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Chemistry I **002** 20 Nov. 2012   08.30am - 11.30am

REPUBLIC OF RWANDA

RWANDA EDUCATION BOARD (REB)

ORDINARY LEVEL NATIONAL EXAMINATIONS 2012

SUBJECT: CHEMISTRY I

DURATION: 3 HOURS

INSTRUCTIONS:

This paper consists of **three** sections: **A, B** and **C**.

Section A: Attempt **all** questions.   (55 marks)

Section B: Attempt any **three** questions.   (30 marks)

Section C: Attempt **only one** question.   (15 marks)

You do not need the Periodic Table.

Silent non-programmable calculators may be used.

SECTION A : Attempt all questions. *(55 marks)*

01. The atomic number of potassium is 19 and that of oxygen is 8.

    (a) Write the electronic configuration (arrangement) of an atom of potassium. *(1 mark)*

    (b) Write the electronic configuration of an atom of oxygen. *(1 mark)*

    (c) Write a balanced chemical equation for the reaction between potassium and oxygen. *(2 marks)*

02. Carbon monoxide was passed over a hot oxide of iron to reduce it to iron. 1.60g of the oxide produced 1.12g of iron. (Fe = 56, O = 16)

    (a) Calculate the number of moles of Fe. *(1 mark)*

    (b) Calculate the mass of oxygen and the number of moles of oxygen atoms. *(2 marks)*

    (c) Determine the empirical formula of the oxide of iron. *(1 mark)*

03. An organic compound has a molecular formula $C_2H_4O_2$. Its aqueous solution produces carbon dioxide when mixed with sodium carbonate.

    (a) Give the empirical formula of the compound. *(1 mark)*

    (b) State the name of the functional group present in the compound. *(1 mark)*

    (c) Give the full structural formula of the compound, showing all the covalent bonds. *(1 mark)*

04. Write one term or word to describe each of the following reactions or processes.

    (a) A reaction between an acid and a base. *(1 mark)*

    (b) A reaction between an alcohol and a carboxylic acid. *(1 mark)*

    (c) A method used to separate different dyes present in ink. *(1 mark)*

    (d) A method used to obtain pure water from sea water. *(1 mark)*

05. Calcium metal can be extracted by electrolysis of molten calcium chloride.

    (a) Give the formula of calcium chloride. *(1 mark)*

    (b) Give a balanced ionic equation to show the reaction which occurs at the anode. *(2 marks)*

    (c) Why is it necessary to have the calcium chloride molten before electrolysis? *(1 mark)*

06. Propane is a compound of carbon and hydrogen. It can be used as a fuel.

    (a) Write the chemical formula of propane. *(1 mark)*

    (b) To which homologous series does propane belong? *(1 mark)*

    (c) Briefly explain how the combustion of propane might affect the environment. *(2 marks)*

07. A student prepared ammonia gas by heating an aqueous mixture of two compounds.

    (a) State any two compounds that can be heated together to produce ammonia gas. *(1 mark)*

    (b) What type of bonding is present in ammonia gas? *(1 mark)*

    (c) Ammonia gas dissolves easily in water. What is the approximate pH of the resulting solution? *(1 mark)*

08. A student prepared zinc sulphate crystals by reacting excess zinc with sulphuric acid. The mixture was filtered to remove excess zinc.

    (a) Why was excess zinc used? *(1 mark)*

    (b) Briefly explain how the student obtained crystals of zinc sulphate from the mixture. *(2 marks)*

09. Ethene is one of the major chemicals used to prepare plastics.

    (a) How is ethene obtained from ethanol? State the reagent and condition used. *(2 marks)*

    (b) State the name of a plastic obtained from ethene. *(1 mark)*

    (c) State the name of the chemical process for changing ethene into the plastic named in (b) above. *(1 mark)*

10. Carbon dioxide gas was prepared by reacting excess hydrochloric acid with zinc carbonate. 0.125g of zinc carbonate was used. (Zn = 65, C = 12, H = 1)

    (a) Write a balanced equation for the reaction. *(2 marks)*

    (b) Calculate the number of moles of zinc carbonate used. *(1 mark)*

    (c) State one use of carbon dioxide. *(1 mark)*

11. From the following list of chemical compounds:

$MgSO_4$, $CaCl_2$, HNO_3, C_2H_4, C_2H_6;

Select the compound (write the formula) which:

    (a) Produces a white precipitate when mixed with acidified silver nitrate solution. *(1 mark)*

(b) Decolourises bromine easily. *(1 mark)*

(c) Is manufactured from ammonia gas. *(1 mark)*

(d) Produces a white precipitate when mixed with acidified barium nitrate solution. *(1 mark)*

12. Iodine vapour was reacted with hydrogen gas in the presence of a suitable catalyst to form hydrogen iodide gas.

(a) What is meant by the term 'catalyst'? *(1 mark)*

(b) Write a balanced equation for the reaction. *(1 mark)*

(c) What volume of hydrogen iodide is produced by reacting 60 cm³ of iodine vapour with 60 cm³ of hydrogen? (Assume that all volumes are measured at the same temperature and pressure). *(2 marks)*

13. Three metals X, Y and Z were investigated in order to place them in order of reactivity. Metal X did not react with a sulphate of Z but metal Y reacted with a sulphate of Z as well as a sulphate of X.

(a) Place the three metals in order of their reactivity, starting with the most reactive and explain your reasoning. *(2 mark)*

(b) Metal Z is heated with an oxide of X. State if there would be a reaction and give a reason for your answer. *(2 marks)*

14. Sodium (atomic number 11) combines with sulphur (atomic number 16).

(a) State what type of bond is present in the compound formed. *(1 mark)*

(b) Give the chemical formula of the compound formed. *(1 mark)*

(c) Would the compound formed conduct electricity when it is in molten form? Give a reason for your answer. *(2 marks)*

15. Air is an important raw material for the manufacture of some important chemicals.

(a) Name a process that is used to separate the major components of air. *(1 mark)*

(b) Name an important chemical manufactured from the most abundant component of air. *(1 mark)*
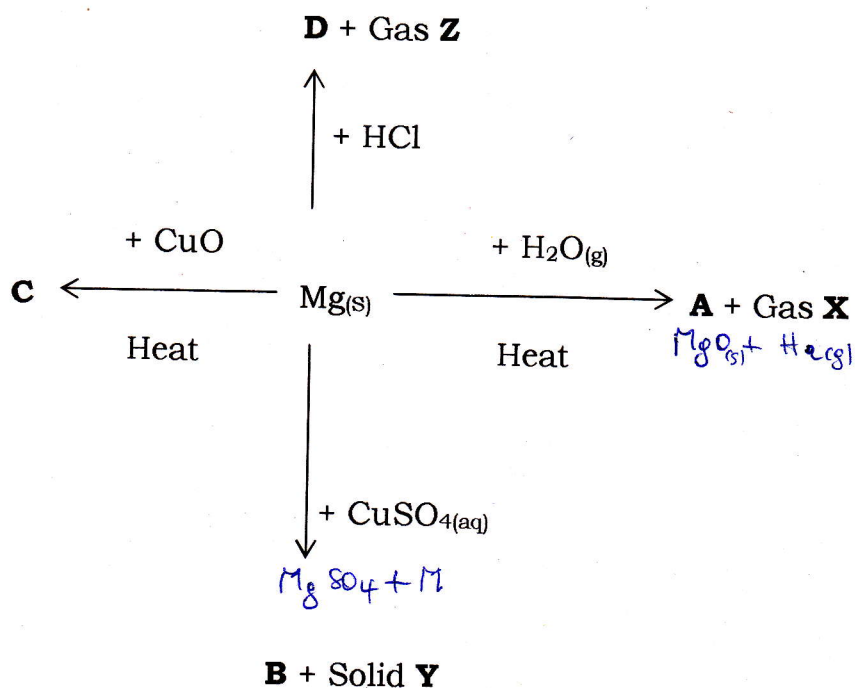
SECTION B: Attempt ONLY any THREE questions

(30 marks)

16. Hydrogen gas was prepared by reacting magnesium with dilute sulphuric acid. The gas was dried and then burnt in air in a controlled way. The gaseous product was cooled to obtain a colourless liquid.

(a) How would you show by a chemical test that the gas is hydrogen? **(2 marks)**

(b) How would you show that the colourless liquid is pure water? **(2 marks)**

(c) Hydrogen gas can be used as a fuel.

State:

(i) One advantage of using hydrogen as a fuel. **(1 mark)**

(ii) One disadvantage of using hydrogen as a fuel. **(1 mark)**

(d) Give the name of the product formed when hydrogen is reacted with propene. **(1 mark)**

(e) Hydrogen gas was passed over hot copper (II) oxide. Write a balanced equation for the reaction. **(2 marks)**

(f) Identify the oxidising agent in the reaction (e) above. **(1 mark)**

17. The scheme below shows some reactions starting with magnesium.

$$\textbf{D} + \text{Gas } \textbf{Z}$$

↑

+ HCl

| + CuO | | + H_2O_{(g)} |

$$\textbf{C} \longleftarrow \text{Mg}_{(S)} \longrightarrow \textbf{A} + \text{Gas } \textbf{X}$$

Heat   Heat $MgO_{(s)} + H_{2(g)}$

+ CuSO_{4(aq)}

↓

$Mg\,SO_4 + M$

B + Solid **Y**

(a) State the name of compound **A** and the name of gas **X**. **(2 marks)**

(b) Give the name of solution **B** and the name of solid **Y**. **(2 marks)**

(c) **C** is a mixture of two solids. Identify the two solids. **(2 marks)**

(d) State the name of solution **D** and the name of gas **Z**. **(2 marks)**

(e) Give two different ways of increasing the rate of reaction between magnesium and hydrochloric acid. **(2 marks)**

18. One of the uses of electrolysis is electroplating. A student used the set up below to electroplate a copper coin with silver.
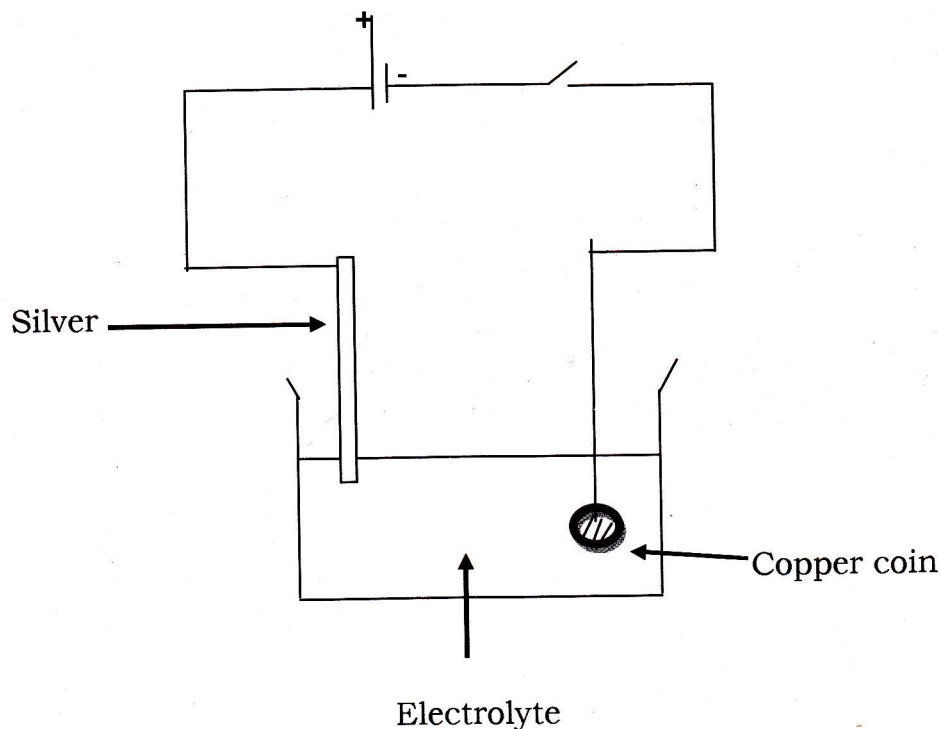
Electrolyte

(a) Name a suitable electrolyte that could have been used. *(1 mark)*

(b) What name is given to the negative electrode? *(1 mark)*

(c) Give an ionic equation for the reaction which occurred on the surface of the copper coin. *(2 marks)*

(d) What happened to the mass of the silver electrode? Explain your answer. *(2 marks)*

(e) State the name of particles responsible for conduction of electricity in: *(2 marks)*

   (i) The electrolyte.

   (ii) The external wire connecting the electrodes.

(f) The original mass of the copper coin used was 12.8g. Calculate the number of moles of copper in the coin. *(2 marks)*

   (Cu = 64)

19. Sulphur dioxide gas was prepared in the laboratory by heating sodium sulphite (Na_2SO_3) with hydrochloric acid. The gas was dried and collected by downward delivery.

(a) Write a balanced chemical equation for the reaction between sodium sulphite and hydrochloric acid. *(2 marks)*

(b) Name one reagent that is used to dry sulphur dioxide. Why is such a reagent unsuitable for drying ammonia gas?

(2 marks)

(c) State the name of the solution produced by disolving sulphur dioxide in water and give the approximate pH of that solution.

(2 marks)

(d) Calculate the percentage by mass of sulphur in the compound sodium sulphite (Na_2SO_3).

[Na = 23, S = 32, O = 16]

(2 marks)

(e) Explain one undesirable effect of sulphur dioxide on the environment.

(2 marks)

20. Calcium (atomic number 20) and fluorine (atomic number 9) combine to form a chemical compound called calcium fluoride.

(a) Explain the type of bonding that is present in calcium fluoride.

(2 marks)

(b) Give the electronic configuration of the calcium and fluoride ions.

(2 marks)

(c) Would you expect the melting point of calcium fluoride to be high or low? Explain your answer.

(2 marks)

(d) Mg (atomic number 12) is in the same group of the Periodic Table as calcium.

    (i) In which group are the two metals found. Give a reason for your answer.

(2 marks)

    (ii) Compare the reactivities of the two metals with water and give a reason for your answer.

(2 marks)

SECTION C: Attempt ONLY ONE question. *(15 marks)*

21. A sample of rock was analysed to determine if it contained the following ions: Fe^{2+}, NH_4^+, Cl^- and CO_3^{2-}. First it was crushed into a fine powder and then nitric acid was added. A vigorous reaction occurred. The mixture was filtered and the filtrate was analysed.

(a) Why was the sample of rock crushed into a fine powder? *(2 marks)*

(b) Define the term "filtrate". *(1 mark)*

(c) Name the gas produced when nitric acid was added. How would you test the gas? Give the reagent you would use and the expected observation. *(3 marks)*

(d) Describe a chemical test you would carry out to confirm the presence of the following ions. In each case state the reagent and the expected observation for a positive result.

(i) Fe^{2+} : *(2 marks)*

(ii) NH_4^+ *(2 marks)*

(iii) Cl^- : *(2 marks)*

(e) Suppose a piece of magnesium metal is added to the filtrate. Which of the ions stated above will react with magnesium? Write a balanced equation for the reaction. *(3 marks)*

22. Precipitation is one of the methods for preparing salts. Lead sulphate ($PbSO_4$) was prepared by mixing 25 cm³ of $0.2 moldm^{-3}$ lead nitrate [$Pb(NO_3)_2$] solution with 25 cm³ of $0.2 moldm^{-3}$ magnesium sulphate ($MgSO_4$) solution. The mixture was filtered to separate the products.

(a) State which salt was in the residue and which salt was in the filtrate. *(2 marks)*

(b) Write a balanced equation for the reaction. *(2 marks)*

(c) Calculate the number of moles of lead nitrate in 25 cm³ of the solution. *(2 marks)*

(d) Calculate the number of moles of magnesium sulphate in 25 cm³ of the solution. *(2 marks)*

(e) State the number of moles of lead sulphate formed. Calculate the molar mass of lead sulphate. Hence calculate the mass of lead sulphate produced.

(Pb = 207, S = 32, O = 16) *(4 marks)*

(f) Write a balanced equation to represent the thermal decomposition of lead nitrate. *(2 marks)*

(g) State one observation you would make if sodium hydroxide solution is added to aqueous lead ions (Pb^{2+}). *(1 mark)*