



NATIONAL EXAMINATIONS COUNCIL  
P.O.BOX 3817 KIGALI

Chemistry III  
025  
12<sup>th</sup> Oct 2004 8.30am-11.30am

ORDINARY LEVEL NATIONAL EXAMINATION 2003/2004

SUBJECT : CHEMISTRY III

LEVEL : ORDINARY LEVEL

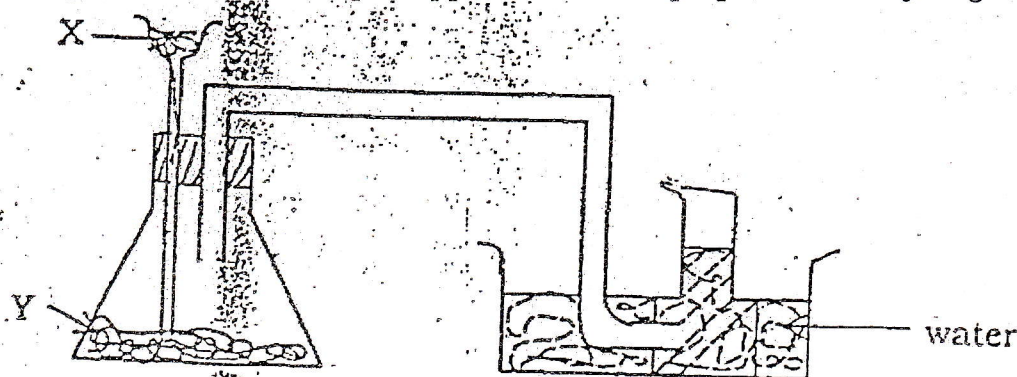
TIME : 3 HOURS

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.**

1. The figure below is a set up of apparatus for the preparation of hydrogen.



a) Identify X and Y:

X is: .....

(1 mark)

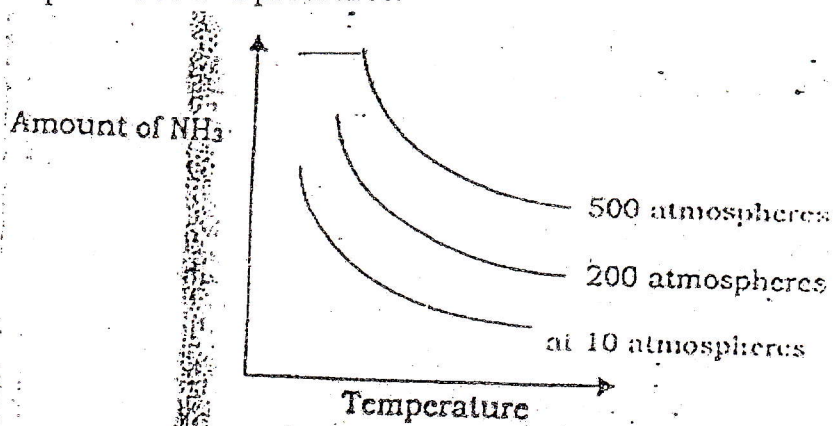
Y is: .....

(1 mark)

b) Write an equation for the formation of hydrogen. (1 mark)

2. Nitrogen reacts with Hydrogen to produce ammonia as shown by the following equation:  $N_{2(g)} + 3H_{2(g)} = 2NH_{3(g)} + \text{Heat}$

The sketch graph below shows the amount of ammonia produced at various temperatures and pressures.



a) How does the amount of ammonia vary with temperature? (1 mark)

b) How does the amount of ammonia vary with pressure? (1 mark)

c) Suggest the catalyst for the reaction between nitrogen and hydrogen. (1 mark)

(1 mark)

(1 mark)

(1 mark)

3. The table below shows an experiment carried out on an aqueous solution of salt A. Study the table and answer the questions that follow.

| Experiment on salt A     | Observation                                          |
|--------------------------|------------------------------------------------------|
| Add dilute NaOH solution | A white precipitate which doesn't dissolve in excess |
| Add aqueous ammonia      | A white precipitate insoluble in excess              |
| Add dilute HCL solution  | A white precipitate that dissolves on boiling        |

i) What is the cation in salt A? (1 mark)

(1 mark)

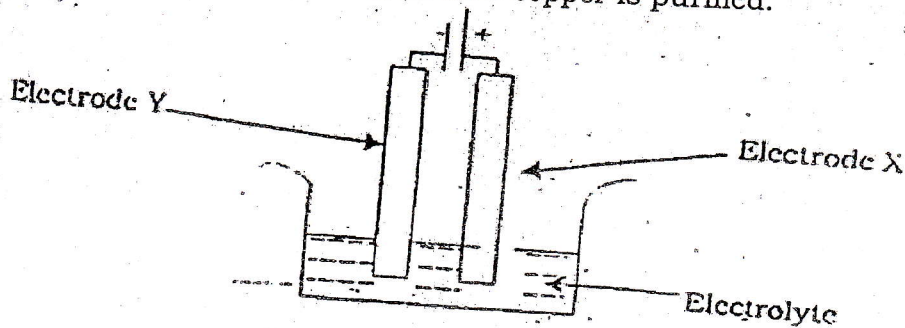
ii) Write a balanced equation for the reaction in experiment (c) as shown in the table above. (1 mark)

(1 mark)

iii) How would you obtain a dry sample of the precipitate in experiment (a)? (2 marks)

(2 marks)

4. The simple diagram below shows how copper is purified.



- a) State which electrode is the anode. (1 mark)
- b) Name the substance that is used as the cathode. (1 mark)
- c) Name the electrolyte used in the process. (1 mark)
- d) Write an equation to show the reaction taking place at the cathode. (1 mark)
5. a) Write the formula of the oxides of:
- Sulphur (1 mark)
  - Iron (1 mark)
- b) State the type of bond that exists in the oxide of:
- Sulphur: (1 mark)
  - Iron: (1 mark)
6. Dry hydrogen gas was passed over 6.85g of heated lead II oxide. When the reaction was over, the solid residue was weighted.
- a) Write a balanced equation of the reaction. (1 mark)
- b) Calculate the mass of the residue. The atomic masses are: Pb = 207, O = 16, H = 1 (3 marks)
7. Element M belongs to group III of the periodic table.
- a) How many electrons does M have in the outer shell? (1 mark)
- b) Write the formula for:
- The oxide of M (1 mark)
  - The chloride for M. (1 mark)
  - Nitride of M (1 mark)
8. An oxide of X can be reduced by metal Q but not by metal R.
- a) Show the order of reactivity of the three metals starting with the least reactive. (1 mark)
- b) If metal Q is in group I of the periodic table, write the formula of the chloride of Q. (1 mark)
- c) State yes if X will displace Q from its chloride solution or no if it will not displace it. (1 mark)
9. A compound X of molecular mass 42 contains 85.7% carbon and the rest is hydrogen.
- a) Calculate the empirical formula of X: (C = 12, H = 1). (3 marks)
- b) Determine the molecular formula of X. (2 marks)
10. Oxygen can be prepared from hydrogen peroxide in the presence of a catalyst.
- a) Name the catalyst that is used in the above preparation. (1 mark)
- b) Write a balanced equation for the reaction. (1 mark)
- c) State two ways of increasing the rate of formation of oxygen. (2 marks)

11. Copy the following table in your answer booklet and match the ions in list A with their corresponding confirmatory chemical tests in list B.

| <u>List A</u>         | <u>List B</u>                                                |           |
|-----------------------|--------------------------------------------------------------|-----------|
| a) $\text{SO}_4^{2-}$ | Aqueous $\text{NH}_3$                                        |           |
| b) $\text{CO}_3^{2-}$ | $\text{HCl}_{(\text{aq})}$ and $\text{BaCl}_2_{(\text{aq})}$ |           |
| c) $\text{Zn}^{2+}$   | $\text{H}^+_{(\text{aq})}$                                   | (4 marks) |

12. Match the substances in List A with the corresponding environmental problems in List B.

| <u>List A</u>                | <u>List B</u>         |           |
|------------------------------|-----------------------|-----------|
| a) Carbon dioxide            | Ozone layer depletion |           |
| b) Sulphur dioxide           | Green house effect    |           |
| c) Chlorofluoro hydrocarbons | Acid rain             |           |
|                              | Soil erosion.         | (3 marks) |

13. Suggest the structural formulae for the following organic substances.

- |                     |           |
|---------------------|-----------|
| a) Methanoic acid   |           |
| b) Sodium ethanoate |           |
| c) Propene          | (3 marks) |

14. Sulphur dioxide and oxygen gases react according to the following equation:  
 $2\text{SO}_2 + \text{O}_2 = 2\text{SO}_3 + \text{Heat}$ . 100 liters of  $\text{SO}_2$  were mixed with 100 liters of oxygen.

- |                                                                      |           |
|----------------------------------------------------------------------|-----------|
| a) Calculate the volume of $\text{SO}_3$ produced.                   | (1 mark)  |
| b) Calculate the total volume of the gas present after the reaction. | (2 marks) |

15. Calculate the percentage of sulphur in  $\text{Fe}_2(\text{SO}_4)_3$ .  
 $\text{Fe} = 56, \text{S} = 32, \text{O} = 16$ .

(3 marks)

**SECTION B: (Choose three questions from this section)**

16. 20 cm<sup>3</sup> of sodium hydroxide solution reacted with 30cm<sup>3</sup> of 1M of sulphuric acid.

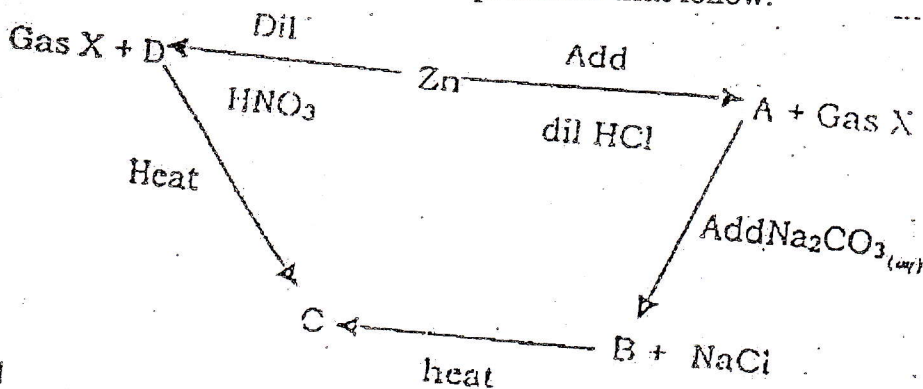
- |                                                                                                                               |           |
|-------------------------------------------------------------------------------------------------------------------------------|-----------|
| a) Write a balanced equation for the reaction.                                                                                | (1 mark)  |
| b) Calculate the molarity of sodium hydroxide and hence its concentration in gm/dm <sup>3</sup> .<br>(Na = 23, O = 16, H = 1) | (5 marks) |
| c) Name the products formed when concentrated sulphuric acid reacts with the following:                                       |           |
| i) Boiling it with sugar                                                                                                      |           |
| ii) Heating with ethanol at 170°C                                                                                             |           |
| iii) Heating with sodium chloride.                                                                                            |           |
| iv) Adding water to it.                                                                                                       | (4 marks) |

17. The table below shows the number of protons, neutrons and electrons in substances W, X, Y and Z. use the table to answer the following questions.

| Substance | No. of Protons | No. of Neutrons | No. of Electrons |
|-----------|----------------|-----------------|------------------|
| W         | 6              | 6               | 6                |
| X         | 9              | 10              | 10               |
| Y         | 12             | 12              | 10               |
| Z         | 19             | 20              | 19               |

- a) Which of the substances is:
- A cation? (1 mark)
  - An anion? (1 mark)
- b) Write the electronic configuration of Z. (1 mark)
- c) What is the mass number (relative mass) of Y? (1 mark)
- d) Write a chemical formula between Z and W when they have chemically combined. (1 mark)
- e) Z reacts very vigorously with water to make an alkaline solution. With the aid of relevant equations, explain how a pure sample of Z chloride can be obtained starting with Z,  $H_2O$  and  $HCl$ . (5 marks)

18. The following question is about some of the reactions of Zinc and its compounds. Study the chart below and answer the questions that follow.



- Name substances A, B, C, D and Gas X. (5 marks)
  - Write a balanced equation to show how substance D is converted to C on heating and state all the observations you would make when D is changing to C. (5 marks)
19. With aid of relevant diagrams, describe:
- An experiment to show that rusting of iron requires both oxygen and water. (6 marks)
  - State four ways of preventing rusting. (4 marks)
20. With aid of a well labeled diagram,
- Explain how sodium hydroxide can be manufactured (prepared on a large scale) (8 marks)
  - Suggest two uses of sodium hydroxide. (2 marks)

### SECTION C.

21. The table below shows results of an experiment to determine the rate of reaction between Zinc and Sulphuric Acid in presence of a catalyst. Study the table below and answer the questions that follow.

|                                  |   |    |    |      |    |    |    |
|----------------------------------|---|----|----|------|----|----|----|
| Time in minutes                  | 0 | 5  | 10 | 15   | 25 | 30 | 35 |
| Volume of gas produced in $cm^3$ | 0 | 10 | 20 | 25.5 | 32 | 32 | 32 |

- Suggest the catalyst for the reaction. (1 mark)
- Plot a graph of volume of gas evolved (Y-axis) against time (X-axis). (9 marks)
- Explain why the volume of the gas increases and then remains constant after 25 minutes. (2 marks)
- Suggest the ions present in the mixture at the end of the experiment. (3 marks)

22. Read the following passage and answer the questions that follow: To a black powder, P was added dilute  $H_2SO_4$  and a blue solution Q was formed. When NaOH solution was added to solution Q, a blue precipitate R was formed. When R was strongly heated, the black powder P was formed. When  $Na_2CO_3$  solution was added to Q, a green-blue precipitate S was formed. When S was strongly heated, a black powder was formed.

- a) Name and write the formula of substances P, Q, R and S. (8 marks)  
 b) Write balanced equations for the reactions mentioned in the passage. (7 marks)

23. a) With the aid of a well labeled diagram, describe an experiment to prepare dry carbon dioxide gas from solid calcium carbonate and dilute HCl Acid. (9 marks)

b) Why can't dilute  $H_2SO_4$  be used in this experiment? (2 marks)

c) Write balanced equations to show how  $CO_2$  reacts with the following:

i)  $H_2O$                       ii) NaOH. (2 marks)

d) State two uses of carbon dioxide. (2 marks)

END

### CHEMISTRY III 2003/2004

#### SECTION A

|                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                                                                                                                                                                     |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Answer to question 1.</b></p> <p>a) X is Zinc<br/>         Y is dilute <math>H_2SO_4</math></p> <p>b) <math>Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2</math></p>                                                                                                    | <p><b>Answer to question 2.</b></p> <p>a) The amount of ammonia increases with decrease in temperature and vice versa.</p> <p>b) The amount of ammonia increases with increase in pressure.</p> <p>c) Finely divided iron.</p>                                                                                                                      |
| <p><b>Answer to question 3</b></p> <p>i) Cation in salt A is <math>Pb^{2+}</math></p> <p>ii) <math>Pb^{2+} + 2Cl \longrightarrow PbCl_2</math></p> <p>iii) Filter the mixture to obtain <math>Pb(OH)_2</math> and then warm to evaporate any soluble substance in it.</p> | <p><b>Answer to question 4.</b></p> <p>a) Anode is electrode X.</p> <p>b) Pure copper.</p> <p>c) <math>CuSO_4</math> solution.</p> <p>d) <math>Cu^{2+}_{(aq)} + 2e \longrightarrow Cu_{(s)}</math></p>                                                                                                                                              |
| <p><b>Answer to question 5.</b></p> <p>a) i) <math>SO_2, SO_3</math><br/>         ii) <math>FeO, Fe_2O_3, Fe_3O_4</math></p> <p>b) i) Sulphur <math>\longrightarrow</math> covalent bond<br/>         ii) Iron <math>\longrightarrow</math> Electrovalent/ionic bond.</p> | <p><b>Answer to question 6.</b></p> <p>a) <math>PbO + H_2 \longrightarrow Pb + H_2O</math></p> <p>b) Rmm of <math>PbO = 207 + 16 = 223</math>.</p> <p>From the equation:<br/> <math>223 \text{ of } PbO \longrightarrow 207 \text{ g of } Pb</math><br/> <math>1 \text{ g of } PbO = \frac{207}{223} \times 6.85 = 6.35 \text{ g of } Pb</math></p> |
| <p><b>Answer to question 7.</b></p> <p>a) 3 electrons</p> <p>b) i) <math>M_2O_3</math><br/>         ii) <math>MCl_3</math><br/>         iii) NM</p>                                                                                                                       | <p><b>Answer to question 8.</b></p> <p>a) <math>R &lt; X &lt; Q</math>.</p> <p>b) <math>QCl</math></p> <p>c) No</p>                                                                                                                                                                                                                                 |

Answer to question 9.

a) % of H =  $100 - 85.7 = 14.3$

|              |             |
|--------------|-------------|
| C            | H           |
| <u>85.7</u>  | <u>14.3</u> |
| 12           | 1           |
| <u>7.142</u> | <u>14.3</u> |
| 7.142        | 7.142       |
| 1            | 2           |

Empirical formula is  $\text{CH}_2$ .

b) Molecular formula  $(\text{CH}_2)_n = 42$

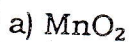
$(12 + 1 \times 2)n = 42$

$14n = 42$

$n = \frac{42}{14} = 3$

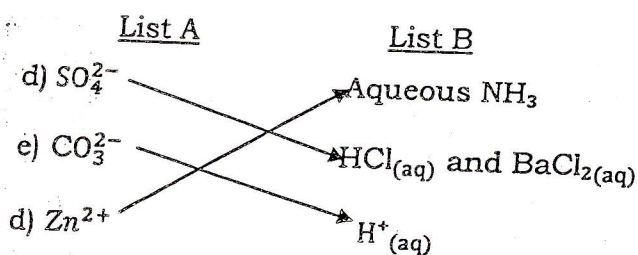
: molecular formula is  $(\text{CH}_2)_3 = \text{C}_3\text{H}_6$

Answer to question 10.

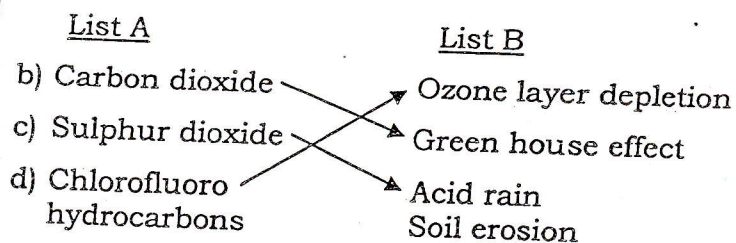


c) - Increasing the concentration of  $\text{H}_2\text{O}_2$   
 - Increasing temperature (heat) of the reactants.

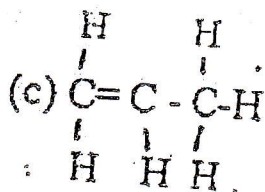
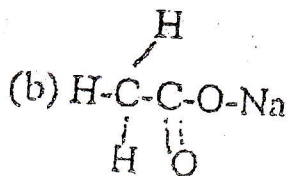
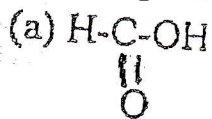
Answer to question 11.



Answer to question 12.

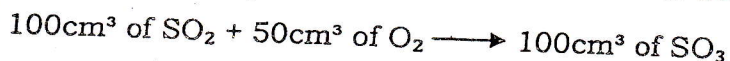
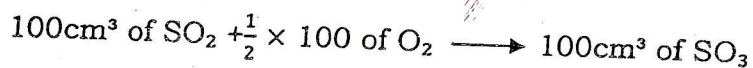
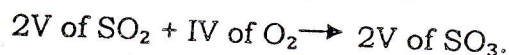


13. Answer to question



Answer to question 14.

a)



Volume of  $\text{SO}_3 = 100\text{cm}^3$ .

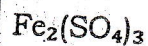
14. b) Total volume of the gas present after the reaction:

= Volume of  $\text{SO}_3$  produced + volume of unreacted oxygen.

Volume of unreacted oxygen =  $100 - 50 = 50\text{m}^3$

Total volume of the gas after the reaction =  $100 + 50 = 150\text{m}^3$

Answer to question 15.



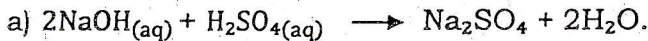
Rmm of  $\text{Fe}_2(\text{SO}_4)_3 = (56 \times 2) + (32 \times 3) + 16 \times 12 = 112 + 96 + 192 = 400$

% of sulphur in  $\text{Fe}_2(\text{SO}_4)_3$

$\frac{96}{400} \times 100 = 24\%$

**SECTION B**

**Answer to question 16.**



b)  $V_b = 20\text{cm}^3$      $N_a = 1$ ,     $M_b = 2$ .

$V_a = 3\text{cm}^3$

$M_a = 1$

c)  $M_b = ? \Rightarrow \frac{n_a}{n_b} = \frac{M_a \times V_a}{M \times V_b} \Rightarrow \frac{1}{2} = \frac{1 \times 30}{M_b \times 20}$

$2 \times 30 = M_b \times 20 \Rightarrow M_b = \frac{2 \times 30}{20} \Rightarrow M_b = 3M$

Concentration of NaOH in  $\text{g/dm}^3$  : Morality  $\times$  Rmm

$\Rightarrow$  Rmm of NaOH:  $23 + 16 + 1 = 40$ .

Concentration in  $\text{g/dm}^3 = 3 \times 40 = 12\text{g/dm}^3$ .

c) i) Carbon and steam

ii) Ethene and water

iii) Sodium hydrogen sulphate and hydrogen chloride gas

iv) Fumes and a lot of heat.

**Answer to question 17.**

a) i) Cation is Y.

ii) Anion is X.

b) Electronic configuration of Z is 2, 8, 8, 1.

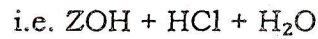
c) Mass number of Y =  $12 + 12 = 24$ .

d)  $Z_4W$ .

e) Z first reacts with water forming a hydroxide,



ZOH is then reacted with HCl,



Then the mixture i.e.  $\text{ZCl} + \text{H}_2\text{O}$  are heated to drive off the water which evaporates leaving a pure sample of ZCl.

**Answer to question 18.**

a) A -  $\text{ZnCl}_2 \rightarrow$  Zinc Chloride.

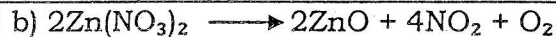
B -  $\text{ZnCO}_3 \rightarrow$  Zinc

Carbonate.

C -  $\text{ZnO} \rightarrow$  Zinc oxide

D -  $\text{Zn}(\text{NO}_3)_2 \rightarrow$  Zinc nitrate.

Gas X -  $\text{H}_2 \rightarrow$  Hydrogen.



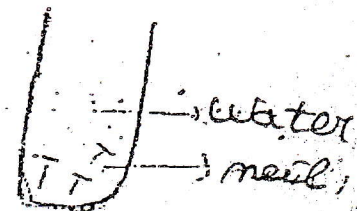
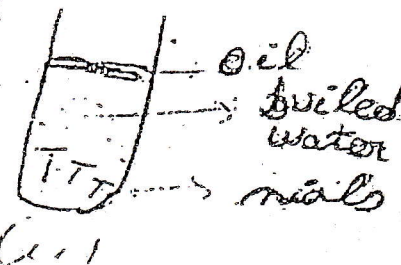
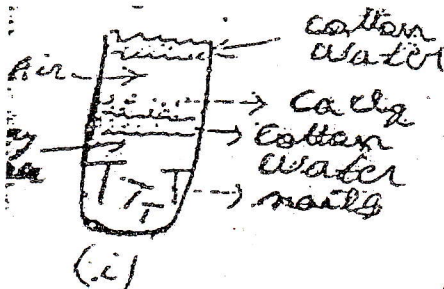
Observations: a yellow residue when hot and white on cooling ( $\text{ZnO}$ ) observed.

10) A brown gas ( $\text{NO}_2$ ) observed.

11) A colorless gas which re-lights glowing splint ( $\text{O}_2$ ) observed.

**Answer to question 19.**

a)



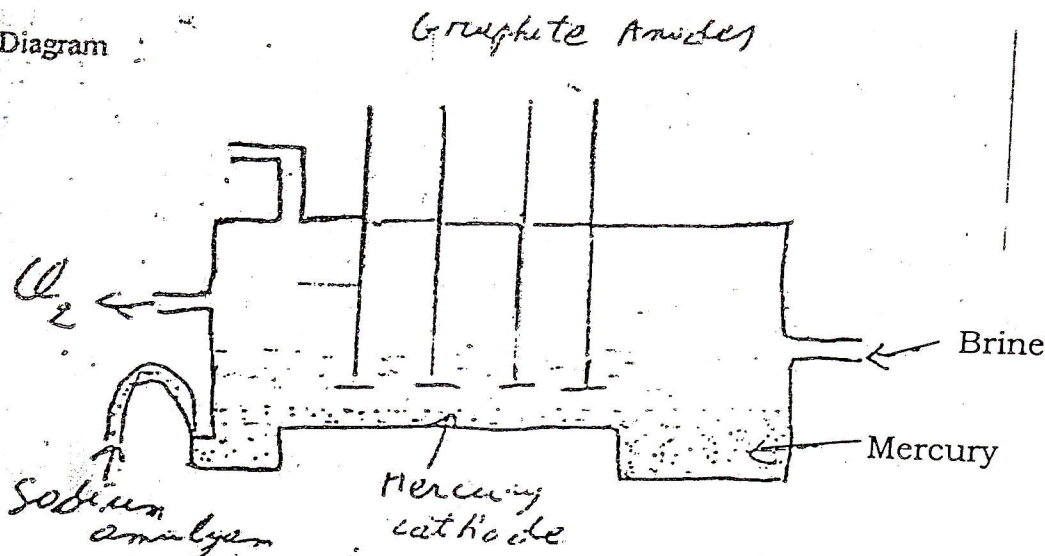


- In experiment (i), there is no moisture (water) since  $\text{CaCl}_2$  is used to absorb any moisture that may be present. So, no rusting takes place.
  - In experiment (ii), there is no air. Oil is used to prevent the entry of air hence no rusting takes place.
  - In experiment (iii) nails will rust since the test-tube is exposed, so there is both moisture and air.
- b) - By oiling/ greasing  
 - By painting  
 - Galvanizing  
 - Tin plating.

Answer to question 20.

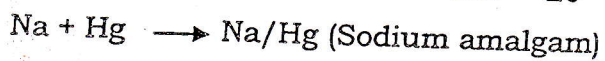
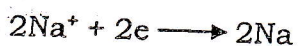
a)

Diagram

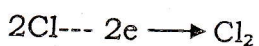


Concentrated sodium chloride (Brine) is the electrolyte  
 The anodes are graphite. The cathode is the mercury

At cathode(-)



At anode (+)



N.B: Sodium amalgam is passed through water where sodium reacts with water to form sodium hydroxide.



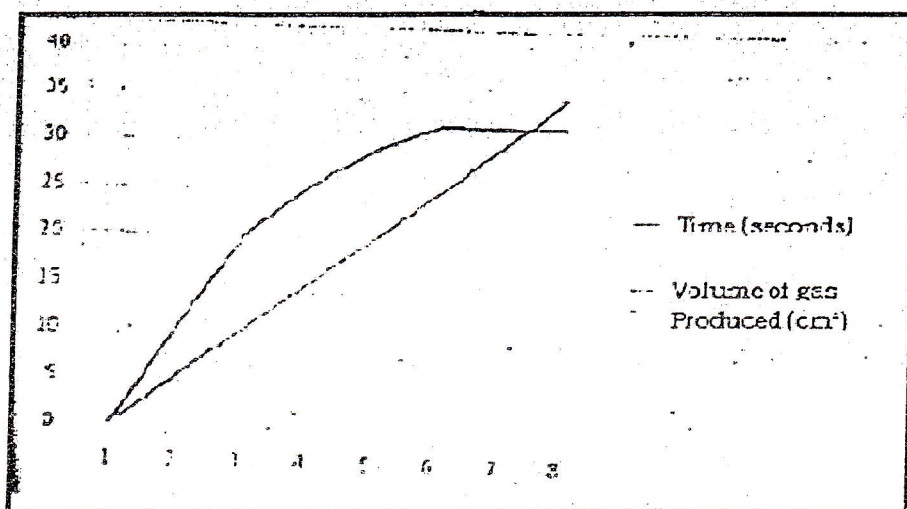
- b) - Used in the laboratory for absorbing  $\text{CO}_2$  and other acidic gases.
- Used in the manufacture of soap.

### SECTION C

Answer to question 21.

a) Copper II sulphate.

b)



c) When the reaction is proceeding, the volume of the gas increases until the reaction is over. When the reaction is over, the volume of the gas remains constant.

d)  $Zn^{2+}$ ;  $SO_4^{2-}$

Answer to question 22.

a) P - Copper II oxide,  $CuO$ .

Q - Copper II sulphate,  $CuSO_4$

R - Copper II hydroxide,  $Cu(OH)_2$

S - Copper II carbonate,  $CuCO_3$

b) i)  $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

ii)  $CuSO_4 + 2NaOH \rightarrow Cu(OH)_2 + Na_2SO_4$

iii)  $CuSO_4 + Na_2CO_3 \rightarrow CuCO_3 + Na_2SO_4$

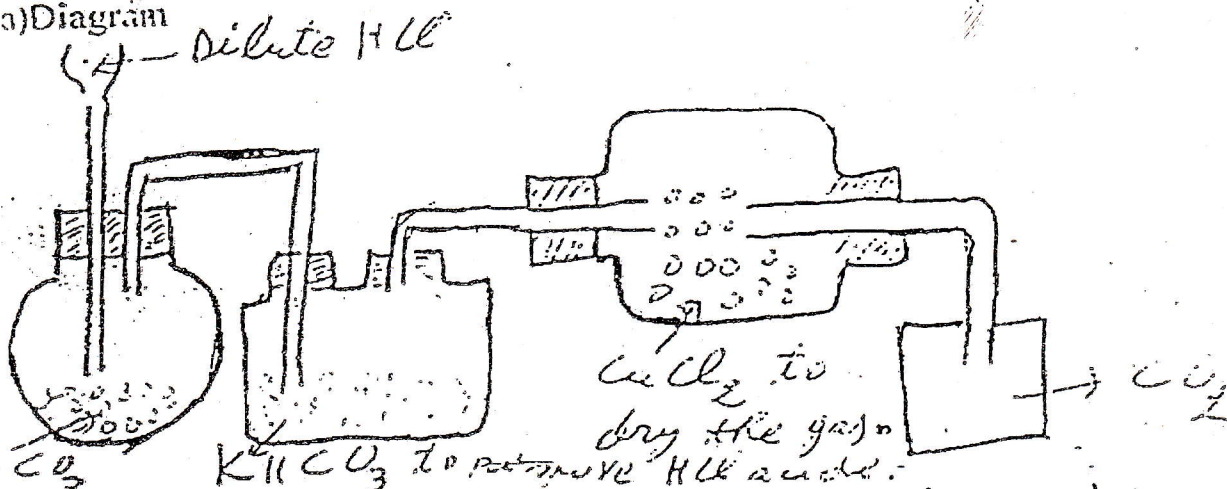
iv)  $Cu(OH)_2 \xrightarrow{\Delta} CuO + H_2O$

v)  $CuCO_3 \xrightarrow{\Delta} CuO + CO$

Answer to question 23.

a)

a) Diagram



b) Dilute  $H_2SO_4$  can't be used in this experiment because when  $H_2SO_4$  reacts with  $CaCO_3$ , they form  $CaSO_4$  which is insoluble and hence prevents further reaction between the acid and the carbonate.

c) i)  $CO_2 + H_2O \rightarrow H_2CO_3$

ii)  $2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$ .

d) Uses of  $CO_2$ : Used in the extinguishers, Used in breweries.

END.