1 (a) Two reagents that can be used to prepare chlorine gas are manganese (IV) oxide and concentrated hydrochloric acid.

(i) Write an equation for the reaction. (1 mark)

(ii) Give the formula of another reagent that can be reacted with concentrated hydrochloric acid to produce chlorine gas. (1 mark)

(iii) Describe how the chlorine gas could be dried in the laboratory. (2 marks)

(b) In an experiment, dry chlorine gas was reacted with aluminium as shown in figure 1.

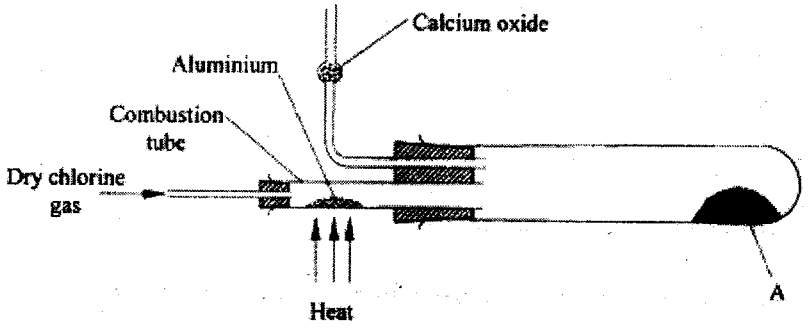


Figure 1

(i) Name substance A. (1 mark)

(ii) Write an equation for the reaction that took place in the combustion tube. (1 mark)

(iii) 0.84 g of aluminium reacted completely with chlorine gas. Calculate the volume of chlorine gas used (Molar gas volume is 24dm^3, Al = 27). (3 marks)

(iv) Give two reasons why calcium oxide is used in the set up. (2 marks)

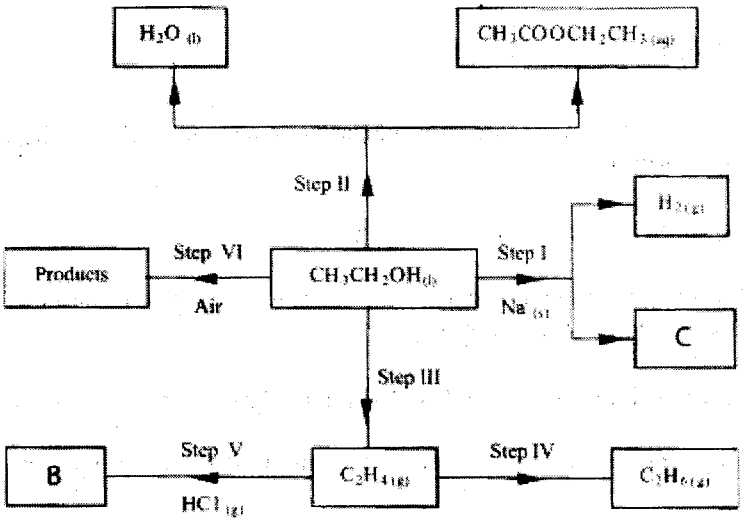
2 (a) Draw the structures of the following compounds: (2 marks)

(i) 2- methylbut-2-ene;

(ii) heptanoic acid.

(b) Describe a physical test that can be used to distinguish between methanol and hexanol. (2 marks)

(c) Use the flow chart below to answer the questions that follow.



(i) Name:

(I) the type of reaction that occurs in step II; (1 mark)

(II) substance B. (1 mark)

(ii) Give the formula of substance C. (1 mark)

(iii) Give the reagent and the conditions necessary for the reaction in step (IV). (3 marks)

3 The set-up below (**Figure 2**) was used to electrolyse a bromide of metal **D**, DBr_2.

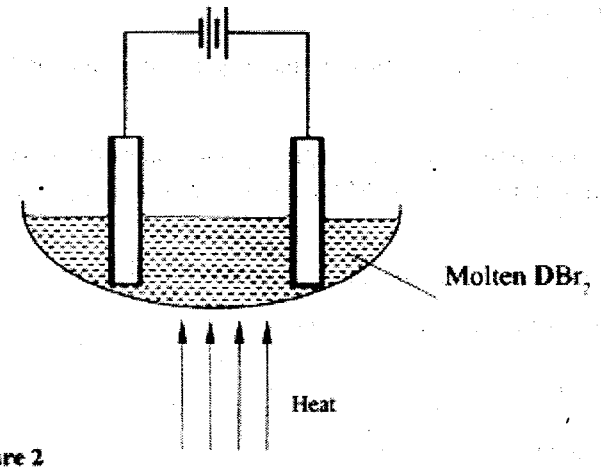


Figure 2

(i) Write equations for the reactions at the:

I cathode (1 mark)

II anode. (1 mark)

(ii) The electrodes used in the experiment were made of carbon and metal **D**. Which of the two electrodes was used as the anode? Give a reason. (2 marks)

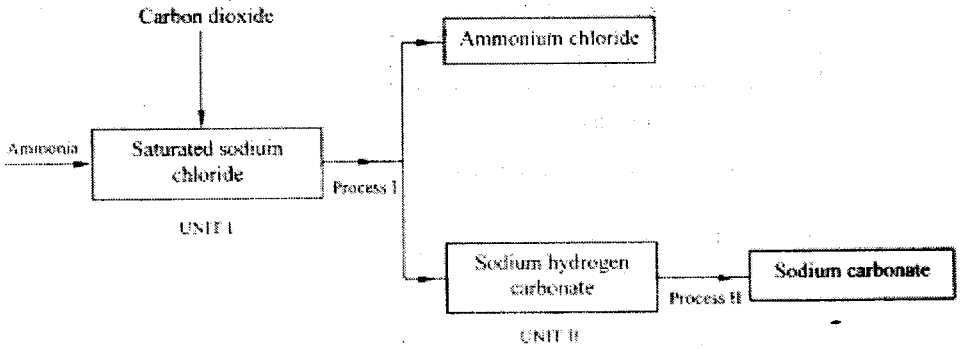
(iii) Give a reason why this experiment is carried out in a fume cupboard.
(1 mark)

(iv) When a current of 0.4 A was passed for 90 minutes, 2.31g of metal **D** were deposited.

I Describe how the amount of metal **D** deposited was determined.
(3 marks)

II Calculate the relative atomic mass of metal **D**. (1 Faraday = 96500 coulombs). **(3 marks)**

4 (a) The schematic diagram shows part of the Solvay process used for the manufacture of sodium carbonate.



(i) Explain how the sodium chloride required for this process is obtained from sea water. **(2 marks)**

(ii) Two main reactions take place in UNIT I. The first one is the formation of ammonium hydrogen carbonate.

I. Write an equation for this reaction. (1 mark)

II. Write an equation for the second reaction. **(1 mark)**

(iii) State how the following are carried out: **(2 marks)**

I. Process I

II. Process II

(iv) In an experiment to determine the percentage purity of the sample of sodium carbonate produced in the Solvay process, 2.15 g of the sample reacted completely with 40.0 cm^3 of 0.5 M sulphuric acid.

I. Calculate the number of moles of sodium carbonate that reacted.
(2 marks)

II. Determine the percentage of sodium carbonate in the sample. (Na = 23.0, C=12.0, O=16.0) **(2 marks)**

(b) Name **two** industrial uses of sodium carbonate. **(2 marks)**

5 (a) **Figure 3** shows the changes that take place between states of matter. Some of them have been identified and others labelled.

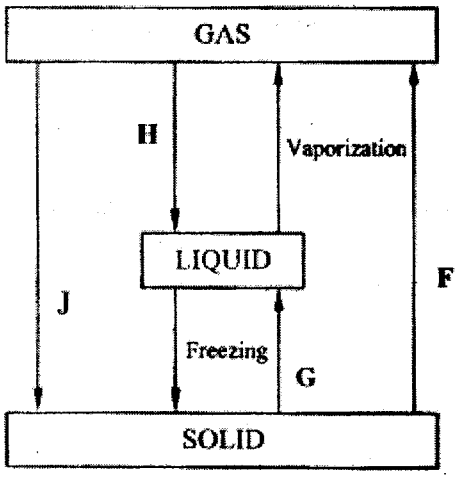


Figure 3

(i) Give the names of the processes:

I **H** (1 mark)

II **G** (1 mark)

(ii) Name **one substance** that can **undergo process F** when left in an open container in the laboratory. (1 mark)

(iii) The process **J** is called **deposition. Using** water as an example, write an equation that represents the process of deposition. (1 mark)

(b) **Figure 4** shows the heating curve for **water.**

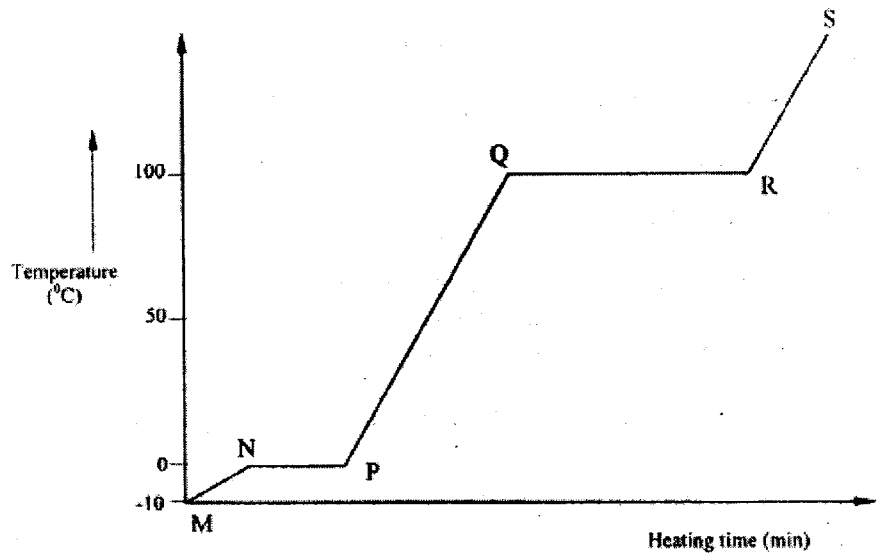


Figure 4

(i) Give the names of the intermolecular forces of attraction in the segments:

I MN (1 mark)

II RS. (1 mark)

(ii) The heats of fusion and vaporisation of water are 334.4 Jg^{-1} and 1159.4 Jg^{-1} respectively.

I Explain why there is a big difference between the two. (2 marks)

II How is the difference reflected in the curve? (1 mark)

(c) Coal, oil and natural gas are major sources of energy. They are known as fossil fuels. Hydrogen is also a source of energy.

(i) State and explain two reasons why hydrogen is a very attractive fuel compared to fossil fuels. (3 marks)

(ii) State one disadvantage of using hydrogen fuel instead of fossil fuels. (1 mark)

6 (a) Study the table below and complete it. (W^- and X^{4+} are not the actual symbols of the ions). (2 marks)

Ion	Number of protons	Number of neutrons	Mass Number	Electron arrangement
W^-	.....	20	.....	2.8.8
X^{4+}	14	.....	28	.....

(b) State the observations that would be made in the following tests to distinguish between metals:

(i) Sodium and copper by burning small pieces of each in air. (2 marks)

(ii) Sodium and Magnesium by placing small pieces of each in cold water which contains two drops of phenolphthalein. (2 marks)

(c) The atomic numbers of Na and Mg are 11 and 12 respectively. Which of the elements has a higher ionisation energy? Explain. (2 marks)

(d) Naturally occurring uranium consists of three isotopes which are radioactive.

Isotope	^{234}U	^{235}U	^{238}U
Abundance	0.01%	0.72%	99.27%

(i) Which of these isotopes has the longest half-life? Give a reason. (1 mark)

(ii) Calculate the relative atomic mass of uranium. (2 marks)

(iii) $^{235}_{92}U$ is an alpha emitter. If the product of the decay of this nuclide is thorium (Th). Write a nuclear equation for the process. (1 mark)

(iv) State one use of radioactive isotopes in the paper industry. (1 mark)

7. Iron is obtained from haematite using a blast furnace shown in figure 5 below.

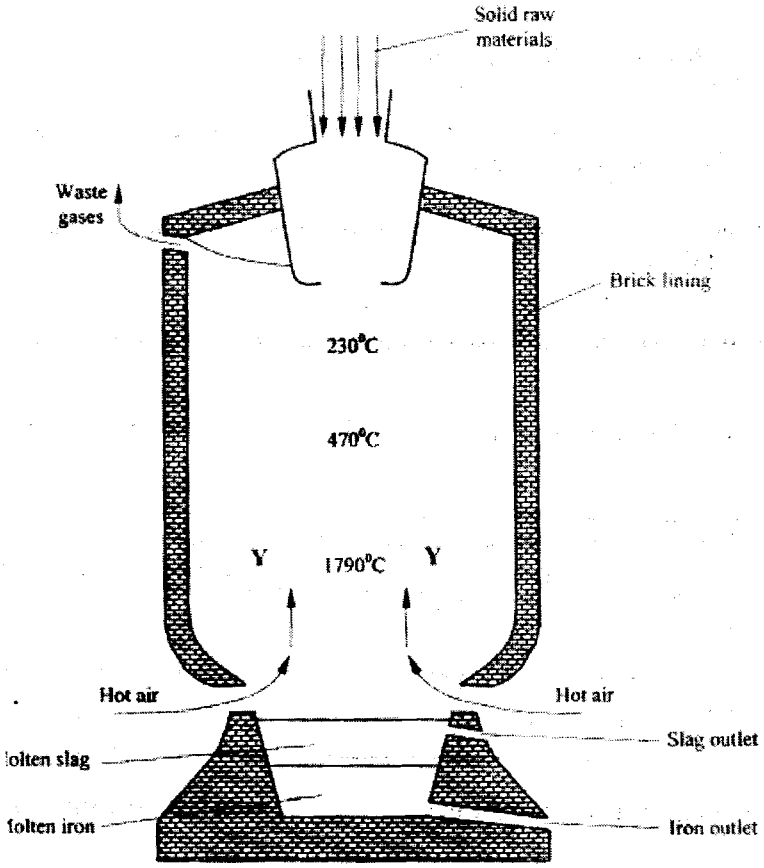


Figure 5

(a) Four raw materials are required for the production of iron. Three of these are iron oxide, hot air and limestone.
Give the name of the fourth raw material. (1 mark)

(b) Write an equation for the reaction in which carbon (IV) oxide is converted into carbon (II) oxide. (1 mark)

(c) Explain why the temperature in the region marked Y is higher than that of the incoming hot air. (2 marks)

(d) State one physical property of molten slag other than density that allows it to be separated from molten iron as shown in figure 5. (1 mark)

(e) One of the components of the waste gases is Nitrogen (IV) oxide.
Describe the adverse effects it has on the environment. **(2 marks)**

(f) Iron from the blast furnace contains about 5% carbon.

(i) Describe how the carbon content is reduced. **(2 marks)**

(ii) Why is it necessary to reduce the carbon content? **(1 mark)**

29.6.3 Chemistry Paper 3 (233/3)

1 You are provided with:

- solid A, a metal carbonate M_2CO_3
- solution B, hydrochloric acid **for use in Questions 1 and 2**
- solution C, 0.30M sodium hydroxide
- methyl orange indicator.

You are required to:

- prepare a dilute solution of hydrochloric acid and determine its concentration;
- determine the solubility of solid A in water.

Procedure:

(Reserve one **dry** conical flask for use in step 4).

Step 1 Place all of solid **A** in a 250 ml **dry** beaker. Add 100 cm^3 of distilled water to **solid A** in the beaker. Using a glass rod, stir the mixture thoroughly for about two minutes. Leave the mixture to stand and proceed with steps 2 and 3.

Step 2 Using a pipette and a **pipette filler**, place 25.0cm^3 of solution **B** in a 250 ml volumetric flask. Add about 200cm^3 of distilled water. Shake the mixture well and add distilled water to make up to the mark. Label this as solution **D**.

Step 3 Fill a burette with solution **C**. Using a pipette and a **pipette filler**, place 25.0cm^3 of solution **D** into a 250ml conical flask. Add two drops of the indicator provided and titrate solution **D** with solution **C**. Record your results in Table 1. Repeat the titration two more times and complete Table 1. **Retain** the remaining solution **D** for use in step 5.

Step 4 Filter the mixture obtained in step 1 using a **dry** filter funnel into a **dry** conical flask. Label the filtrate as solution **A**.

Step 5 Clean the burette and fill it with solution **D**. Using a pipette and **a pipette filler**, place 25.0cm^3 of solution **A** into a 250ml conical flask. Add two drops of the indicator provided and titrate solution **A** with solution **D**. Record your results in Table 2. Repeat the titration two more times and complete Table 2.

Table 1

	I	II	III
Final burette reading			
Initial burette reading			
Volume of solution **C** used (cm^3)			

(4 marks)

(a) Calculate:

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

(ii) moles of sodium hydroxide in the average volume of solution **C** used; **(1 mark)**

(iii) moles of hydrochloric acid in 25.0cm^3 of solution **D**; **(1 mark)**

(iv) the molarity of hydrochloric acid, solution **D**. **(1 mark)**

Table 2

	I	II	III
Final burette reading			
Initial burette reading			
Volume of solution **D** used (cm^3)			

(4 marks)

(b) Calculate:

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

(ii) moles of hydrochloric acid in the average volume of solution **D** used; **(1 mark)**

(iii) moles of the metal carbonate, solid **A** in 25.0cm^3 of solution **A**; **(2 marks)**

(iv) the solubility of the metal carbonate, solid **A** in water.
(Relative formula mass of metal carbonate = 74, assume density of solution = 1g/cm^3).
(2 marks)

2 You are provided with solid **E**. Carry out the following tests and write your observations and inferences in the spaces provided.

(a) Place about one-half of solid **E** in a dry test-tube. Heat it strongly and test any gas produced using hydrochloric acid, solution **B** on a glass rod.

Observations	**Inferences**
(2 marks)	(1 mark)

(b) Place the rest of solid **E** in a boiling tube. Add about 10cm^3 of distilled water. Shake well and use 2cm^3 portions for each of the tests below.

(i) To one portion, add aqueous ammonia dropwise until in excess.

Observations	**Inferences**
(1 mark)	(1 mark)

(ii) To a second portion, add about 1cm^3 of hydrochloric acid, solution **B**.

Observations	**Inferences**
(1 mark)	(2 marks)

(iii) To a third portion, add two drops of aqueous lead (II) nitrate and heat the mixture to boiling.

Observations	**Inferences**
(1 mark)	(1 mark)

3 You are provided with solid **F**. Carry out the following tests and record your observations and inferences in the spaces provided.

(a) Place about one half of solid **F** in a dry test-tube. Retain the other half of solid **F** for use in (b). Add all of the **absolute** ethanol provided to solid **F** in the test-tube. **Shake** the mixture.

Observations	**Inferences**
(1 mark)	(1 mark)

Divide the mixture into two portions.

(i) Determine the P^H of the first portion using universal indicator solution and a P^H chart.

Observations	**Inferences**
(1 mark)	(1 mark)

(ii) To the second portion, add one half of the solid sodium hydrogen carbonate provided.

Observations	**Inferences**
(1 mark)	(1 mark)

(b) Place the remaining amount of solid **F** in a boiling tube. Add $10cm^3$ of distilled water and shake. Boil the mixture and divide it into three portions while still warm.

(i) To the first portion, add the remaining amount of solid sodium hydrogen carbonate.

Observations	**Inferences**
(1 mark)	(1 mark)

(ii) **To the second portion, add three drops of acidified potassium dichromate (VI) solution and warm.**

Observations	**Inferences**
(1 mark)	(1 mark)

(iii) To the **third portion, add five drops of bromine water.**

Observations	**Inferences**
(1 mark)	(1 mark)