## 29.6 CHEMISTRY (233)

### 29.6.1 Chemistry Paper 1 (233/1)



1 (a) Distinguish between a deliquescent and a hygroscopic substance. (2 marks)

(b) Give **one** use of hygroscopic substances in the laboratory. (1 mark)

2 (a) What is meant by the terms: (2 marks)

(i) element;

(ii) atomic number?

(b) The formula for a chloride of titanium is $TiCl_3$. What is the formula of its sulphate? (1 mark)

3 What is the name given to each of the following:

(a) ability of a metal to be made into a wire; (1 mark)

(b) minimum energy required for a chemical reaction to start; (1 mark)

(c) type of force that holds atoms of neon together? (1 mark)

4 Draw the structures and give the names of three alkanes having molecular formula $C_5H_{10}$. (3 marks)

5 Hydrated cobalt(II) chloride exists as pink crystals and anhydrous cobalt (II) chloride is a blue powder. Describe a laboratory experiment that can be used to show that the action of heat on hydrated cobalt (II) chloride is a reversible reaction. (3 marks)

6 Aluminium oxide reacts with both acids and bases.

(a) Write an equation for the reaction between aluminium oxide and hydrochloric acid. (1 mark)

(b) Using the equation in (a) above, calculate the number of moles of hydrochloric acid that would react completely with 153.0g of aluminium oxide. (Al = 27.0, O = 16.0). (2 marks)

7 Complete the table below by writing the products formed at the electrodes during the electrolysis of the electrolytes given in the table. (3 marks)

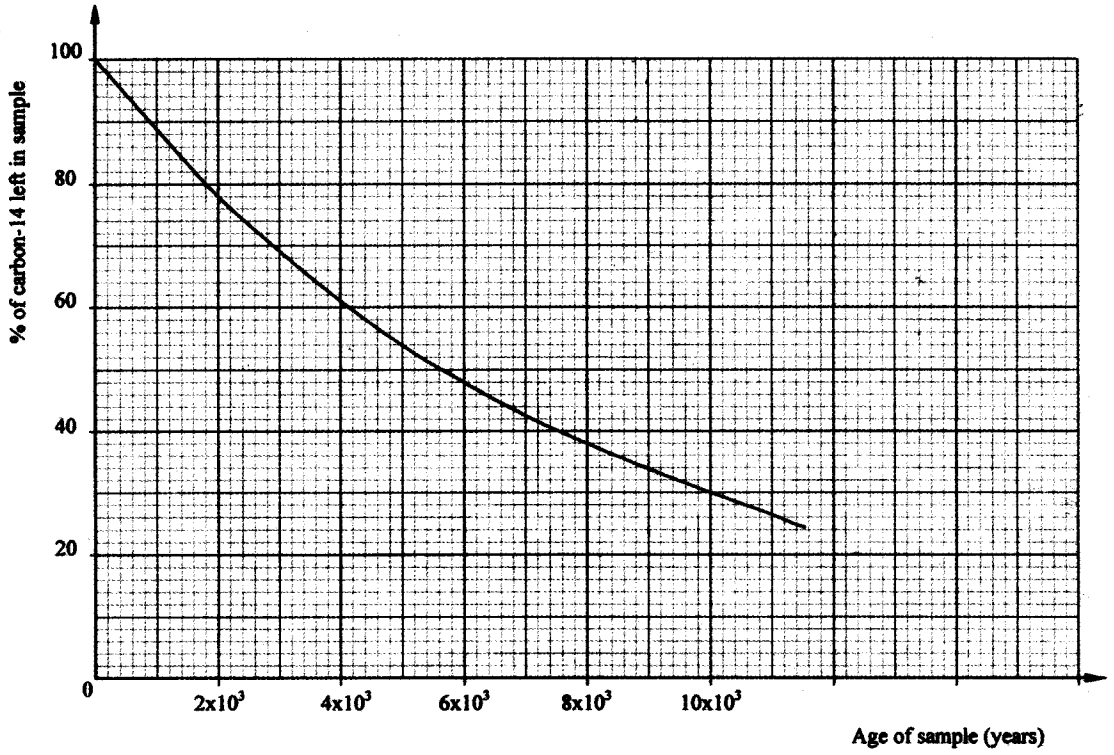
| Electrolyte | Product at anode | Product at cathode |
|---|---|---|
| Aqueous sodium sulphate using inert electrodes. | (½ mark) | (½ mark) |
| Aqueous copper(II) sulphate using copper electrodes. | (1 mark) | (1 mark) |

8 The pressure of nitrogen gas contained in a $1dm^3$ cylinder at -196°C was $10^7$ Pascals. Calculate the:

(a) volume of the gas at 25°C and $10^5$ Pascals; (1½ marks)

(b) mass of nitrogen gas (Molar volume of gas is $24dm^3$, N = 14.0). ($1\frac{1}{2}$ marks)

**9** Carbon -14, $^{14}_{6}C$ , is used in carbon dating. It decays to form nitrogen, $^{14}_{7}N$ . The graph below shows the amount of carbon -14 left in a sample against its age in years.



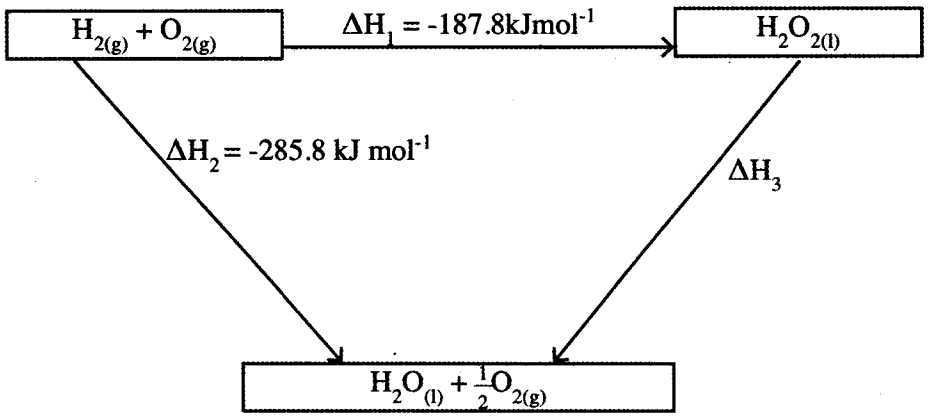

(a) Write a nuclear equation for the decay process of carbon -14. (1 mark)

(b) From the graph, determine the:

(i) half-life of carbon -14; (1 mark)

(ii) percentage of carbon -14 in a sample whose age is 1950 years. (1 mark)

**10** The figure below shows an energy cycle.




(a) Give the name of the enthalpy change $\Delta H_1$. (1 mark)

(b) Determine the value of $\Delta H_3$. (2 marks)

11 Hydrogen sulphide is a highly toxic and flammable gas. It is normally prepared in a fume chamber.

(a) Name **two** reagents that can be used to prepare hydrogen sulphide in the laboratory. (1 mark)

(b) One of the uses of hydrogen sulphide is to produce sulphur as shown in the following equation:

$$2H_2S_{(g)} + SO_{2(g)} \longrightarrow 3S_{(s)} + 2H_2O_{(l)}$$

Identify the reducing agent in this reaction and give a reason for your answer. (1 mark)

(c) Other than production of sulphuric (VI) acid, state **one** commercial use of sulphur. ( 1 mark)

12 A beaker contained $75.0cm^3$ of aqueous copper (II) sulphate at 23.7°C. When scrap iron metal was added to the solution, the temperature rose to 29.3°C.

(a) Write an ionic equation for the reaction that took place. (1 mark)

(b) Given that the mass of copper deposited was 5.83g, calculate the molar enthalpy change in $kJmol^{-1}$. (specific heat capacity of solution = $4.2Jg^{-1}K^{-1}$, density of solution = $1.0gcm^{-3}$, Cu = 63.5). (2 marks)

13 Some animal and vegetable oils are used to make margarine and soap.
Give the reagents and conditions necessary for converting the oils into:

(a) margarine; (2 marks)

(b) soap. (1 mark)

14 (a) Using electrons in the outermost energy level, draw the dot (•) and cross(×) diagrams for the molecules $H_2O$ and $C_2H_4$.
(H = 1 , C = 6, O = 8). (2 marks)

(i) $H_2O$

(ii) $C_2H_4$

(b) The formula of a complex ion is $Zn(NH_3)_4^{2+}$. Name the type of bond that is likely to exist between zinc and ammonia in the complex ion. (1 mark)

15 Carbon (II) oxide is described as a "silent killer".

(a) State **one** physical property of carbon (II) oxide that makes it a "silent killer." (1 mark)

(b) State and explain **one** chemical property that makes carbon (II) oxide poisonous to human beings. (2 marks)

16 A sample of fertilizer is suspected to be calcium ammonium nitrate. Describe chemical tests for each of the following ions in the sample:

(a) calcium ions; (2 marks)

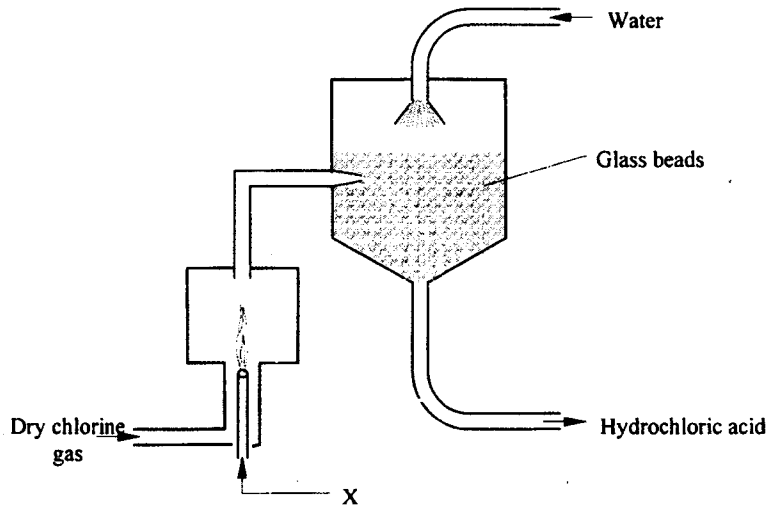
(b) ammonium ions. (1 mark)

**17** Analysis of a compound showed that it had the following composition:
69.42% carbon, 4.13% hydrogen and the rest oxygen.

(a) Determine the empirical formula of the compound. (C = 12.0, H = 1.0, O = 16.0)
(2 marks)

(b) If the mass of one mole of the compound is 242, determine its molecular formula.
(1 mark)

**18** The diagram below represents a set up for large scale manufacture of hydrochloric acid.
Study it and answer the questions that follow.




(a) Name substance X. (1 mark)

(b) What is the purpose of the glass beads? (1 mark)

(c) Give two uses of hydrochloric acid. (1 mark)

**19** The half equations involved in a cell are:

$2H_2O_{(l)} + 2e \rightleftharpoons H_{2(g)} + 2OH^-_{(aq)}: E^\theta = -0.83V$

$O_{2(g)} + 2H_2O_{(l)} + 4e \rightleftharpoons 4OH^-_{(aq)}: E^\theta = +0.40V$

(a) Write the overall equation for the electrochemical cell. (1 mark)

(b) Calculate the e.m.f. generated by a battery consisting of ten cells. (1 mark)

(c) State **one** environmental advantage of using these cells in spacecrafts. (1 mark)

**20** In an experiment to prepare nitrogen (I) oxide, ammonium nitrate was gently heated in a flask.

(a) Write the equation for the reaction that took place in the flask. (1 mark)

(b) State and explain how the gas was collected. (1 mark)

(c) A sample of the gas was tested with damp blue and red litmus papers. What observations were made? (1 mark)

**21** The use of CFCs has been linked to depletion of the ozone layer.

(a) What does CFC stand for? (1 mark)

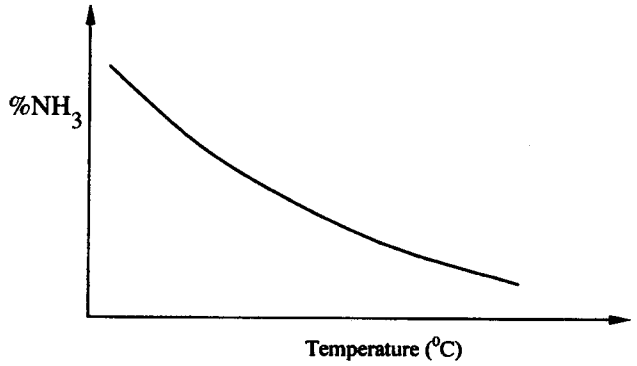
(b) Explain the problem associated with the depletion of the ozone layer. (1 mark)

(c) State another environmental problem caused by CFCs. (1 mark)

**22** Nitrogen and hydrogen react to form ammonia gas as shown in the following equation:

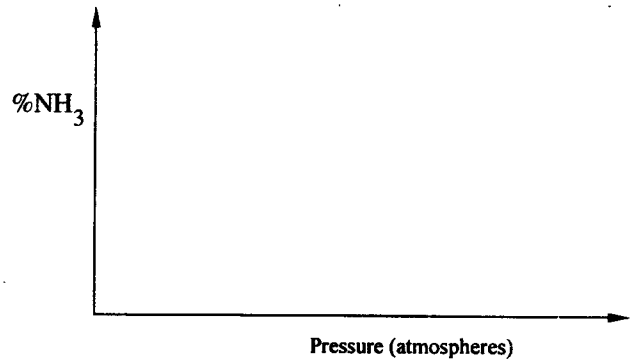
$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$: $\Delta H$ is negative

(a) The figure below shows how the percentage of ammonia gas in the equilibrium mixture changes with temperature.

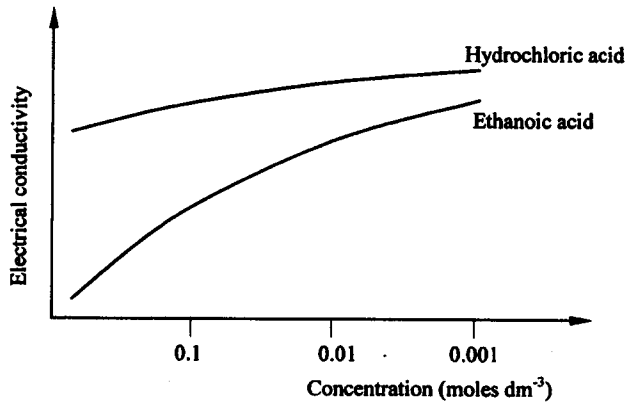



Explain why the percentage of ammonia gas changes as shown in the figure. (2 marks)

(b) On the axes below, sketch a graph showing how the percentage of ammonia gas in the equilibrium mixture changes with pressure. (1 mark)




**23** The curves below show how the electrical conductivity of hydrochloric and ethanoic acids vary with concentration.




Explain why the electrical conductivity of 0.01M hydrochloric acid is higher than that of 0.01M ethanoic acid. (2 marks)

**24** Describe how a solid sample of the double salt, ammonium iron (II) sulphate, can be prepared using the following reagents: Aqueous ammonia, sulphuric (VI) acid and iron metal. (3 marks)

**25** A sample of river water was divided into three portions. The table below shows the tests carried out on the portions and the observations made.

| Test | Observation | Inference |
|---|---|---|
| To the first portion, $1cm^3$ of soap solution was added. | No lather formed. | |
| The second portion was boiled, cooled and $1cm^3$ of soap solution was added. | No lather formed. | |
| To the third portion, $3cm^3$ of aqueous sodium carbonate was added, the mixture filtered and $1cm^3$ of soap solution added to the filtrate. | Lather formed immediately. | |

Complete the table by filling in the inferences. (3 marks)

**26** A water trough, aqueous sodium hydroxide, burning candle, watch class and a graduated gas jar were used in an experimental set up to determine the percentage of active part of air. Draw a labelled diagram of the set up at the end of the experiment. (3 marks)

**27** The atomic numbers of phosphorus, sulphur and potassium are 15, 16 and 19 respectively. The formulae of their ions are $P^{3-}$, $S^{2-}$ and $K^{+}$. These ions have the same number of electrons.

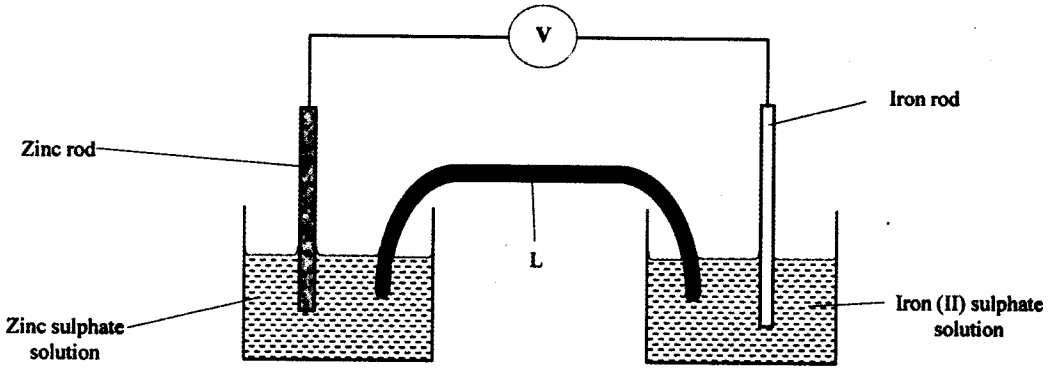
(a) Write the electron arrangement for the ions. (1 mark)

(b) Arrange the ions in the order of increasing ionic radius starting with the smallest. Give a reason for the order. (2 marks)

## 29.6.2 Chemistry Paper 2 (233/2)

1 (a) Which one of the following compounds; urea, ammonia, sugar and copper (II) chloride will conduct an electric current when dissolved in water? Give a reason. (2 marks)

(b) The diagram below shows an electrochemical cell. Study it and answer the questions that follow.




Given the following

$Fe^{2+}(aq) + 2e \longrightarrow Fe(s)$ ; $E^{\ominus} = -0.44V$
$Zn^{2+}(aq) + 2e \longrightarrow Zn(s)$; $E^{\ominus} = -0.76V$

(i) Show on the diagram using an arrow, the direction of flow of electrons. (1 mark)

(ii) Name **two** substances that are used to fill the part labelled L. (2 marks)

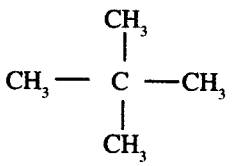
(c) In an experiment to electroplate iron with silver, a current of 0.5 amperes was passed through a solution of silver nitrate for one hour.

(i) Give **two** reasons why it is necessary to electroplate iron with silver. (2 marks)

(ii) Calculate the mass of silver that was deposited on iron (Ag = 108, 1 Faraday = 96,500 coulombs). (3 marks)

2 (a) Give the names of the following compounds:

(i)

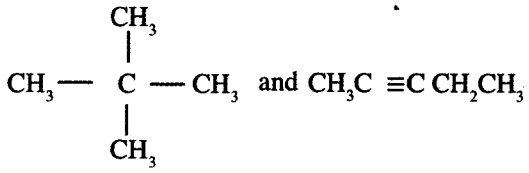


(1 mark)

(ii) $CH_3C \equiv C\,CH_2CH_3$

(1 mark)

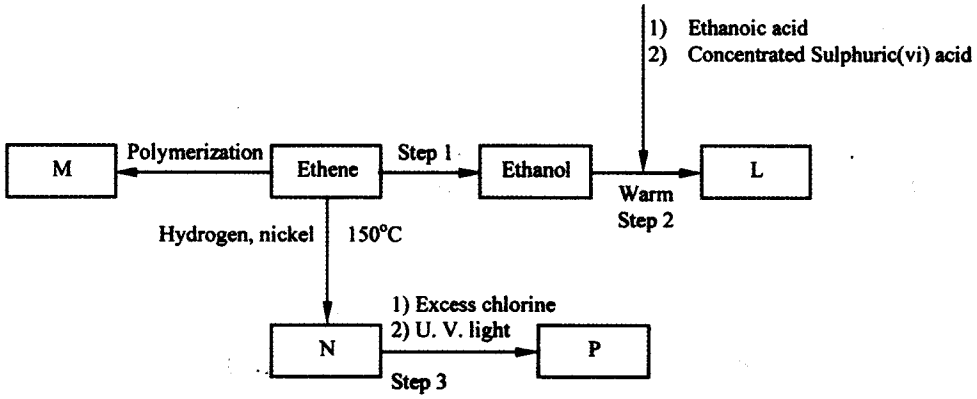
(b) Describe a chemical test that can be carried out in order to distinguish between



and $CH_3C \equiv C\,CH_2CH_3$

(2 marks)

(c) Study the flow chart below and answer the questions that follow.




(i) Name the compounds: (2 marks)

(I) L .....

(II) N .....

(ii) Draw the structural formula of compound **M** showing two repeat units. (1 mark)

(iii) Give the reagent and the condition used in step 1. (1 mark)

(iv) State the type of reaction that takes place in: (2 marks)

(I) step 2;

(II) step 3;

(d) The molecular formula of compound **P** is $C_2H_2Cl_4$. Draw the two structural formulae of compound **P**. (2 marks)

3 Use the information in the table below to answer the questions that follow. The letters do not represent the actual symbols of the elements.

| Element | Atomic Number | Melting Point (°C) |
|---|---|---|
| R | 11 | 97.8 |
| S | 12 | 650.0 |
| T | 15 | 44.0 |
| U | 17 | -102 |
| V | 18 | -189 |
| W | 19 | 64.0 |

(a) Give reasons why the melting point of:

(i) S is higher than that of R; (1 mark)

(ii) V is lower than that of U. (2 marks)

(b) How does the reactivity of W with chlorine compare with that of R with chlorine? Explain. (2 marks)

(c) Write an equation for the reaction between T and excess oxygen. (1 mark)

(d) When 1.15g of R were reacted with water, 600cm$^3$ of gas was produced. Determine the relative atomic mass of R. (Molar gas volume = 24 000 cm$^3$). (3 marks)

(e) Give **one** use of element V. (1 mark)

4 (a) 50 cm$^3$ of 1M copper (II) sulphate solution was placed in a 100cm$^3$ plastic beaker. The temperature of the solution was measured. Excess metal A powder was added to the solution, the mixture stirred, and the maximum temperature of the mixture measured. The experiment was repeated using powders of metals **B** and **C**. The results obtained are given in the table below:

| | A | B | C |
|---|---|---|---|
| Maximum temperature (°C) | 26.3 | 31.7 | 22.0 |
| Initial temperature (°C) | 22.0 | 22.0 | 22.0 |

(i) Arrange the metals **A**,**B**,**C** and copper in order of reactivity starting with the least reactive. Give reasons for the order. (3 marks)

(ii) Other than temperature change, state one other observation that was made when the most reactive metal was added to the copper (II) sulphate solution. (1 mark)

(b) The standard enthalpy change of formation of methanol is $-239\ kJmol^{-1}$.

(i) Write the thermo chemical equation for the standard enthalpy change of formation of methanol. (1 mark)

(ii) Methanol is manufactured by reacting carbon (II) oxide with hydrogen at 300°C and a pressure of 250 atmospheres.
The equation for the reaction is

$$CO_{(g)} + 2H_{2(g)} \rightleftharpoons CH_3OH_{(g)}$$

(I) How would the yield of methanol be affected if the manufacturing process above is carried out at, 300°C and a pressure of 400 atmospheres? Explain. (2 marks)

(II) Use the following data to calculate the enthalpy change for the manufacture of methanol from carbon (II) oxide and hydrogen. (3 marks)

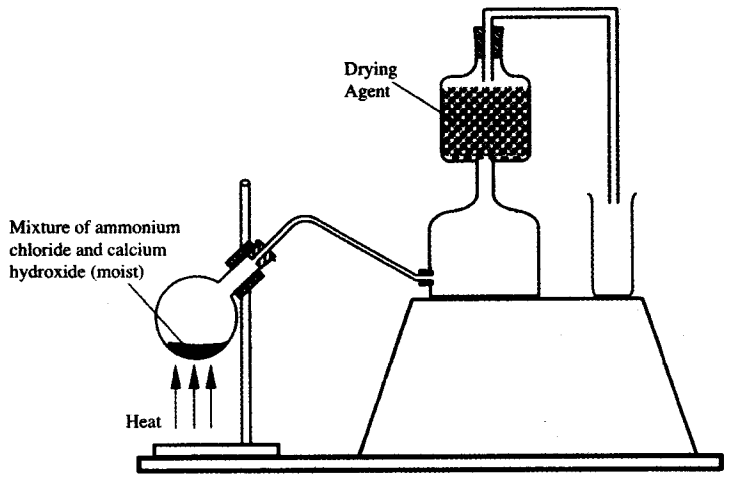
$$CO(g) + \frac{1}{2}O_2(g) \longrightarrow CO_2(g);\ \Delta H^{\ominus} = -283\ kJmol^{-1}$$

$$H_2(g) + \frac{1}{2}O_2(g) \longrightarrow H_2O(l);\ \Delta H^{\ominus} = -286\ kJmol^{-1}$$

$$CH_3OH(l) + \frac{3}{2}O_2(g) \longrightarrow CO_2(g) + 2H_2O(l);\ \Delta H^{\ominus} = -715\ kJmol^{-1}$$

(iii) The calculated enthalpy change in part b (ii) (II) above differs from the standard enthalpy change of formation of methanol. Give a reason. (1 mark)

5 (a) A student set up the apparatus as shown in the diagram below to prepare and collect dry ammonia gas.




(i) Identify **two** mistakes in the set up and give a reason for each mistake. (3 marks)

(I) Mistake .....

Reason .....

(II) Mistake .....

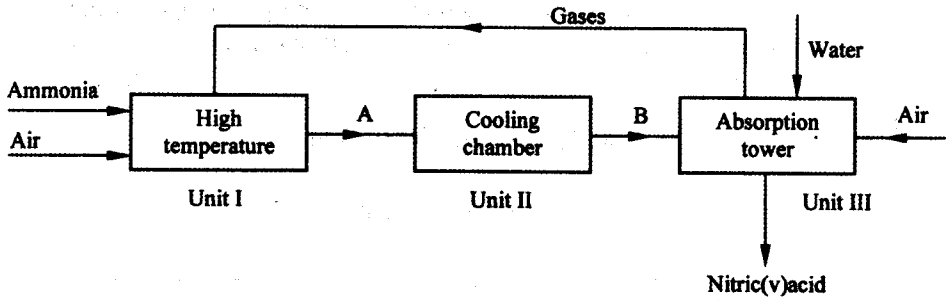
Reason .....

(ii) Name a suitable drying agent for ammonia. (1 mark)

(iii) Write an equation for the reaction that occurred when a mixture of ammonium chloride and calcium hydroxide was heated. (1 mark)

(iv) Describe **one** chemical test for ammonia gas. (1 mark)

(b) Ammonia gas is used to manufacture nitric (V) acid, as shown below.




(i) This process requires the use of a catalyst. In which unit is the catalyst used? (1 mark)

(ii) Identify compounds **A** and **B**. (1 mark)

**A** .....

**B** .....

(iii) Using oxidation numbers, explain why the conversion of ammonia to nitric (V) acid is called catalytic oxidation of ammonia. (2 marks)

(iv) Ammonia and nitric (V) acid are used in the manufacture of ammonium nitrate fertilizer. Calculate the amount of nitric (V) acid required to manufacture 1000kg of ammonium nitrate using excess ammonia. (3 marks)

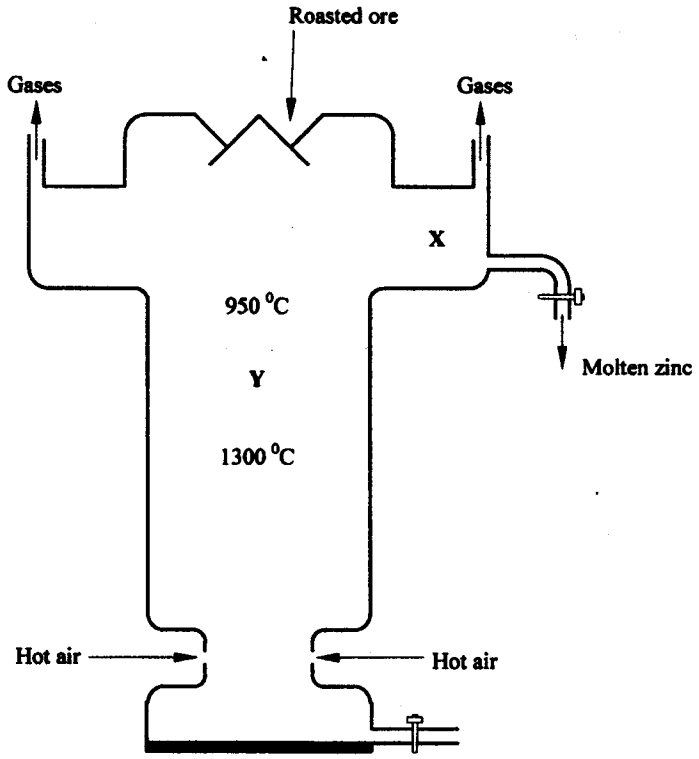
(N = 14.0, H = 1.0, O = 16.0)

**6** The melting and boiling points of zinc are 419°C and 907C° respectively. One of the ores of zinc is zinc blende. To extract zinc, the ore is first roasted in air before feeding it into a furnace.

(a) (i) Write the formula of the main zinc compound in zinc blende. (1 mark)

(ii) Explain using an equation why it is necessary to roast the ore in air before introducing it into the furnace. (2 marks)

(b) The diagram below shows a simplified furnace used in the extraction of zinc. Study it and answer the questions that follow:




(i) Name **two** other substances that are also introduced into the furnace together with roasted ore. (1 mark)

(ii) The main reducing agent in the furnace is carbon (II) oxide. Write **two** equations showing how it is formed. (2 marks)

(iii) In which physical state is zinc at point **Y** in the furnace? Give a reason. (1 mark)

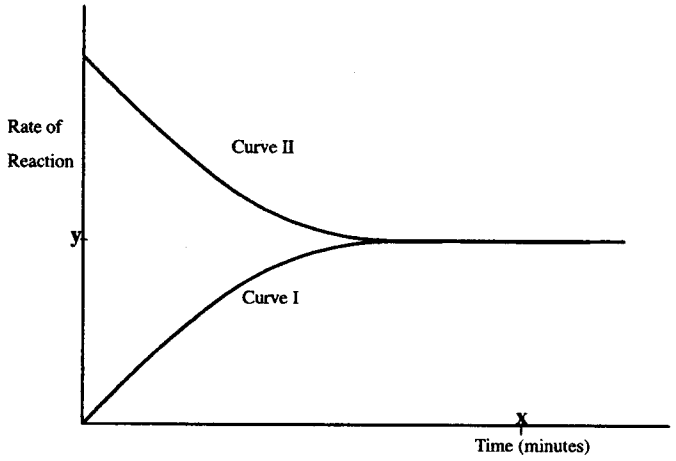
(iv) Suggest a value for the temperature at point **X** in the furnace. Give a reason. (1 mark)

(v) State and explain **one** environmental effect that may arise from the extraction of zinc from zinc blende. (2 marks)

(vi) Give **two** industrial uses of zinc. (1 mark)

7 (a) The figure below shows how the rate of the following reaction varies with time.

$$A(g) + B(g) \rightleftharpoons 2C(g) + D(g)$$




(i) Which of the two curves represents the rate of the reverse reaction? Give a reason. (2 marks)

(ii) What is the significance of points **X** and **Y** on the figure? (2 marks)

(b) State and explain the effect of an increase in pressure on the rates of the following reactions.

(i) $H_2(g) + Cl_2(g) \longrightarrow 2HCl(g)$ (2 marks)

(ii) $CH_3OH(l) + CH_3COOH(l) \longrightarrow CH_3COOCH_3(l) + H_2O(l)$ (1 mark)

(c) In an experiment to study the rate of reaction between barium carbonate and dilute hydrochloric acid, 1.97g of barium carbonate were reacted with excess 2M hydrocholoric acid. The equation for the reaction is

$BaCO_3(s) + 2HCl(aq) \longrightarrow BaCl_2(aq) + CO_{2(g)} + H_2O(l)$.

The data in the table was obtained.

| Time in seconds | 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 |
|---|---|---|---|---|---|---|---|---|---|
| Volume of gas ($cm^3$) | 0 | 80 | 135 | 175 | 210 | 230 | 240 | 240 | 240 |

(i) On the grid provided, plot a graph of volume of gas produced (vertical axis) against time. (3 marks)

(ii) From the graph, determine the rate of the reaction at:

(I) 15 seconds; (1 mark)

(II) 120 seconds; (1 mark)

(III) Give a reason for the difference between the two values. (1 mark)

## 29.6.3 Chemistry Paper 3 (233/3)

1 You are provided with:

acid **A** labelled solution **A**;
2.0 M sodium hydroxide solution labelled solution **B**;
Solution **C** containing 25.0 g per litre of an alkanoic acid.

You are required to:

(a) prepare a dilute solution of sodium hydroxide, solution **B**.
(b) determine the:
  (i) molar mass of the alkanoic acid
  (ii) reaction ratio between sodium hydroxide and acid **A**.

**Procedure 1**

Using a pipette and **a pipette filler**, place 25.0 $cm^3$ of solution **B** into a 250.0 ml volumetric flask. Add about 200 $cm^3$ of distilled water. Shake well. Add more distilled water to make upto the mark. Label this solution **D**. **Retain the remaining solution B for use in procedure II.**

Fill a burette with solution **C**. Using a clean pipette and a **pipette filler**, place 25.0 $cm^3$ of solution **D** into a 250 ml conical flask. Add two drops of phenolpthalein indicator and titrate with solution **C**. Record your results in **table 1**. Repeat the titration two more times and complete the table.

| **Table 1** | I | II | III |
|---|---|---|---|
| Final burette reading | | | |
| Initial burette reading | | | |
| Volume of solution **C** ($cm^3$) added | | | |

(4 marks)

Determine the:

(i) average volume of solution **C** used; (1 mark)

(ii) concentration of solution **D** in moles per litre; (1 mark)

(iii) concentration of the alkanoic acid in solution **C** in moles per litre (1 mole of the acid reacts with 3 moles of the base); (1 mark)

(iv) molar mass of the alkanoic acid. (1 mark)

**Procedure II**

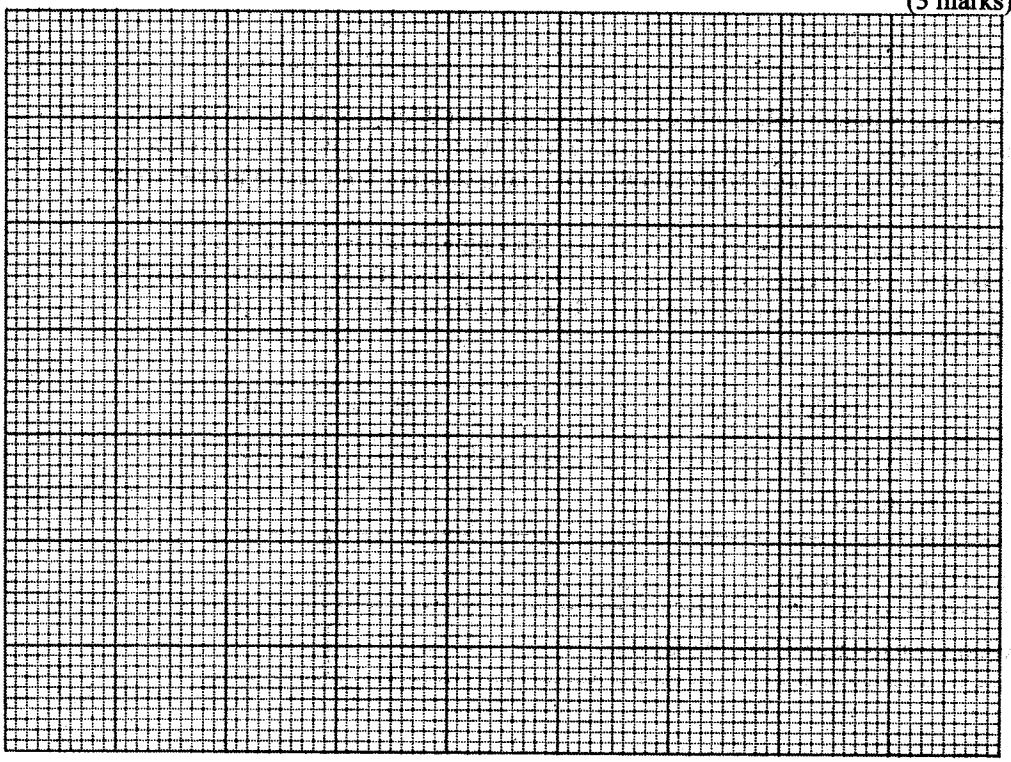
Fill a **clean** burette with solution **A**. Place 5 $cm^3$ of solution **A** into a 100 ml beaker. Measure the initial temperature of solution **A** in the beaker and record it in **table II**. Using a 10 ml or a 100 ml measuring cylinder, measure 25 $cm^3$ of solution **B**. Add it to solution **A** in the beaker and immediately stir the mixture with the thermometer. Record the maximum temperature reached in **table II**. Repeat the experiment with other sets of volumes of solutions **A** and **B** and complete the table.

**Table II**

| Volume of solution **A** ($cm^3$) | 5 | 9 | 13 | 17 | 21 | 25 |
|---|---|---|---|---|---|---|
| Volume of solution **B** ($cm^3$) | 25 | 21 | 17 | 13 | 9 | 5 |
| Maximum temperature (°C) | | | | | | |
| Initial temperature (°C) | | | | | | |
| Change in temperature, $\Delta T$ | | | | | | |

(6 marks)

(a) On the grid provided; plot a graph of $\Delta T$ (Vertical axis) against the volume of solution **A**.
(3 marks)



(b) From the graph, determine the volume of solution **A** which gave the maximum change in temperature.
(1 mark)

(c) Determine the volume of solution **B** that reacted with the volume of solution **A** in (b) above.
(1 mark)

(d) Calculate the:

(i) ratio between the volumes of solutions **A** and **B** that neutralised one another;
(1 mark)

(ii) concentration in moles per litre of the acid in solution **A**.
(Assume that the volume ratio is the same as the mole ratio).
(1 mark)

2 You are provided with solids **E**, **F** and **G**.
Carry out the tests below and write your observations and inferences in the spaces provided.

(a) Place all of solid **E** in a boiling tube. Add 20 $cm^3$ of distilled water and shake until all the solid dissolves. Label this as solution **E**.

(i) To about 2 $cm^3$ of solution **E** in a test-tube, add 4 drops of 2 M sulphuric (VI) acid.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (2 marks) |

(ii) To about 2 $cm^3$ of solution **E** in a test-tube, add 2 M sodium hydroxide dropwise until in excess.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

(iii) Place one half of solid **F** in a test-tube. Add 2 $cm^3$ of distilled water and shake well. Add 4 drops of this solution to about 2 $cm^3$ of solution **E** in a test-tube.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

(iv) To about 2 $cm^3$ of solution **E** in a test tube, add 2 drops of aqueous potassium iodide.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

(b) (i) Using a **metallic** spatula, ignite about one half of solid **G** in a Bunsen burner flame.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

(ii) Place the other half of solid **G** into a boiling tube.
Add 15 $cm^3$ of distilled water and shake well. Label this solution **G**.
Use this solution for the following tests.

I Place 2 $cm^3$ of solution **G** in a test-tube and determine its pH.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

II To about 2 $cm^3$ of the solution obtained in (ii) above, add 3 drops of acidified potassium manganate (VII).

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

III To about 2 $cm^3$ of the solution obtained in (ii) above, add 2 drops of bromine water.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |

(iii) To the remaining solution **G** in the boiling tube, add the other half of solid **F**.

| OBSERVATIONS | INFERENCES |
|---|---|
| (1 mark) | (1 mark) |