

1977

Chemistry

Higher II

SCOTTISH CERTIFICATE OF EDUCATION

CHEMISTRY

Higher Grade—Paper II

Tuesday, 10th May—1.30 p.m. to 4.00 p.m.

Marks may be deducted for bad spelling, and bad punctuation, and for writing that is difficult to read.

Working should be shown in all answers involving calculations.

Necessary data will be found in the book of Mathematical Tables and Science Data.

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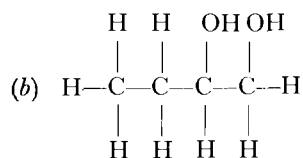
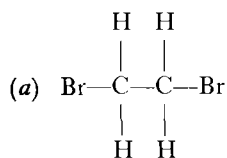
PART A

All questions should be attempted. It should be noted, however, that some questions contain a choice.

It is suggested that about one hour be spent on this part of the paper.

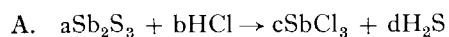
Marks

1. Give the systematic names of the following compounds:---



(2)

2. EITHER



Balance the equation and write down the values for a, b, c and d.

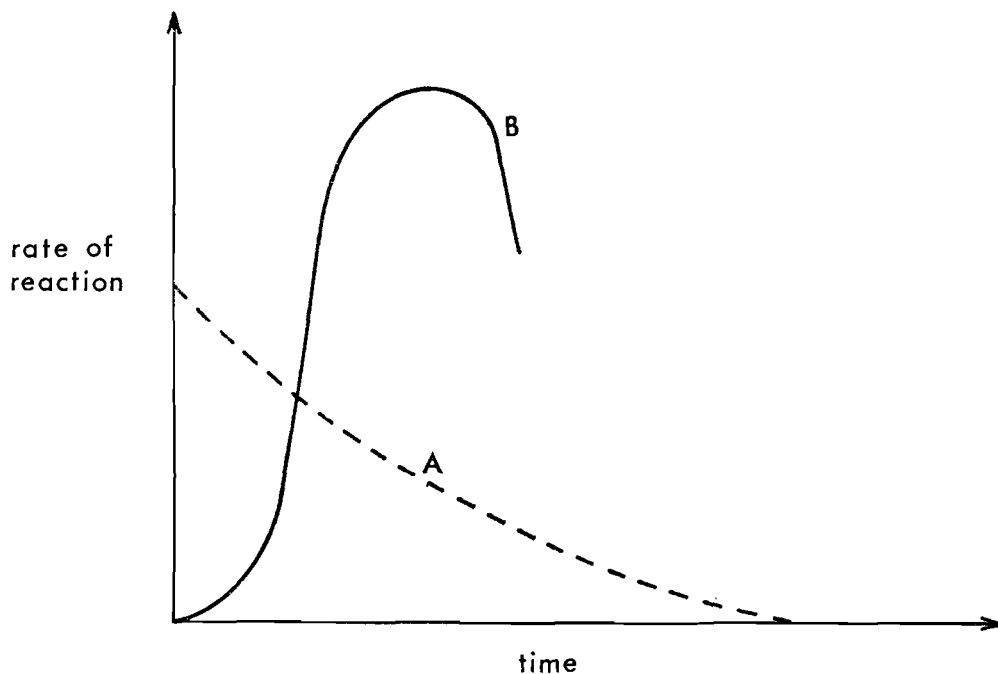
(2)

OR

- B. Hydrazine (N_2H_4) is widely used in industry to remove dissolved oxygen from boiler water. Its ability to act as an oxygen scavenger depends on its rapid oxidation to nitrogen and water in aqueous solution. Write a balanced equation for this reaction.

(2)

3.

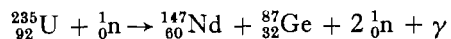


(a) Write the letters A and B in your examination book and opposite each write the type of reaction described by the appropriate curve:

explosive chain reaction; non chain reaction

2

(b) During the fission of uranium suppose that one of the processes which may occur is:—



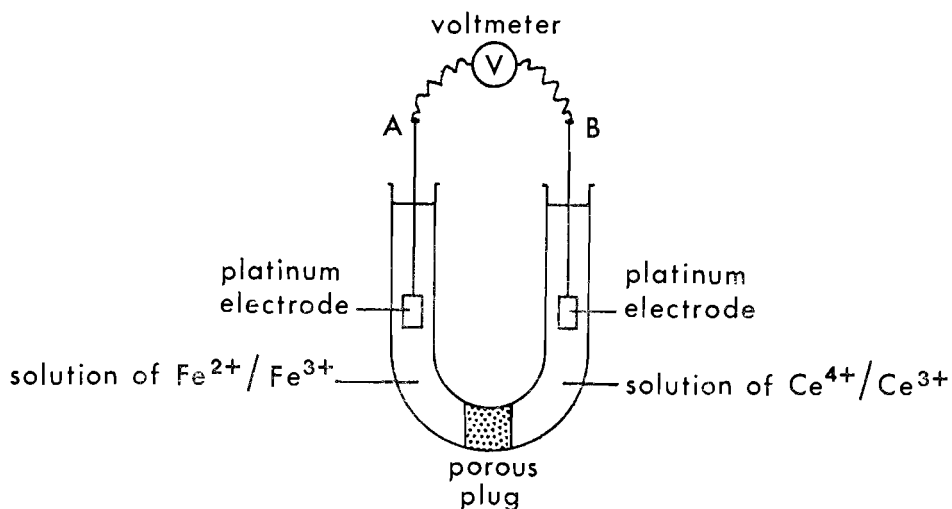
Which of the above curves would fit this hypothetical reaction? Explain your choice.

2

(4)

[Turn over

4. In a laboratory experiment the following apparatus was set up:—



The half reaction $\text{Ce}^{4+}(\text{aq}) + \text{e}^- \rightarrow \text{Ce}^{3+}(\text{aq})$ has a Standard Reduction Electrode Potential of +1.44 V. Use this information and that on page 40 of your Data Book to answer the following questions:

- (a) In the above cell, if all ionic concentrations are equal, in which direction will electrons flow in the external circuit? 1
- (b) Assuming standard conditions, what reading will appear on the voltmeter? 1
- (c) Write a balanced equation for the complete redox reaction occurring in the apparatus. 1
- (3)**

5. EITHER

A. A piece of copper was electro-plated with silver by passing a current of 5 amperes through the plating cell for 6 minutes 26 seconds.

- (i) Give the equation representing the deposition of silver. 1
- (ii) Calculate the mass of silver deposited. 3
- (4)**

OR

B. A cube of aluminium has a side of length 10 cm. If each cm^3 aluminium has a mass of 2.7 g, calculate the number of atoms of aluminium in the cube. (4)

6. (a) Place the following compounds in order of base strength **beginning with the strongest:** ammonia; aniline; ethylamine. 1

(b) Write an equation for the action of ethylamine on water. 1

(c) Why are amino acids described as amphoteric? 2

(d) What would be formed when glycine ($\text{NH}_2\text{CH}_2\text{COOH}$) reacts with:

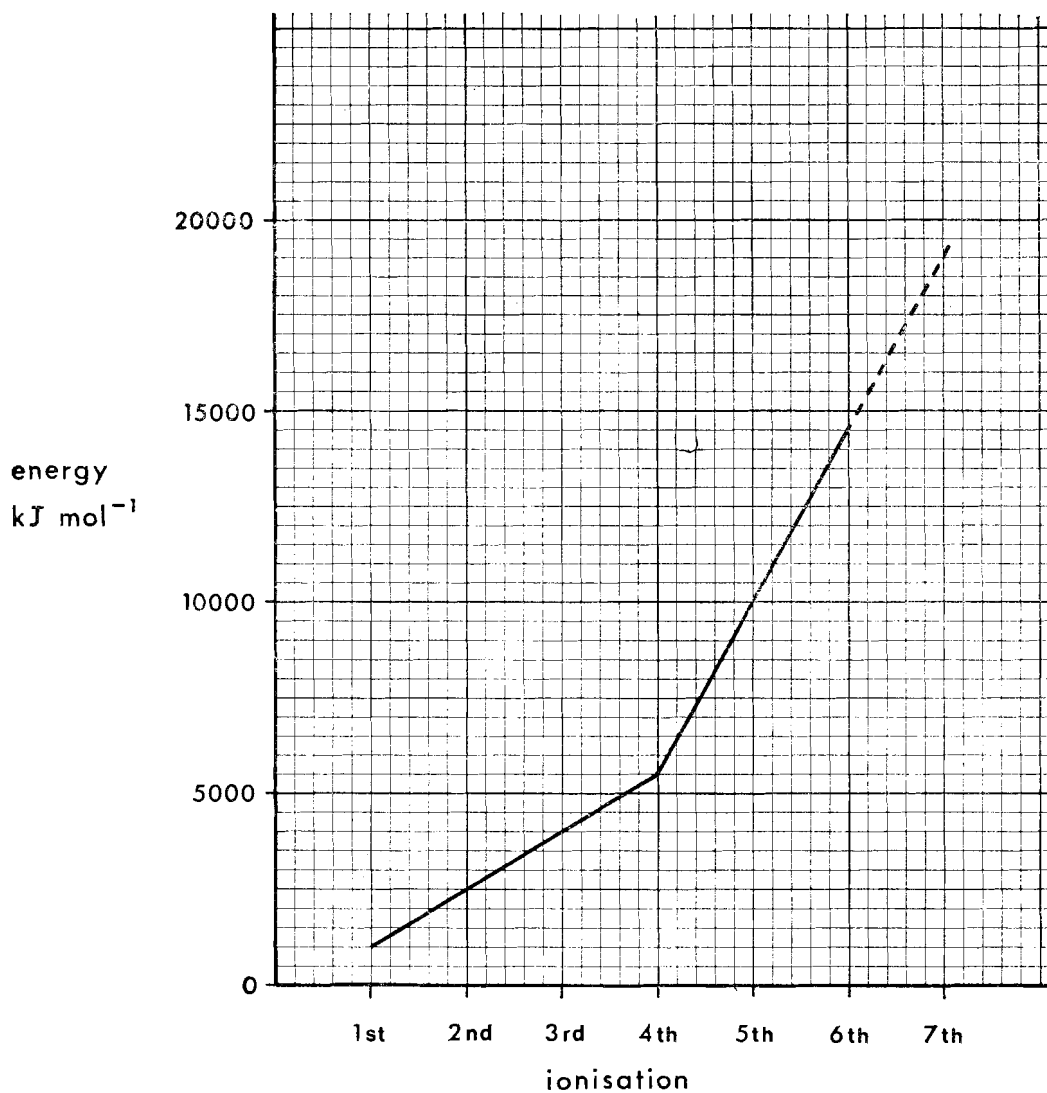
- (i) methanol, and
- (ii) hydrochloric acid? 2
- (6)**

7. EITHER

- A. Use the information on bond energies given on page 38 of the Data Book to calculate the heat of reaction for the complete hydrogenation of 1 mole of ethyne. (5)

OR

- B. The graph below shows the quantities of energy equivalent to successive ionisation potentials for an element X.

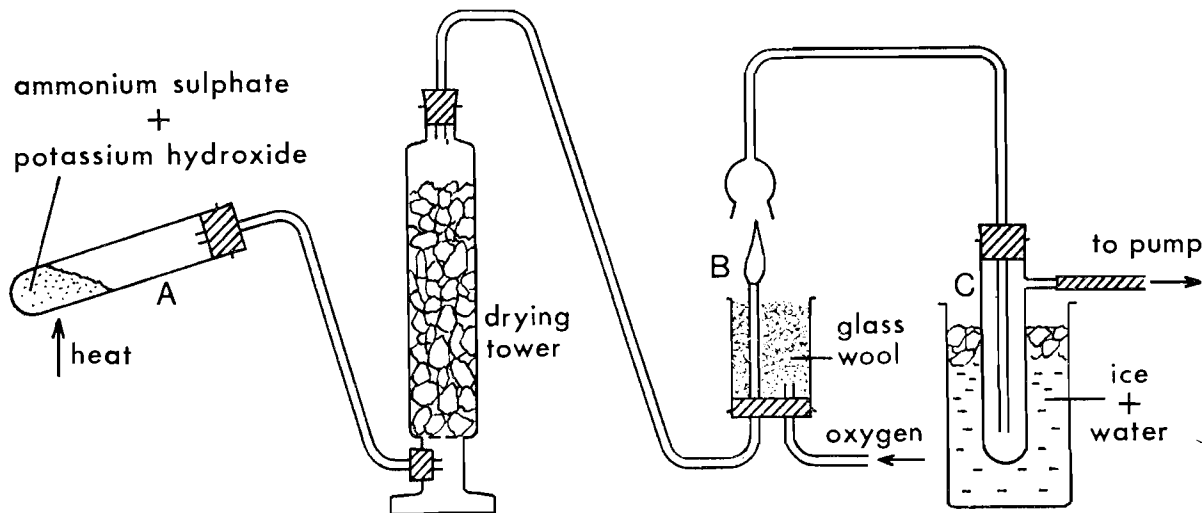


- (a) In which group is element X in the Periodic Table? 1
- (b) Explain the change in gradient of the graph. 2
- (c) What energy is required to form a mole of $X^{2+}(g)$ from $X(g)$? 2
- (5)
8. (a) Draw the structural formula of a dimer of ethyne. 2
- (b) Would this dimer decolourise bromine? Explain your answer. 1
- (3)

[Turn over

9. Gaseous hydrogen fluoride contains species of molecular weight 20, 40, 60, 80 and above. Explain this phenomenon. (2)

10. Consider the experiment shown below.

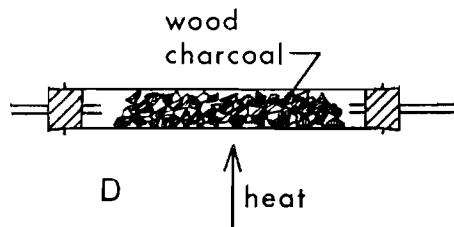
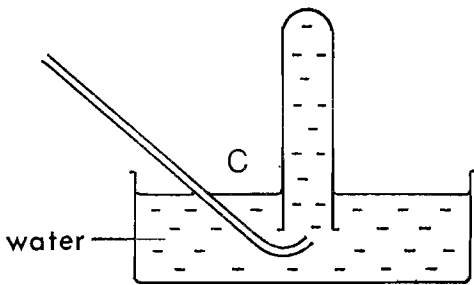
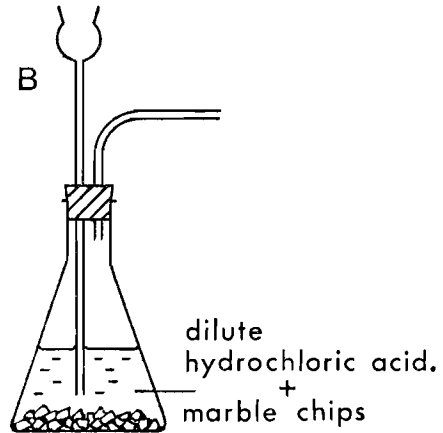
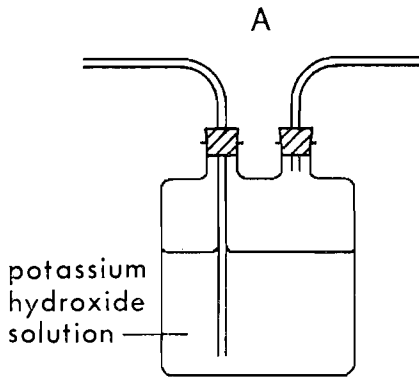


- (a) What gas is burning at B? 1
- (b) What product would you expect to collect in tube C? 1
- (c) Write an ionic equation for the reaction occurring in tube A. 1
(3)
11.
$$\text{C}_4\text{H}_9\text{Br} \xrightarrow{1} \text{C}_4\text{H}_{10}\text{O} \xrightarrow{2} \text{C}_4\text{H}_8\text{O}$$

2-bromobutane A B
- (a) Draw the structural formulae of compounds A and B. 2
- (b) What reagents are necessary to carry out steps 1 and 2? 2
(4)
12. (a) ${}^{14}_7\text{N} + x \rightarrow {}^{17}_8\text{O} + {}^1_1\text{H}$
- (b) ${}^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + y$
- State the mass and charge of each of the particles x and y , and identify them. (2)
13. Explain why:
- (a) an aqueous solution of potassium cyanide (KCN) has a pH greater than 7 and; 2
- (b) on warming, the pH of potassium cyanide solution rises further. 2
(4)
14. One volume of methane is burned in 4 volumes of oxygen in a closed vessel. What is the composition by volume of the resulting mixture at:
- (a) 130 °C, and
- (b) 20 °C? (4)

15. Arrange the following pieces of apparatus so that they can be used to convert carbon dioxide to carbon monoxide.

DO NOT DRAW THE APPARATUS, but answer by putting the letters in order, e.g. *A, B, C, D*.



(2)

[Turn over

PART B

All three questions should be attempted. Each question contains a choice.

Candidates are advised to spend about 1½ hours on this part.

16. Answer EITHER A. OR B.

A. TIN.

The main source of tin is the ore cassiterite or tinstone, SnO_2 . After preliminary treatment the concentrated ore is heated in a furnace with coke at about 1200°C . The molten tin runs to the bottom of the furnace and is tapped off.

Tin is a low melting (m.p. 232°C) silvery-white metal which can exist in allotropic forms. Ordinary tin is called white tin and it has metallic properties but at temperatures below 13°C white tin changes slowly to grey tin in which each atom is joined covalently to four others. This transition alters the appearance of tin and at very low temperatures, around -50°C , the speed of this conversion is so great that tin objects can crumble to powder.

When heated in air tin forms tin(IV) oxide, SnO_2 . Heated tin also reacts with chlorine to form tin(IV) chloride, SnCl_4 , a colourless liquid (b.p. 114°C) which fumes strongly in moist air.

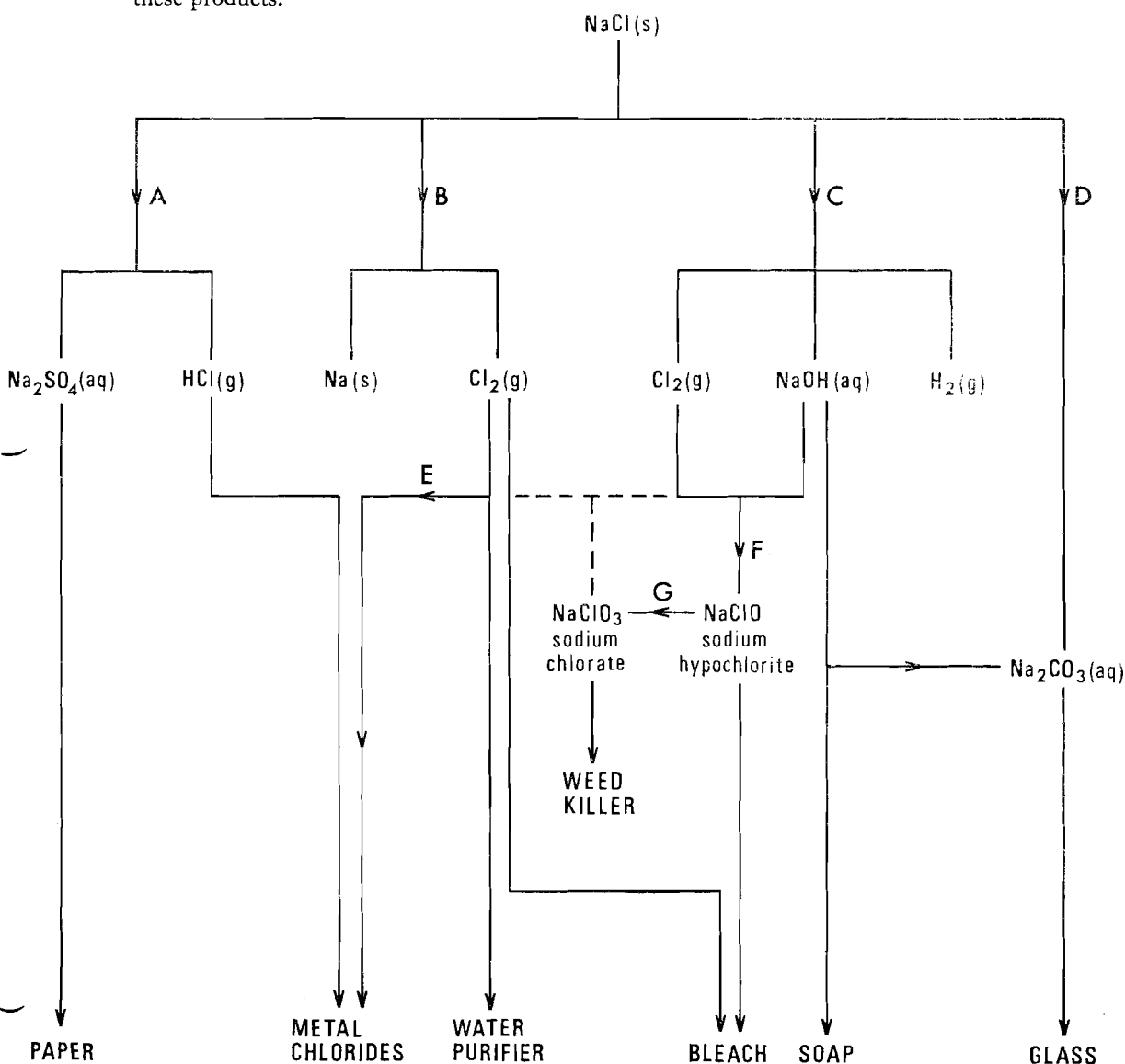
Tin is used extensively as a protective coating for steel, especially in making "tin cans". Copper and other metals are sometimes coated with tin. Tin is also used to make alloys such as pewter, bronze and solder.

- (a) Write a balanced chemical equation for the conversion of tinstone to tin. **1**
- (b) (i) What type of chemical bonding do you think is present in tin(IV) chloride? **1**
(ii) Explain what happens when tin(IV) chloride fumes in moist air. **2**
- (c) What **in the text** indicates the nature of the term "allotropic forms"? **1**
- (d) Draw a diagram to show the arrangement of the atoms in grey tin. **1**
- (e) (i) Explain why white tin metal is a conductor of electricity. **2**
(ii) Is grey or white tin likely to be the better conductor of electricity? Give a reason for your answer. **2**
- (f) In some ancient cathedrals after very severe winter weather it was found that the tin organ pipes had developed "spots" and "growths", called "tin disease", and these were originally attributed to the devil. From the information in the passage what explanation can be offered for this phenomenon? **2**
- (g) A chemistry text states that "large quantities of tin are recovered from scrap tinplate by electrolysis". Make a labelled drawing of an apparatus that could be used to carry out this process. **2**
- (h) Tin is used to protect iron and copper from the effects of corrosion. Explain why tin offers better protection to copper than to iron. **3**
- (i) From the evidence in the passage, suggest one property of tin that makes it suitable for use in the alloy solder. **1**

(18)

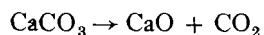
OR

- B. Sodium chloride is an extremely important compound as it can be used, directly or indirectly, to make a variety of substances. The accompanying flow-chart shows some of these products.



- (a) Give the reactant and conditions for step A. 2
- (b) Under what conditions, and by what means is:
- (i) step B carried out, and
 - (ii) step C carried out? 3
- (c) Step D represents a method of manufacturing sodium carbonate called the Solvay process. This is a two-stage process:
- (i) $\text{NaCl} + \text{NH}_3 + \text{H}_2\text{O} + \text{CO}_2 \rightarrow \text{NaHCO}_3 + \text{NH}_4\text{Cl}$
 - (ii) $2 \text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{H}_2\text{O} + \text{CO}_2$

The carbon dioxide for stage (i) is obtained by roasting limestone:



From the information given above in part (c) suggest an economic method of regenerating the ammonia required for stage (i) and give the equation. 3

[Turn over

- (d) Aluminium chloride can be formed by step *E*. Dry chlorine is passed over hot aluminium and a vapour of molecular weight 267 is formed which sublimes at 183 °C as anhydrous aluminium chloride.
- (i) From the above information suggest a formula for the vapour. **1**
- (ii) What does the sublimation temperature suggest about the bonding in aluminium chloride? **1**
- (iii) If the chlorine had not been dry which compound of aluminium would have been formed? Explain your answer. **2**
- (e) In what way does chlorine purify water? **1**
- (f) Reactions *F* and *G* can be described respectively by the equations:
- $$\text{Cl}_2 + 2\text{OH}^- \rightarrow \text{ClO}^- + \text{Cl}^- + \text{H}_2\text{O}$$
- $$3\text{ClO}^- \rightarrow \text{ClO}_3^- + 2\text{Cl}^-$$
- (i) Assuming total conversion, how many moles of chlorine could be obtained from 1 mole sodium chlorate? **1**
- (ii) Hence deduce the number of moles of chlorate ion produced from this quantity of chlorine. **1**
- (g) Suggest **two** industrial uses for the hydrogen, for which no use is shown in the flow-chart. **2**
- (h) Name one major constituent which can be fused with sodium carbonate to form glass. **1**
- (18)**

17. Answer EITHER A. OR B.

A. A chemist is supplied with an old sample of potassium sulphite which is known to contain potassium sulphate as an impurity. He has at his disposal dilute hydrochloric acid, distilled water, barium chloride solution, and the apparatus normally found in a chemistry laboratory.

- (a) Describe how the chemist should proceed in order to find the percentage by weight of the potassium sulphate impurity in the sample.
- Your answer should include:
- (i) a clear statement of the chemistry involved; **3**
- (ii) balanced equations for the chemical reactions involved; **3**
- (iii) experimental details; **6**
- (iv) method of calculating results. **3**
- (b) Explain the importance of using distilled water rather than tap water in the experiment. **2**
- (17)**

OR

B. A chemist working in a fully equipped chemistry laboratory is studying the reaction of iron(II) sulphide with hydrochloric acid—a reaction which produces a poisonous evil-smelling gas. He has available 5 M hydrochloric acid and iron(II) sulphide in both lump and powder form.

- (a) Imagine that you have been asked to write out for him details of an experimental method he could follow to study the effect of varying the particle size of iron(II) sulphide in the reaction of this substance with hydrochloric acid, using appropriate apparatus and the chemicals available.
- Your answer should give the following:
- (i) a labelled diagram of the apparatus to be used; **2**
- (ii) a description of the procedure to be followed and the measurements to be taken; **5**
- (iii) an outline of any precautions to be observed to ensure that the reaction was carried out safely. **1**

- (b) How would you change the experiment described in part (a) in order to investigate the effect of varying temperature on the reaction rate?

Your answer should give the following:

- (i) a labelled diagram of the apparatus to be used; 2
(ii) a description of the procedure to be followed and the measurements to be taken. 5
- (c) In the chemical industry the “poisoning” of a catalyst can have a very serious effect on a reaction. Explain why this is so. 2

(17)

18. Answer EITHER A. OR B.

- A. Write an essay on “Fuels and Fuel Products”.

Your answer should include reference to the following:

- (a) naturally occurring fuels, their formation and uses;
(b) the chemical reasons for substances being used as fuels;
(c) the combustion of fuels;
(d) fuels and chemicals derived by the chemist from natural fuels, including an outline of the industrial processes involved;
(e) the industrial importance and uses of derived fuels and chemicals;
(f) advantages and disadvantages of various types of fuels.

(15)

OR

- B. Write an essay on “Soaps and Synthetic Detergents”.

Your answer should include reference to the following:

- (a) the structure of an ester;
(b) naturally occurring esters which can be converted into soaps;
(c) the structure of soap;
(d) sources and structures of synthetic detergents;
(e) action of soaps and synthetic detergents on grease or oil;
(f) hard water and its effect on soaps and synthetic detergents;
(g) the advantages and disadvantages of synthetic detergents compared with soaps.

(15)

[END OF QUESTION PAPER]