

Chemistry III

025

22 Nov. 2005

8h30 – 11h30

RWANDA NATIONAL EXAMINATIONS COUNCIL



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NATIONAL EXAMINATION 2005

SUBJECT: CHEMISTRY III

LEVEL : TRONC COMMUN

DURATION : 3 HOURS

INSTRUCTIONS :

Answer ALL questions in Section A,

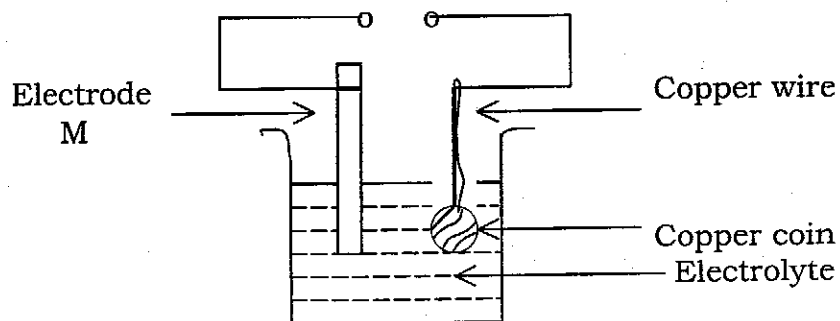
Choose THREE questions from Section B and ONE question from Section C.

Calculators may be used.

SECTION A: Answer ALL questions.

1. Element X has atomic number 13 and element Y has atomic number 8
- (a) Give the electronic arrangement of element X. (1mark)
 - (b) In which group of the periodic table is element X? (1mark)
 - (c) State the name of the bond formed when X combines with Y. (1mark)
 - (d) Give the formula (using X and Y as symbols) of the compound formed when X combines with Y. (1mark)
2. Acid rain can cause damage to plant and animal life. It is formed when gases produced in industry are allowed to escape and react with moisture in the atmosphere. If this rain has a p^H of less than seven then it is acidic.
Sulphur dioxide and an oxide of nitrogen are the main gases responsible for acid rain.
- (a) Give the name of the acid formed when sulphur dioxide dissolves in water. (1mark)
 - (b) Write a balanced equation for the reaction of sulphur dioxide with water. (1mark)
 - (c) Give the name of the oxide of nitrogen that dissolves in water to form an acid. (1mark)
 - (d) Give the name of an acid produced in the reaction in (c). (1mark)
3. This question concerns the following compounds
Ammonium Chloride
Barium Chloride
Copper (II) nitrate
Hydrated Copper (II) Sulphate
Potassium nitrate.
- (a) From the above list of compounds select one which, on heating
 - (i) changes from blue to white (1mark)
 - (ii) gives off brown fumes (1mark)
 - (iii) forms two gases as the only products. (1mark)
 - (b) Aqueous solutions of two of the above compounds were mixed and a white precipitate was produced.
 - (i) Give the names of the two compounds. (1mark)
 - (ii) Write an ionic equation for the reaction including state symbols. (2marks)

4. The simple diagram shows how a Copper coin is electroplated with silver.



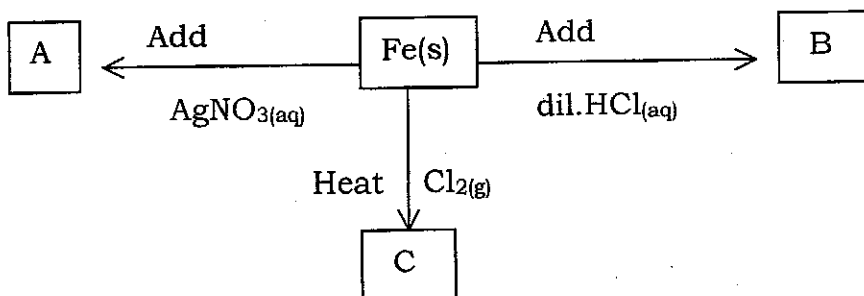
- Name the electrolyte which should be used in this process. **(1mark)**
 - Name the metal used as electrode M. **(1mark)**
 - Give the polarities of the two electrodes, that is, the positive and the negative electrodes. **(2marks)**
 - Give an ionic equation for the reaction which occurs on the surface of the copper coin. **(1mark)**
5. The table below shows the results of tests carried out on salt P. Study the table and answer the questions which follow.

Tests on salt P solution	Observations
(a) Add dilute NaOH solution	A white precipitate which dissolves in excess
(b) Add dilute ammonia solution	A white precipitate which is insoluble in excess
(c) Add dilute H_2SO_4 solution	No change
(d) Add aqueous HNO_3 followed by AgNO_3 solution	A white precipitate

- State the name or the formula of the cation in P. **(1mark)**
 - State the name or the formula of the anion in P. **(1mark)**
 - Give the formula of the white solid formed in test (d). **(1mark)**
 - Classify the hydroxide of the cation in P as basic or Acidic or Neutral or Amphoteric. **(1mark)**
6. An oxide of copper was reduced to copper by passing dry hydrogen gas over the hot oxide. After the reduction process more hydrogen was allowed to pass over the solid product as it cooled. 0.40g of the oxide of copper was decreased to 0.32g of copper.
- Calculate the number of moles of copper produced. **(2marks)**
 - Calculate the number of moles of oxygen atoms produced. **(2marks)**

- (c) In what ratio does copper combine with oxygen. **(1mark)**
(Atomic mass: Cu = 64; O = 16)
7. Ammonia gas is prepared by heating ammonium chloride with calcium hydroxide. It is dried by passing it over calcium oxide and collected by upward delivery.
- (i) Why is conc. sulphuric acid not used to dry ammonia gas? **(2marks)**
- (ii) Describe a chemical test for ammonia gas. **(1mark)**
- (iii) A student attempted to collect ammonia gas over water. Why did the student not succeed? **(1mark)**
- (iv) What can be deduced about the density of ammonia from the method which was used to collect it in the above experiment? **(1mark)**
8. Calculate the percentage of oxygen in the salt $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (Cu = 64, S = 32, O = 16, H = 1) **(4marks)**
9. Give the meaning of the following terms
- (a) isotopes (b) Allotropes **(4marks)**
10. Iron is extracted from haematite (Fe_2O_3) by reduction using carbon monoxide.
- (a) Write a balanced equation for the reaction. **(2marks)**
- (b) Give two ways in which the environment is affected by the process of extracting iron. **(2marks)**
11. (a) An organic compound of molecular formula C_4H_8 reacts with bromine water (aqueous bromine) to form a colourless product. Write down the structural formulae of C_4H_8 . **(1mark)**
- (b) One of the members of a family of organic compounds has the formula C_5H_{12} .
Give the name of the organic compound whose formula is C_5H_{12} . **(1mark)**
12. An organic compound contains 40% of carbon, 53.3% of oxygen and 6.7% of hydrogen by mass.
- (a) Calculate the empirical formula of the compound. **(3marks)**
- (b) Given that its relative molecular mass is 90, determine its molecular formula. **(2marks)**

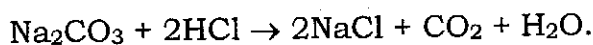
13. Some reactions involving iron are shown below



- Give the formulae of the products formed in box A. (1mark)
- Give the formulae of the products formed in box B. (1mark)
- What is the formula of the compound formed in box C? (1mark)

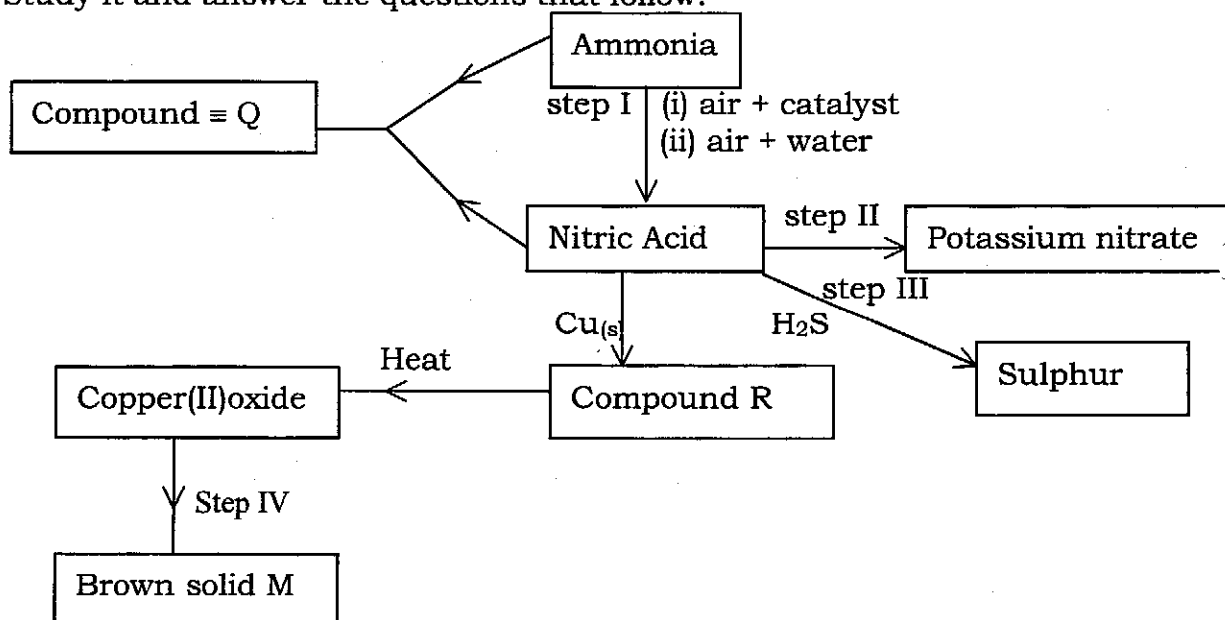
SECTION B: Answer THREE questions from this section.

14. In an experiment it was found that 25cm³ of sodium carbonate solution reacted completely with 20cm³ of 2 mol dm⁻³ hydrochloric acid (2M HCl) as follows:



- Calculate the number of moles of HCl in 20 cm³ of 2 mol dm⁻³ HCl. (2marks)
 - Calculate the concentration of sodium carbonate in mol dm⁻³. (3marks)
 - Calculate the mass of sodium carbonate in grams present in 1 dm³ of the solution (Na = 23, C = 12, O = 16) (2marks)
 - Describe how a pure dry sample of sodium chloride would be obtained from a mixture of sodium carbonate and hydrochloric acid assuming that the two reagents have reacted completely leaving none of the two reagents in excess. (3marks)
15. Sulphur dioxide and oxygen react to form Sulphur trioxide according to the equation:
- $$2\text{SO}_{2(g)} + \text{O}_{2(g)} \rightleftharpoons 2\text{SO}_{3(g)}$$
- Exothermic reaction in the forward direction.
- What does the symbol $\rightleftharpoons$ mean? (1mark)
 - What is the effect of increasing temperature
 - on the rate of the reaction?
 - on the amount of Sulphur trioxide present at equilibrium?
 (2marks)
 - This reaction forms the basis of the industrial manufacture of

- (ii) State the temperature and pressure at which the reaction is carried out.
- (iii) How is the Sulphur trioxide converted into sulphuric acid? **(5marks)**
- (d) State 2 large scale uses of sulphuric acid. **(2marks)**
16. (a) With the aid of a well labelled diagram, describe the preparation of dry hydrogen chloride gas from concentrated sulphuric acid and sodium chloride. **(8marks)**
- (b) Write balanced equations to show how hydrogen chloride gas reacts with:
- (i) ammonia gas
- (ii) hot iron metal **(2marks)**
17. (a) With the aid of a labelled diagram, describe how you would prepare dry carbon dioxide gas from calcium carbonate (marble chips). **(6marks)**
- (b) Write balanced equations to show carbon dioxide reacts with
- (i) hot magnesium.
- (ii) hot carbon. **(2marks)**
- (c) Briefly explain the effect of carbon dioxide as a "green house gas" **(2marks)**
18. The chart below shows some reactions starting with ammonia. Study it and answer the questions that follow:



- (a) Give the name of the catalyst used in step I. **(1mark)**
- (b) Name the process that takes place in step II. **(1mark)**

- (c) Is the change from H_2S to sulphur oxidation or reduction?
Give a reason for your answer. (2marks)
- (d) Give the name of a compound that would react with the aqueous solution of R to form solid M. (1mark)
- (e) Give the chemical formula of compound Q. (1mark)
- (f) Calculate the percentage by mass of nitrogen present in compound Q ($\text{H} = 1$, $\text{N} = 14$, $\text{O} = 16$) (2marks)
- (g) Give the names of three elements found in most artificial fertilizers. (1mark)
- (h) State one environmental disadvantage of using artificial fertilizers. (1mark)

SECTION C: Answer only ONE question from this section.

19. A student reacted metal H with a colourless liquid I in a beaker. A vigorous reaction was observed and a colourless gas J was given out. On standing, a white precipitate L was formed. He filtered the precipitate L and collected the colourless filtrate M. He dried the solid L. On heating, the solid L gave out a vapour which condensed into a colourless liquid I and a solid O remained. When cold liquid I was added to solid O heat was given out. When carbon dioxide was bubbled through liquid M, a white precipitate P was observed which disappeared on further bubbling of carbon dioxide. A colourless solution Q remained.

NB: The letters used in this question are not the actual symbols of any elements implied.

- (a) Identify the substances represented by the following letters:

H, I, J, L, M, O, P, Q

(8marks)

- (b) Using the actual symbols or formulae of the substances identified, write an equation for the reaction that occurred between

(i) metal H and substance I.

(2marks)

(ii) substance P, water and carbon dioxide.

(2marks)

- (c) Chlorine gas is bubbled through a colourless aqueous solution of potassium bromide.

Describe what is observed and write an equation for the reaction that occurs.

(3marks)

20. (a) Draw a well labeled diagram showing electrolysis of dilute sulphuric acid (so called electrolysis of water). **(7marks)**
- (b) Write equations to show the reactions taking place at the cathode and anode. **(2marks)**
- (c) If 5 ml of gas are collected at the cathode, what volume of gas is collected at the anode? **(1marks)**
- (d) Give one example of
- (i) strong electrolyte
 - (ii) weak electrolyte
 - (iii) conductors
 - (iv) Non-conductors
 - (v) Non-electrolyte. **(5marks)**