K.C.S.E. CHEMISTRY PAPER 233/2 2007

1 (a) State **two** factors that should be considered when choosing fuel for cooking. (2 marks)

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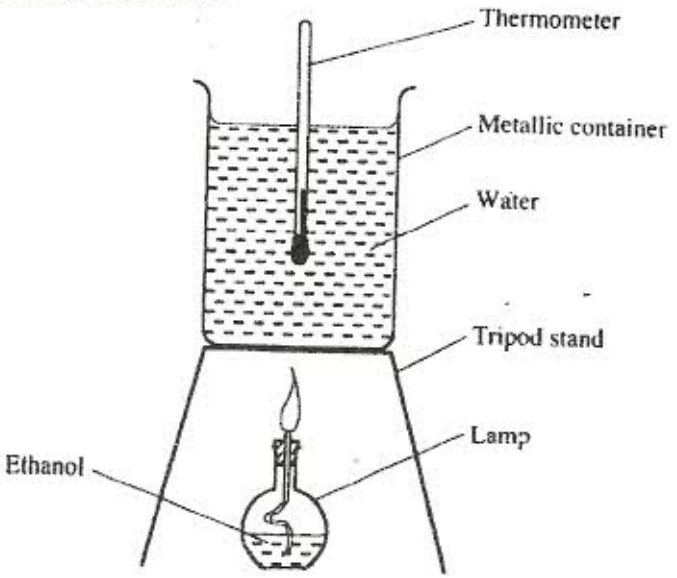
(b) The diagram below represents a set-up that was used to determine the molar heat of combustion of ethanol.



During the experiment, the data given below was recorded.

Volume of water	450 cm^3
Initial temperature of water	25°C
Final temperature of water	46.5°C
Mass of ethanol + lamp before burning	125.5g
Mass of ethanol + lamp after burning	124.0g

Calculate the:

(i) heat evolved during the experiment (Density of water = 1 g/cm^3, specific heat capacity of water = 4.2 $Jg^{-1}K^{-1}$) (3 marks)

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(ii) molar heat of combustion of ethanol (C = 12.0, O = 16.0, H = 1.0). (2 marks)

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(c) Write the equation for the complete combustion of ethanol. (1 mark)

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(d) The value of the molar heat of combustion of ethanol obtained in (b)(ii) above is lower than the theoretical value. State **two** sources of error in the experiment. (2 marks)

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

(i) $CH_2 = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - CH_3$

(1 mark)

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(ii) $CH_3CH_2CH_2C \equiv CH$ (1 mark)

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(b) State the observations made when propan-1-ol reacts with:

(i) acidified potassium dichromate (VI) solution (1 mark)

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(ii) sodium metal. (1 mark)

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(c) Ethanol obtained from glucose can be converted to ethene as shown below:

$$C_6H_{12}O_6 \xrightarrow{Step\ I} C_2H_5OH \xrightarrow{Step\ II} CH_2 = CH_2$$

Name and describe the processes that take place in steps I and II.

Step I ($1\frac{1}{2}$ marks)

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Step II ($1\frac{1}{2}$ marks)

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(d) Compounds A and B have the same molecular formula $C_3H_6O_2$. Compound A liberates carbon (IV) oxide on addition of aqueous sodium carbonate while compound B does not. Compound B has a sweet smell. Draw the possible structures of:

(i) compound A (1 mark)

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(ii) compound B. (1 mark)

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(e) Give two reasons why the disposal of polymers such as polychloroethene by burning pollutes the environment. (2 marks)

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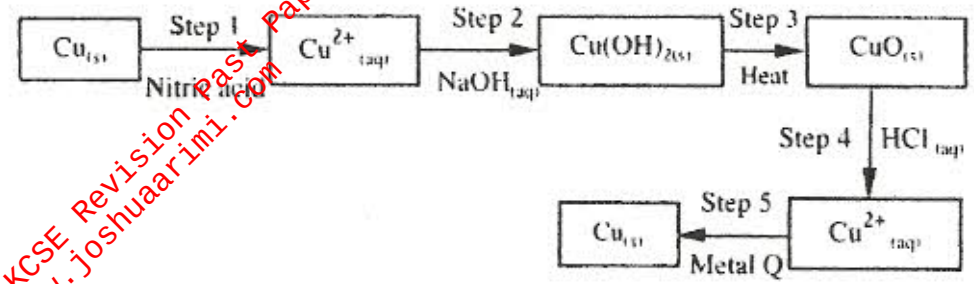
3. The flow chart below shows a sequence of chemical reactions starting with copper. Study it and answer the questions that follow.



(a) In step 1, excess 3M nitric acid was added to 0.5g of copper powder.

(i) State **two** observations which were made when the reaction was in progress. (2 marks)

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(ii) Explain why dilute hydrochloric acid cannot be used in step 1. (1 mark)

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(iii) I Write the equation for the reaction that took place in step 1. (1 mark)

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II Calculate the volume of 3M nitric acid that was needed to react completely with 0.5g of copper powder. (Cu=63.5). (3 marks)

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(b) Give the names of the types of reactions that took place in steps 4 and 5. (1 mark)
Step 4

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Step 5

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(c) Apart from the good conductivity of electricity, state **two** other properties that make it possible for copper to be extensively used in the electrical industry. (2 marks)

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4. (a) Methanol is manufactured from carbon (IV) oxide and hydrogen gas according to the equation:

$$CO_{2(g)} + 3H_{2(g)} \rightleftharpoons CH_3OH_{(g)} + H_2O_{(g)}$$

The reaction is carried out in the presence of a chromium catalyst at 700K and 30kPa. Under these conditions, an equilibrium is reached when 2% of the carbon (IV) oxide is converted to methanol.

(i) How does the rate of the forward reaction compare with that of the reverse reaction when 2% of the carbon (IV) oxide is converted to methanol? (1 mark)

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(ii) Explain how each of the following would affect the yield of methanol:

I reduction in pressure (2 marks)

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II using a more efficient catalyst. (2 marks)

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(iii) If the reaction is carried out at 500K and 30 kPa, the percentage of carbon (IV) oxide converted to methanol is higher than 2%.

I. What is the sign of ΔH for the reaction? Give a reason. (2 marks)

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II Explain why in practice the reaction is carried out at 700K but NOT at 500K. (1 mark)

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(b) Hydrogen peroxide decomposes according to the following equation:

$2H_2O_2\ (aq) \rightarrow 2H_2O(l) + O_2(g)$

In an experiment, the rate of decomposition of hydrogen peroxide was found to be 6.0×10^{-8} mol dm^{-3} S^{-1}.

(i) Calculate the number of moles per dm^3 of hydrogen peroxide that had decomposed within the first 2 minutes. (2 marks)

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(ii) In another experiment, the rate of decomposition was found to be 1.8×10^{-7} mol $dm^{-3}S^{-1}$. The difference in the two rates could have been caused by addition of a catalyst. State, giving reasons, one other factor that may have caused the difference in the two rates of decomposition. (2 marks)

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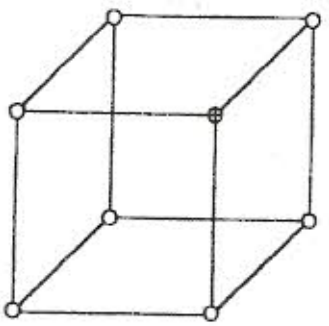
5. (a) The diagram below represents part of the structure of a sodium chloride crystal. The position of one of the sodium ions in the crystal is shown as ⊕.



(i) on the diagram, mark the positions of the other three sodium ions. (2 marks)

(ii) The melting and boiling points of sodium chloride are 801°C and 1413°C respectively. Explain why sodium chloride does not conduct electricity at 25°C, but does so at temperatures between 801°C and 1413°C. (2 marks)

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(b) Give a reason why ammonia gas is highly soluble in water. (2 marks)

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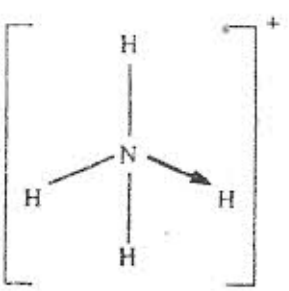
(c) The structure of an ammonium ion is shown below:



Name the type of bond represented in the diagram by N ⟶ H. (1 mark)

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(d) Carbon exists in different crystalline forms. Some of these forms were recently discovered in soot and are called fullerenes.

(i) What name is given to different crystalline forms of the same element? (1 mark)

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(ii) Fullerenes dissolve in methylbenzene while the other forms of carbon do not. Given that soot is a mixture of fullerenes and other solid forms of carbon, describe how crystals of fullerenes can be obtained from soot. (3 marks)

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(iii) The relative molecular mass of one of the fullerenes is 720. What is the molecular formula of this fullerene? (C = 12.0). (1 mark)

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6. (a) The elements nitrogen, phosphorus and potassium are essential for plant growth.

(i) Potassium in fertilizers may be in the form of potassium nitrate. Describe how a sample of a fertiliser may be tested to find out if it contained nitrate ions. (2 marks)

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(ii) Calculate the mass of nitrogen present if a 25kg bag contained pure ammonium phosphate, $(NH_4)_2HPO_4$. (N = 14.0, H = 1.0, P = 31.0, O = 16.0) (2 marks)

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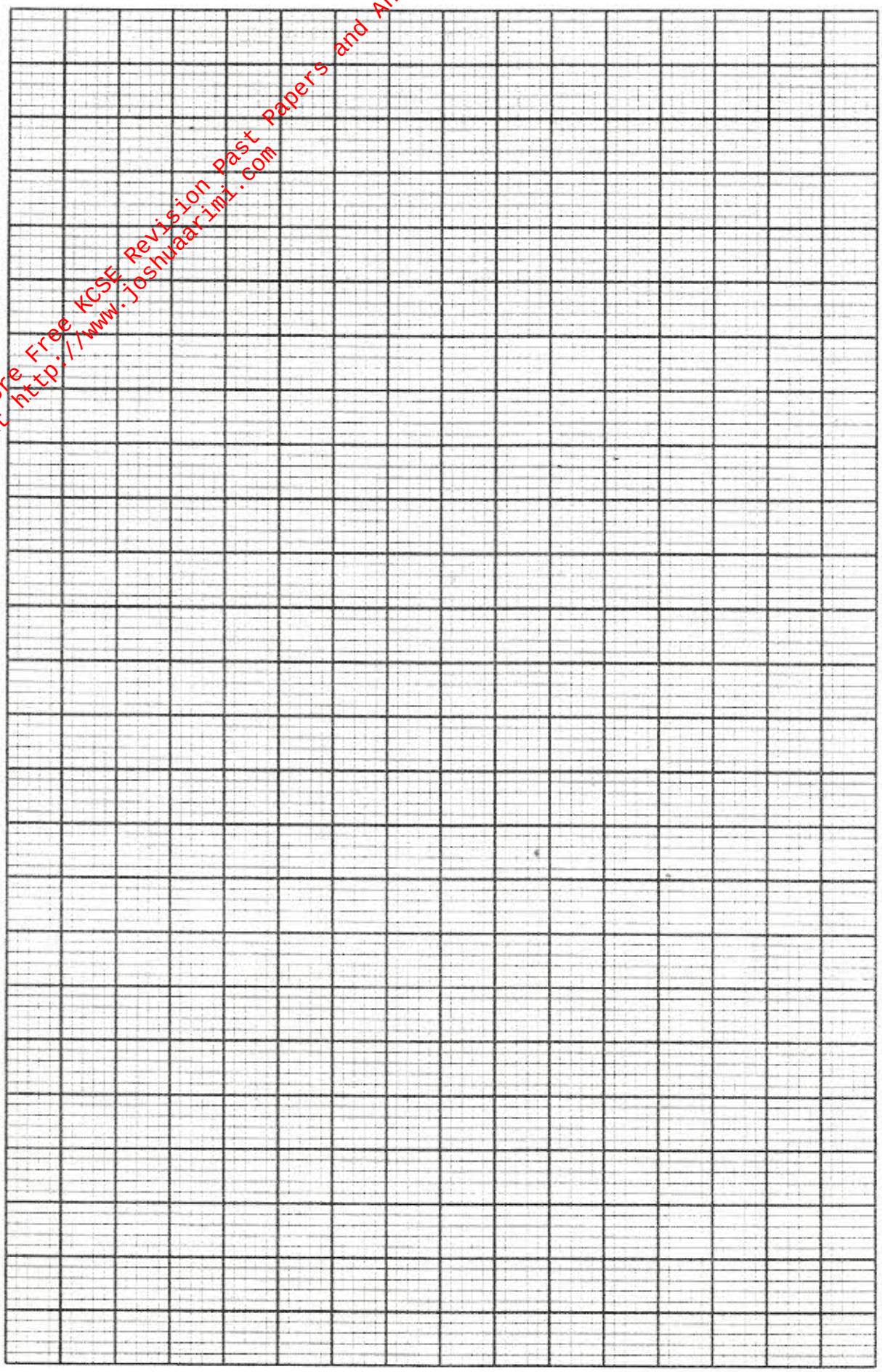
(b) The table below shows the solubility of ammonium phosphate in water at different temperatures.

Temperature (°C)	Solubility of ammonium phosphate in g/100g water
10	63.0
20	69.0
30	75.0
40	82.0
50	89.0
60	97.0

(i) On the grid provided, draw the solubility curve of ammonium phosphate. (Temperature on x - axis). (3 marks)



(ii) Using the graph, determine the solubility of ammonium phosphate at 25°C. (1 mark)

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(iii) 100g of a saturated solution of ammonium phosphate was prepared at 25°C.

I. What is meant by a saturated solution? (1 mark)

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II Calculate the mass of ammonium phosphate which was used to prepare the saturated solution. (2 marks)

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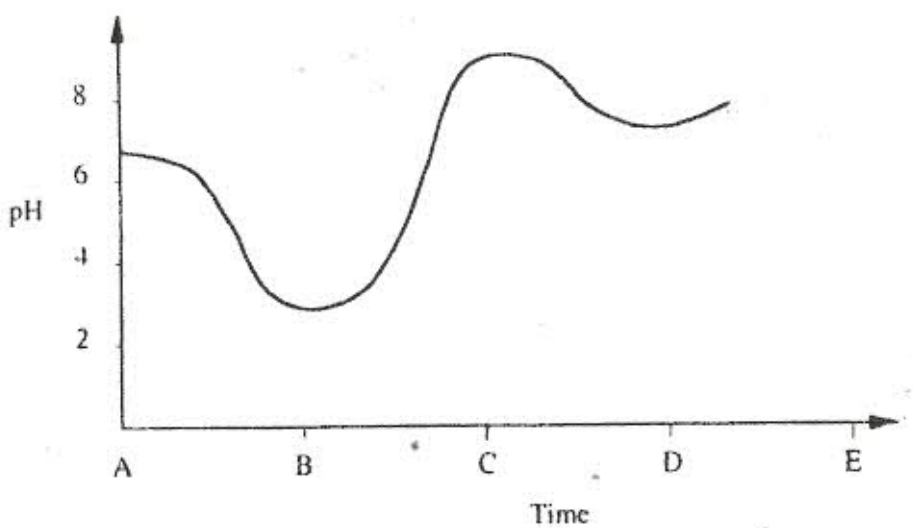
(c) The graph below shows how the pH value of soil in a farm changed over a period of time.



(i) Describe how the pH of the soil can be determined. (2 marks)

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(ii) State **one** factor that may have been responsible for the change in the soil pH in the time interval AB. (1 mark)

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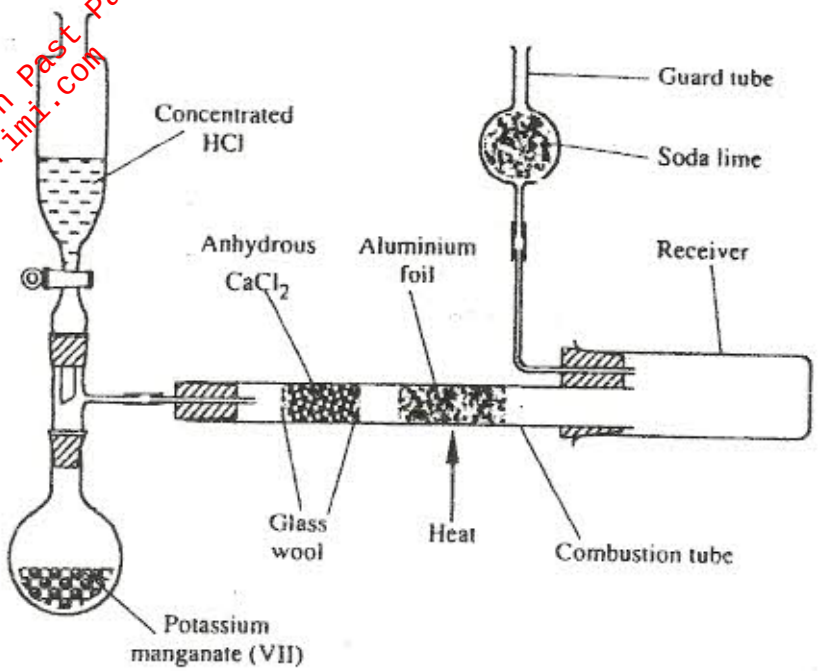
7. The diagram below shows the set up used in an experiment to prepare chlorine gas and react it with aluminium foil. Study it and answer the questions that follow.



(a) In the experiment, concentrated hydrochloric acid and potassium manganate (VII) were used to prepare chlorine gas. State two precautions that should be taken in carrying out this experiment. (2 marks)

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(b) Write the formula of another compound that could be used instead of potassium manganate (VII). (1 mark)

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(c) Explain why it is necessary to allow the acid to drip slowly onto potassium manganate (VII) before the aluminium foil is heated. (2 marks)

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(d) State the property of the product formed in the combustion tube that makes it possible for it to be collected in the receiver. (1 mark)

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(e) When 1.08g of aluminium foil were heated in a stream of chlorine gas, the mass of the product formed was 3.47g.

Calculate the:

(i) maximum mass of the product formed if chlorine was in excess; (Al=27; Cl=35.5) (3 marks)

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(ii) percentage yield of the product formed. (1 mark)

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(f) Phosphorus trichloride is a liquid at room temperature. What modification should be made to the set up if it is to be used to prepare phosphorus trichloride? (1 mark)

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