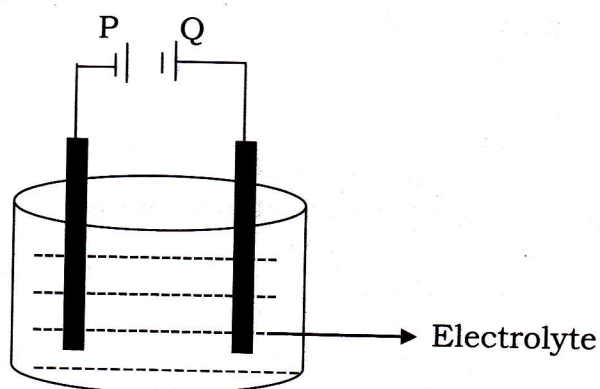
(a) Indicate which part is the anode and which part is the cathode on the diagram above. **(1mark)**

(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, $Na_2CO_3.nH_2O$ was heated,
the mass of the residue was 10.6g.
(a) Complete this equation: $Na_2CO_3.nH_2O \xrightarrow{\text{heat}}$ .... + ... **(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.
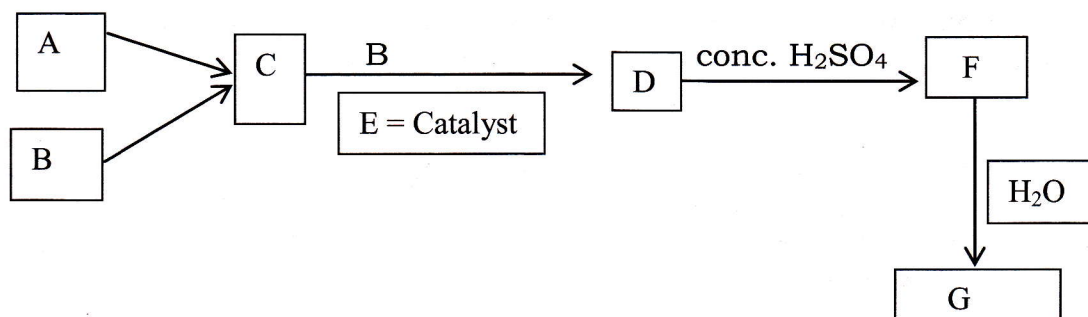
(a) Write the molecular formula of the substance: A, B, C, D, E and F. **(3marks)**
(b) Write the equation of the reaction that gives substance:

   (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:
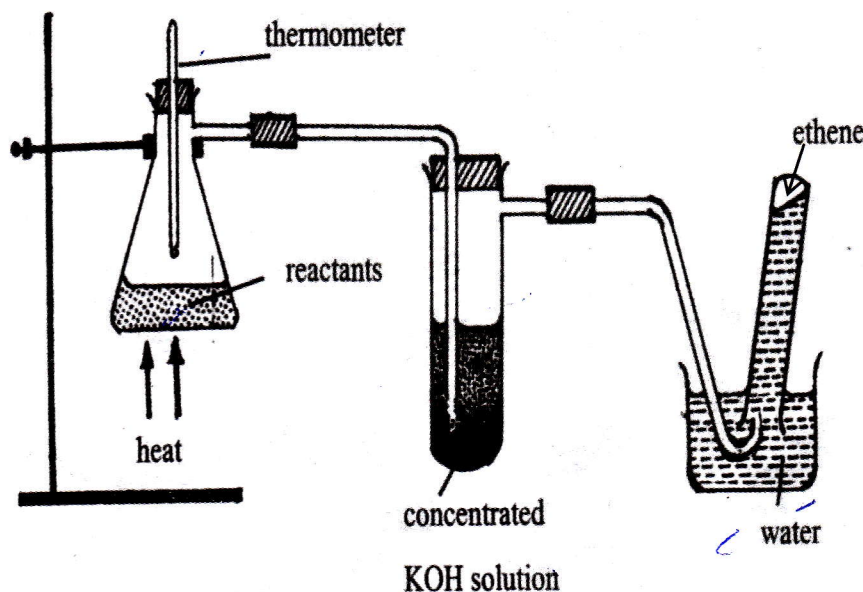
(a) Name the reactants. **(1mark)**

(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.
    (Atomic mass: H=1, C=12, O=16)   (3marks)

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 cm^3 of the solution. 20 cm^3 of this solution neutralized 15 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 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 g/dm^3.   (1.5marks)

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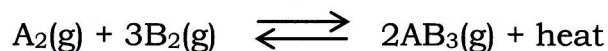   oxide with concentrated sulphuric acid. Below is a diagram of this preparation:
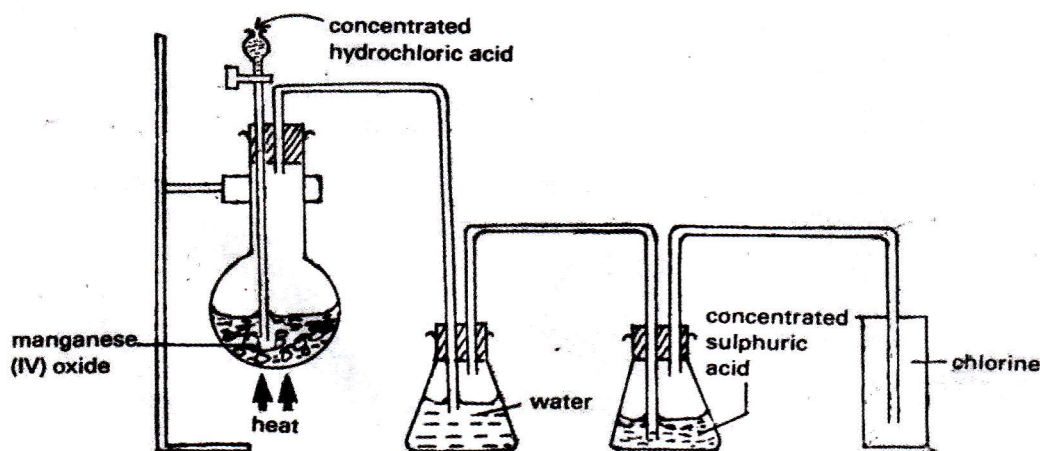
(a) Write the chemical equation of the reaction between manganese (IV) oxide

(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_2 reacts with B_2 to produce AB_3 according to the following equation (the letters A and B are not correct symbols of elements):

$$A_2(g) + 3B_2(g) \rightleftharpoons 2AB_3(g) + heat$$

(a) Is this reaction exothermic or endothermic? Explain.   **(2marks)**

The table below shows percentage yield of AB_3 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_3 at different pressures

and 250 °C. (%: x-axis, Pressure: y-axis)   **(6.5marks)**

(c) Using the graph, find the percentage yield of AB_3 at 700 atm. and 250°C.   **(2.5marks)**

(d) State :

      (i) How the percentage yield of AB_3 varies with the temperature at constant pressure.   **(1mark)**

      (ii) How the percentage yield of AB_3 varies with pressure at constant temperature.   **(1mark)**
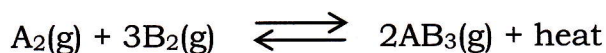
(e) At which temperature and pressure is the production of AB_3 maximum?   **(2marks)**

(h) The nitrate of X was strongly heated.

  (i) State what was observed. **(1mark)**
  (ii) Write the equation of the reaction. **(1mark)**

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  and 250 °C. (%: x-axis, Pressure: y-axis) **(6.5marks)**

(c) Using the graph, find the percentage yield of AB_3 at 700 atm. and 250°C. **(2.5marks)**

(d) State :

  (i) How the percentage yield of AB_3 varies with the temperature at constant pressure. **(1mark)**

  (ii) How the percentage yield of AB_3 varies with pressure at constant temperature. **(1mark)**

(e) At which temperature and pressure is the production of AB_3 maximum? **(2marks)**