Chemistry III

025

22nd 2005 8.30am-11.30am

REPUBLIC OF RWANDA

NATIONAL EXAMINATIONS COUNCIL
P.O.BOX 3817 KIGALI

ORDINARY LEVEL NATIONAL EXAMINATION 2005

SUBJECT : CHEMISTRY III

LEVEL : TRONC COMMUN

TIME : 3 HOURS

INSTRUCTIONS:

- This paper consists of **THREE** Sections A, B and C.
- Answer **ALL** the questions in section A. **(55 marks)**
- Answer **THREE** questions in section B. **(30 marks)**
- Answer only **ONE** question in section C. **(15 marks)**
- Calculators may be used.

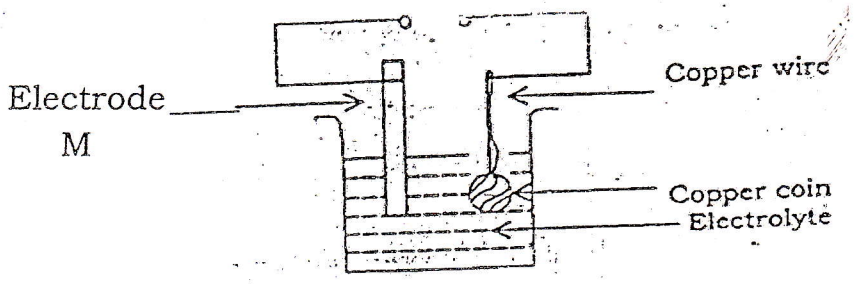
**SECTION A: Answer ALL questions.**

1. Element X has atomic number 13 and element Y has atomic number 8.
   a) Give the electronic arrangement of element X. **(1 mark)**
   b) In which group of periodic table is element X? **(1 mark)**
   c) State the name of the bond formed when X combines with Y. **(1 mark)**
   d) Give the formula (using X and Y as symbols) of the compound formed when X combines with Y. **(1 mark)**

2. Acid rain can cause damage to plant life and animal life. It is formed when gases produced in industries 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. **(1 mark)**
   b) Write a balanced equation for the reaction of sulphur dioxide with water. **(1 mark)**
   c) Give the name of the oxide of nitrogen that dissolves in water to form an acid. **(1 mark)**
   d) Give the name of an acid produced in the reaction in (c). **(1 mark)**

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. **(1 mark)**
      ii) Gives off brown fumes **(1 mark)**
      iii) Forms two gases as the only products. **(1 mark)**
   b) Aqueous solutions of two of the above compounds were mixed and a white precipitate was formed.
      i) Give the names of the two compounds. **(1 mark)**
      ii) Write an ionic equation for the reaction including state symbols. **(2 marks)**

4. The diagram below shows a copper coin electroplated with silver.




   a) Name the electrolyte which should be used in this process. **(1 mark)**
   b) Name the metal used as electrode M. **(1 mark)**
   c) Give the polarities of the two electrodes, that is, the positive and the negative electrodes. **(2 marks)**
   d) Give an ionic equation for the reaction which out on salt P. study the table and answer the questions which follow.

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 | Observation |
|---|---|
| Add dilute NaoH solution | A white precipitate which dissolves in excess |
| Add dilute ammonia solution | A white precipitate which is insoluble in excess |
| Add dilute $H_2SO_4$ solution | No change |
| Add aqueous $HNO_3$ followed by $AgNO_3$ solution | A white precipitate |

a) State the name or the formula of the cation in P. (1 mark
b) State the name or formula of the anion in P. (1 mark
c) Give the formula of the white solid formed in test (d). (1 mark
d) Classify the hydroxide of the cation in P as basic or acidic or neutral or Amphoteric. (1 mark)

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. 0.4g of the oxide of copper was decreased to 0.32g of copper.

a) Calculate the number of moles of copper produced. (2 marks)
b) Calculate the number of moles of oxygen atoms produced. (2 marks)
c) In what ratio does copper combine with oxygen? (1 mark)
(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? (2 marks)
ii) Describe a chemical test for ammonia gas. (1 mark)
iii) A student attempted to collect ammonia gas over water. Why did the student not succeed? (1 mark)
iv) What can be deduced about the density of ammonia from the method which was used to collect it in the above experiment? (1 mark)

8. Calculate the percentage of oxygen in the salt $CuSO_4.5H_2O$. (4 marks)
(Cu = 64, S = 32, O = 16, H = 1)

9. Give the meaning of the following terms.

i) Isotopes ii) Allotropes. (4 marks)

10. Iron is extracted from haematite ($Fe_2O_3$) by reduction using carbon monoxide.

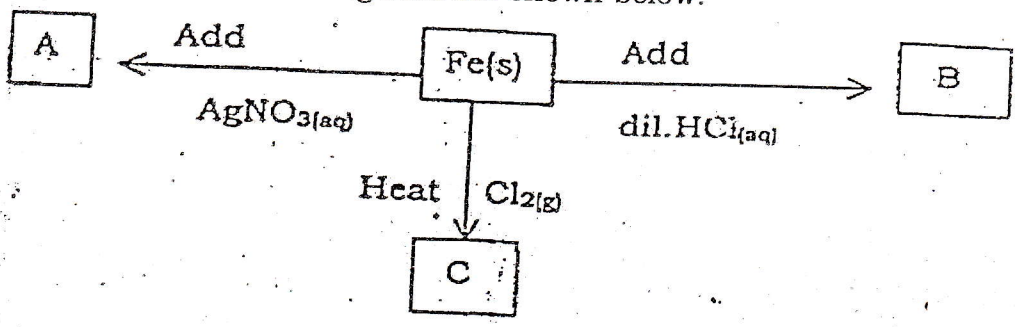
a) Write a balanced equation for the reaction. (2 marks)
b) Give two ways in which the environment is affected by the process of extracting iron. (2 marks)

11. a) An organic compound of molecular formula $C_4H_8$ reacts with bromine water (aqueous bromine) to form a colorless product. Write the structural formula of $C_4H_8$ (1 mark)
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 $C_5H_{12}$. (1 mark)

12. An organic compound contains 40% of carbon. 53.3% of oxygen and 7% of hydrogen by mass.

a) Calculate the empirical formula of the compound. (3 marks)
b) Given that its relative molecular mass is 90, determine its molecular formula. (2 marks)

13. Some reactions involving iron are shown below.



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

**SECTION B: Answer THREE questions from this section.**

14. In an experiment, it was found that 25cm³ of sodium carbonate solution reacted with 20cm³ of 2 mol dm³ hydrochloric acid (2M HCl) as follows:
$Na_2CO_3 + 2HCl \longrightarrow 2NaCl + CO_2 + H_2O$.

a) Calculate the number of moles of HCl in 20cm³ of 2 mol dm³ HCl. (2 marks)
b) Calculate the concentration of sodium carbonate mol $dm^{-3}$.
c) Calculate the mass of sodium carbonate in grams present in 1 dm³ of solution. (Na = 23, C = 12, O = 16. (2 marks)
d) 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 regents in excess. (3 marks)

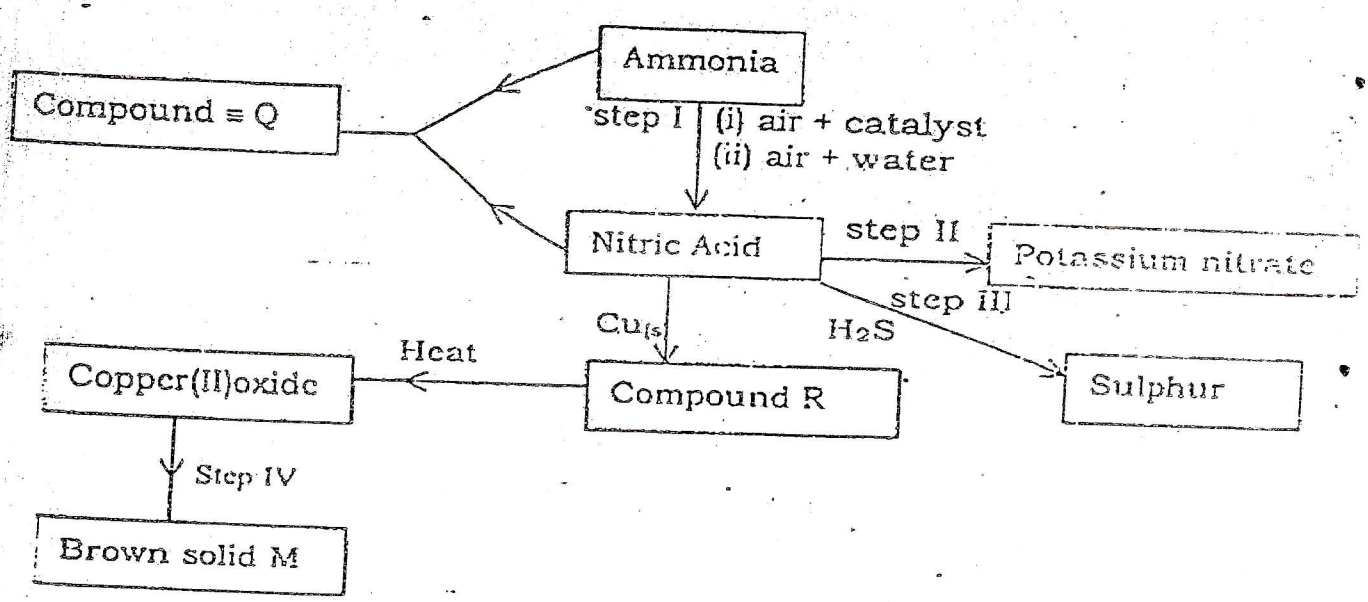
15. Sulphur dioxide and oxygen react to form sulphur trioxide according to the equation:
$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ Exothermic reaction in the forward direction.

a) What does the symbol $\rightleftharpoons$ mean? (1 mark)
b) What is the effect of increasing temperature:
i) On the rate of the reaction? (1 mark)
ii) On the amount of sulphur trioxide present at equilibrium? (1 mark)
c) i) This reaction forms the basis of the industrial manufacture of..... (1 mark)
ii) State the temperature and pressure at which the reaction is carried out.
iii) How is the sulphur trioxide converted into sulphuric acid? (5 marks)
d) State 2 large scale uses of sulphuric acid. (2 marks)

16. a) With the aid of a well labeled diagram, describe the preparation of dry hydrogen chloride gas from concentrated sulphuric acid and sodium chloride. (8 marks)
b) Write balanced equations to show how hydrogen chloride gas reacts with:
i) Ammonia gas
ii) Hot iron metal (2 marks)

17. a) With aid of a labeled diagram, describe how you would prepare dry carbon dioxide gas from calcium carbonate (marble chips). (6 marks)
b) Write balanced equations to show how carbon dioxide reacts with
i) Hot magnesium
ii) Hot carbon. (2 marks)
c) Briefly explain the effect of carbon dioxide as a "green house gas" (2 marks)

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. (1 mark)

b) Name the process that takes place in step II. (1 mark)

c) Is the change from $H_2S$ to sulphur oxidation or reduction? Give a reason for your answer. (2 marks)

d) Give the chemical name of a compound that would react with the aqueous solution of R to form solid M. (1 mark)

e) Give the chemical formula of compound Q. (1 mark)

f) Calculate the percentage by mass of nitrogen present in compound Q. (H = 1, N = 14, O = 16) (2 marks)

g) Give the names of three elements found in most artificial fertilizers. (1 mark)

h) State one environmental disadvantage of using artificial fertilizers. (1 mark)

**SECTION C: Answer only ONE question from this section.**

19. A student reacted metal H with a colorless liquid in a beaker. A vigorous reaction was observed and a colorless gas J was given out. On standing, a white precipitate L was formed. He filtered the precipitate L and collected the colorless filtrate M. He dried the solid L. On heating, the solid L gave out a vapor which condensed into a colorless 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 colorless 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, K, M, O, P, Q. (8 marks)

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. (2 marks)

ii) Substance P, water and carbon dioxide. (2 marks)

c) Chlorine gas is bubbled through a colorless aqueous solution of potassium bromide. Describe what is observed and write an equation for the reaction that occurs. (3 marks)

20. a) Draw a well labeled diagram showing electrolysis of dilute sulphuric acid (so called electrolysis of water). (7 marks)

b) Write equations to show the reactions taking place at the cathode and anode. (2 marks)

c) If 5ml of gas are collected at the cathode, what volume of gas is collected at the anode? (1 mark)

d) Give one example of:

i) A strong electrolyte
ii) A weak electrolyte
iii) A Conductor
iv) A non-conductor
v) A non-electrolyte (5 marks)

**END.**

**CHEMISTRY III 2005**

**SECTION A**

| | |
|---|---|
| **Answer to question 1.**<br>a) X: 2, 8, 3<br>b) Group 3<br>c) ionic/ electrovalent<br>d) $X_2Y_3$ | **Answer to question 2.**<br>a) Sulphorous acid<br>b) $SO_2 + H_2O \longrightarrow H_2SO_3$<br>c) Nitrogen dioxide<br>d) Nitric acid / Nitrous acid. |
| **Answer to question 3.**<br>a) i) Hydrated copper II sulphate.<br>ii) Copper II nitrate<br>iii) Ammmonium chloride.<br>b) i) Hydrated copper II sulphate and barium chloride.<br>ii) $Ba^{2+}{}_{(aq)} + SO_4^{2-}{}_{aq)} \longrightarrow BaSO_{4(s)}$ (White precipitate). | **Answer to question 4.**<br>a) Copper II sulphate<br>b) Solver/platinum<br>c) $M \longrightarrow +$ (positive)<br>d) $Ag^+{}_{(aq)} + e \longrightarrow Ag_{(s)}$ |
| **Answer to question 5.**<br>a) Aluminium ion ($Al^{3+}$)<br>b) Chloride ion (Cl)<br>c) AgCl<br>d) Amphoteric | **Answer to question 6.**<br>a) Number of moles = $\frac{mass}{Rmm} = \frac{0.32}{64} = 0.005$<br>b) 1st find the mass of oxygen = 0.40 – 0.32<br>= 0.08<br>Number of moles of oxygen $\frac{0.08}{16} = 0.005$<br>c) Cu O<br>$\frac{0.005}{0.005}$ $\frac{0.005}{0.005}$<br>1 1<br>Ratio of Cu: 0 = 1:1 |
| **Answer to question 7.**<br>i) It reacts with it.<br>ii) Pass ammonia through a gas jar of HCl, white fumes are observed.<br>i.e. $NH_3 + HCl \longrightarrow NH_4Cl$<br>iii) Ammonia gas is very soluble in water. | |

**Answer to question 8.**

First Rmm of $CuSO_4.\ 5H_2O$.

$64 + 32 + 16\times4 + 5(1\times 2 + 16)$

$64 + 64 + 32 + 90 = 250$.

% oxygen = 64 + 80

$= \frac{144\times100}{250} = 57.6\%$.

**Answer to question 9.**

i) Isotopes are atoms of the same element with same atomic number but different mass numbers.

ii) Allotropes are different forms in which an element can exist.

**Answer to question 10.**

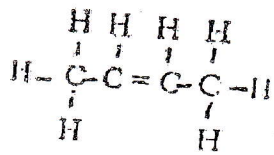
a) $Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$

b) - It causes soil erosion

- It may global warming.

**Answer to question 11.**

(a)



b) Pentane

**Answer to question 12.**

a)

| C | H | O |
|---|---|---|
| $\frac{40}{12}$ | $\frac{6.7}{1}$ | $\frac{53.3}{16}$ |
| $\frac{3.33}{3.33}$ | $\frac{6.7}{3.33}$ | $\frac{3.33}{3.33}$ |
| 1 | 2 | 1 |

Empirical formula is $CH_2O$

$(CH_2O)_n = 90$.

$(12 + 1\times2 + 16)n = 90$

$30n = 90$

$n = \frac{90}{30} = 3$.

b) M.F = $(CH_2O)_3$ = $C_3H_6O_3$

**Answer to question 13.**

a) A = $Fe(NO_3)_2 + 2Ag$

b) B = $FeCl_2 + H_2$

c) C = $FeCl_3$

## SECTION B

**Answer to question 14.**

a) Number of moles of HCl = $\frac{2\times20}{1000} = \frac{4}{100} = 0.04$.

b) From the above equation:

2 moles of HCl reacts with 1 mole of $CO_3^{2-}$

1 mole of HCl reacts with $\frac{1}{2}$ moles of $CO_3^{2-}$

But Number of moles = $\frac{\text{molarity} \times \text{volume}}{1000}$

$0.02 = \frac{Mb\times100}{25} = 0.8M$.

c) Concentration in $g/dm^3$ = morality × Rmm

Rmm of $NaCO_3 = 23\times 2 + 12 + 16\times3$

$46 + 12 + 48 = 106$.

Concentation in $g/dm^3 = 0.8\times106$

$= 84.8 g/dm^3$

d) Evaporate the mixture to dryness.

**Answer to question 15.**

a) Reversible reaction.

b) i) It increases

ii) It decreases.

c) i) Temperature: 450°C - 500°C

ii) $SO_3$ is first dissolved in concentrated sulphuric acid

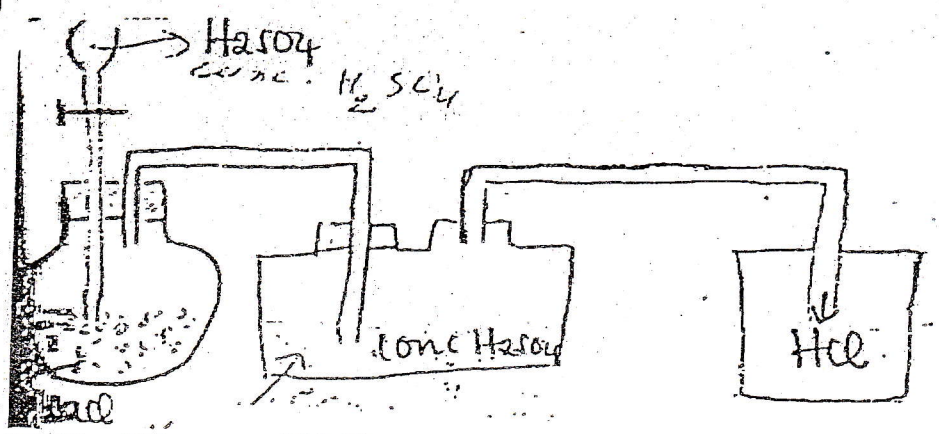
i.e. $SO_3 + H_2SO_4$

d) – It is used in the manufacture of fertilizers.

- Used in the manufacture of soaps and detergents.

**Answer to question 16.**

a)

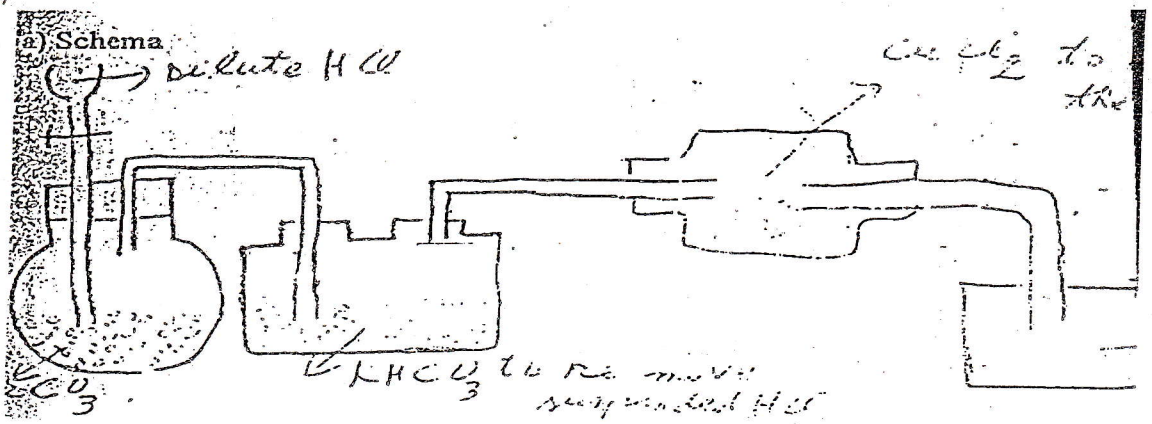



b) i) $HCl + NH_3 \longrightarrow NH_4Cl$

ii) $Fe + 2HCl \longrightarrow FeCl_2 + H_2$

**Answer to question 17.**

a)




b) i) $CO_2 + Mg \longrightarrow 2MgO + C$.

ii) $CO_2 + C = 2CO$.

c) When $CO_2$ accumulates in the atmosphere; it forms a blanket preventing the penetration of reflected radiations here causing global warming.

**Answer to question 18.**

a) Platinum – Rhodium gauze

b) Neutralization

c) Oxidation: Reason: $H_2$ has been removed from $H_2O$.

d) A compound of any metal above copper in the reactivity series.

e) $NH_4NO_3$

f) Rmm of $NH_4NO_3$ = 14 + 1×4+14+16×3

28+4+48 = 80 ⇒ % of nitrogen = $\frac{28}{80} \times 100$

= 35%.

h) May cause water pollution of land pollution.

**20. d)** i) NaOH

ii) $CH_3COOH$

iii) Copper (any metal)

iv) Plastics

v) Sugar solution.

**SECTION C**

**Answer to question 19.**

a) H = Ca, I = water, J = $H_2$, L = $Ca(OH)_{2(s)}$ ,

M = $Ca(OH)_{2(aq)}$ , O = CaO, Q = $Ca(OH)_2$.

b) i) $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2$.

ii) $CaCO_3 + H_2O + CO_2 \longrightarrow Ca(HCO_3)_2$

c) There is color change from colorless to red.

$2KBr + Cl_2 \longrightarrow 2KCl + Br$

**Answer to question 20.**

a) Teacher's guidance.

b) At cathode (-) At Anode (+)

$2H^+ + 2\bar{e} \longrightarrow H_2$ $4OH^- - 4\bar{e} \longrightarrow 2H_2O + O_2$

c) At the anode: $\frac{5}{2}$ = 2.5ml of $O_2$

**END**