

**OXFORD CAMBRIDGE AND RSA EXAMINATIONS  
AS LEVEL**

**H032/02**

**CHEMISTRY A**

**Depth in Chemistry**

**FRIDAY 25 MAY 2018: Morning**

**TIME ALLOWED: 1 hour 30 minutes  
plus your additional time allowance**

**MODIFIED ENLARGED**

<b>First name</b>		<b>Last name</b>	
-----------------------	--	----------------------	--

<b>Centre number</b>						<b>Candidate number</b>				
--------------------------	--	--	--	--	--	-----------------------------	--	--	--	--

**YOU MUST HAVE:**

**the Data Sheet for Chemistry A  
(sent with general stationery)  
Loose Sheet for Question 7**

**YOU MAY USE:**

**a scientific or graphical calculator**

**READ INSTRUCTIONS OVERLEAF**



## **INSTRUCTIONS**

**Use black ink. HB pencil may be used for graphs and diagrams.**

**Complete the boxes on the front page with your name, centre number and candidate number.**

**Answer ALL the questions.**

**Write your answer to each question in the space provided. If additional answer space is required, you should use the lined page(s) at the end of the booklet. The question number(s) must be clearly shown.**

## **INFORMATION**

**The total mark for this paper is 70.**

**The marks for each question are shown in brackets [ ].**

**Quality of extended responses will be assessed in questions marked with an asterisk (\*).**

**Answer ALL the questions.**

- 1 A student carries out a titration to determine the molar mass and structure of a weak acid A.**

**The student follows the method below.**

**Dissolve a weighed mass of A in  $100\text{ cm}^3$  of distilled water and make the solution up to  $250\text{ cm}^3$  in a beaker. Add the solution of A to a burette.**

**Titrate the solution of A with a standard solution of sodium hydroxide, NaOH.**

- (a) What is meant by the term standard solution?**

\_\_\_\_\_  
\_\_\_\_\_ [1]

- (b) Sodium hydroxide is an alkali.**


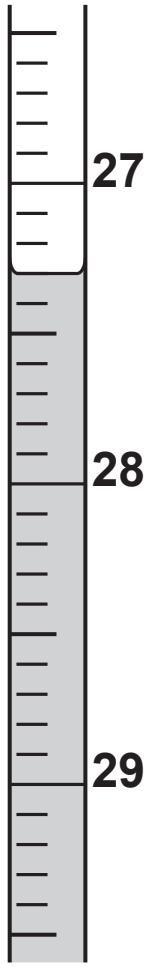


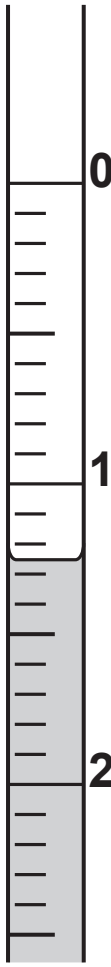

**What is meant by the term alkali?**

\_\_\_\_\_  
\_\_\_\_\_ [1]

(c) The student carries out a trial, followed by three further titrations.

The diagram shows the initial and final burette readings for the three FURTHER titrations.

The student measures all burette readings to the nearest  $0.05 \text{ cm}^3$ .

Titration 1		Titration 2		Titration 3	
Initial reading	Final reading	Initial reading	Final reading	Initial reading	Final reading
					

- (i) Record the student's readings and the titres in the table below.

Calculate the mean titre, to the nearest  $0.05\text{ cm}^3$ , that the student should use for analysing the results.

	Titration 1	Titration 2	Titration 3
Final reading/ $\text{cm}^3$			
Initial reading/ $\text{cm}^3$			
Titre/ $\text{cm}^3$			

mean titre = \_\_\_\_\_  $\text{cm}^3$  [4]

- (ii) The uncertainty in each burette reading is  $\pm 0.05\text{ cm}^3$ .

Calculate the percentage uncertainty for the titre in TITRATION 1.

percentage uncertainty = \_\_\_\_\_ % [1]

- (iii) The student realised that the solution of A had not been prepared correctly.

How should the student have made up the solution?

---

---

---

[1]

- (d) A student repeats the titration to determine the molar mass and structure of A.

The student prepares a  $250.0\text{ cm}^3$  solution from  $1.513\text{ g}$  of A.

The solution of A is added to the burette and titrated with  $25.0\text{ cm}^3$  volumes of  $0.112\text{ mol dm}^{-3}$  NaOH(aq).

1 mol of A reacts with 2 mol of NaOH.

The student obtains a mean titre of  $27.30\text{ cm}^3$ .

- (i) Calculate the molar mass of A from these results.

Give your answer to the nearest whole number.

Show your working.

molar mass of A = \_\_\_\_\_ g mol<sup>-1</sup> [4]

- (ii) A is an organic acid, containing C, H and O only.  
One molecule of A contains two COOH groups.

Suggest the structure of A. Use the space below. [1]

**BLANK PAGE**

**2 Sodium sulfide,  $\text{Na}_2\text{S}$ , is an ionic compound of sodium, Na, and sulfur, S.**

**(a) Draw a 'dot-and-cross' diagram to show the bonding in sodium sulfide.**

**Show outer electrons only. Use the space below.**

**[2]**

**(b) The table below compares the properties of sodium sulfide, sodium and sulfur.**

**Complete the table. [3]**

		<b>Sodium sulfide</b>	<b>Sodium</b>	<b>Sulfur</b>
<b>Melting point/°C</b>		<b>1180</b>	<b>98</b>	<b>113</b>
<b>Type of structure (GIANT or SIMPLE)</b>				
<b>Electrical conductivity (GOOD or POOR)</b>	<b>solid</b>			
	<b>liquid</b>			

**(c) Selenium is in the same group of the periodic table as sulfur.**

**(i) Complete the full electron configuration of a selenium atom.**

**1s<sup>2</sup> \_\_\_\_\_ [1]**

**(ii) Sodium selenide reacts with hydrochloric acid to form a toxic gas, B, with a relative molecular mass of 81.0.**

**Identify gas B and write an equation for this reaction.**

**Gas B \_\_\_\_\_**

**Equation \_\_\_\_\_ [2]**

**3 This question is about halogens.**

**(a) Bromine is used to extract iodine from a solution containing iodide ions.**

**(i) Write an ionic equation for the reaction.**

\_\_\_\_\_ **[1]**

**(ii) Explain why iodine is less reactive than bromine.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[3]**

**(b) Iodine can be used for the small-scale purification of drinking water.**

**(i) Iodine reacts with water as shown below.**



**Using oxidation numbers, explain why this reaction is a disproportionation.**

---

---

---

---

---

**[3]**

**(ii) Chlorine is used to purify water on a large scale.**

**State ONE disadvantage of using chlorine for the purification of drinking water.**

---

---

**[1]**

(c) Hydrogen reacts with chlorine to form hydrogen chloride,  $\text{HCl}$ :



TABLE 3.1 shows bond enthalpies.

TABLE 3.1

Bond	Bond Enthalpy / $\text{kJ mol}^{-1}$
H–H	+436
Cl–Cl	+243

Calculate the bond enthalpy for the H–Cl bond from the information above.

bond enthalpy = \_\_\_\_\_  $\text{kJ mol}^{-1}$  [2]

**(d) 'Enthalpy change of vaporisation' is the enthalpy change when one mole of a substance changes from a liquid to a gas at its boiling point.**

**(i) Write an equation, including state symbols, to represent the enthalpy change of vaporisation of bromine.**

\_\_\_\_\_ **[1]**

**(ii) Suggest whether the enthalpy change of vaporisation of bromine is exothermic or endothermic.**

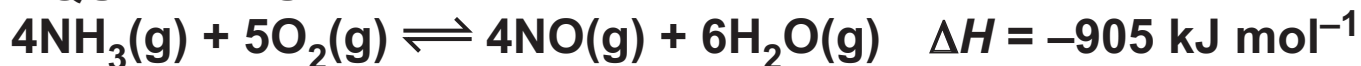
**Explain your answer.**

\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_ **[1]**

- 4 The reaction of ammonia,  $\text{NH}_3$ , with oxygen to form nitrogen monoxide,  $\text{NO}$ , is an important industrial process.

The equation for this reaction is shown in EQUILIBRIUM 4.1 below.

**EQUILIBRIUM 4.1**



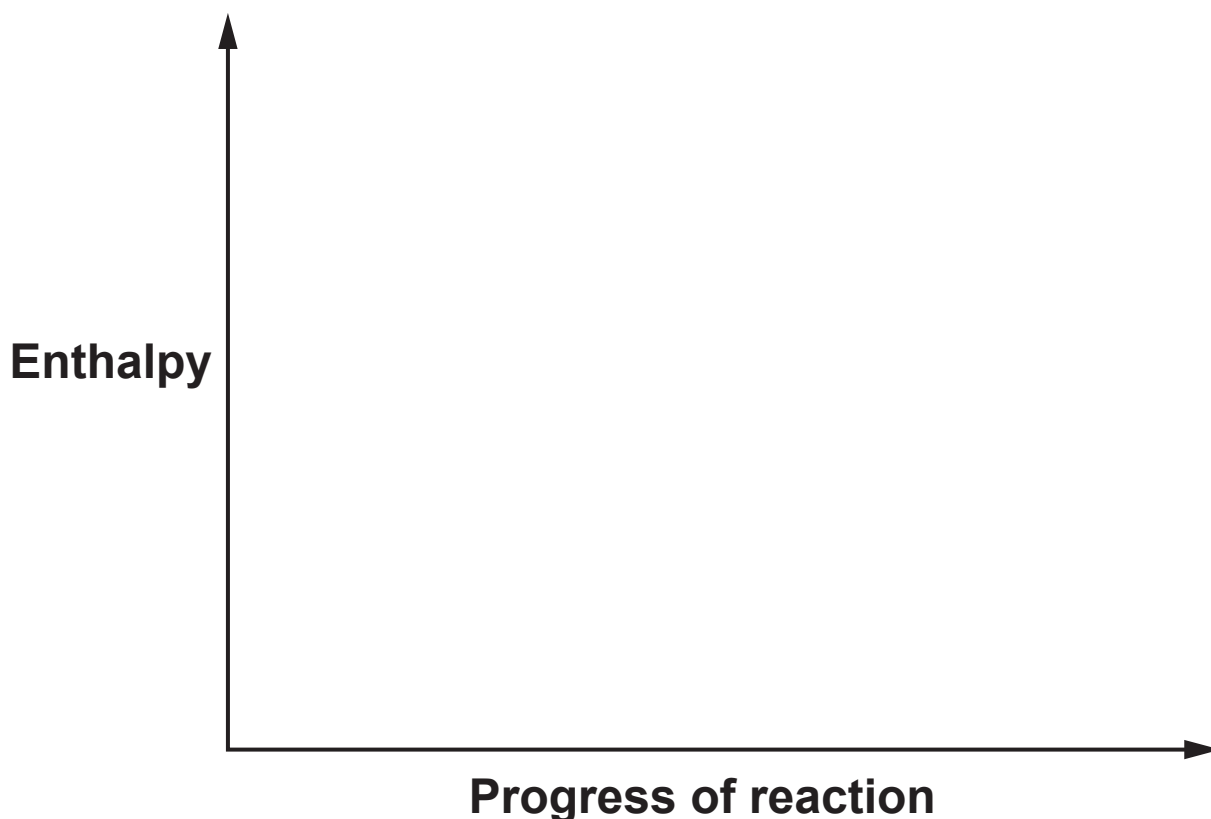
- (a) The forward reaction in EQUILIBRIUM 4.1 converts  $\text{NH}_3$  into  $\text{NO}$ .
- (i) Complete the enthalpy profile diagram for this reaction. [2]

On your diagram:

Label the activation energy,  $E_a$

Label the enthalpy change of reaction,  $\Delta H$

Include the formulae of the reactants and products.



(ii) 5.10 tonnes of  $\text{NH}_3$  are converted into NO.

Calculate the energy released, in kJ, for this conversion.

Give your answer in STANDARD FORM and to an APPROPRIATE number of significant figures.

energy released = \_\_\_\_\_ kJ [4]

(b) Write an expression for the equilibrium constant,  $K_c$ , in EQUILIBRIUM 4.1. Use the space below. [1]

- (c) Predict the conditions of temperature and pressure for a maximum equilibrium yield of nitrogen monoxide in EQUILIBRIUM 4.1.**

**Explain your prediction in terms of le Chatelier's principle.**

**State and explain how these conditions could be changed to achieve a compromise between equilibrium yield, rate and other operational factors.**

---

---

---

---

---

---

---

---

---

---

---

[5]

**BLANK PAGE**

- 5 (a) 1-Bromobutane is an organic liquid with a boiling point of 102 °C.

A student prepares 1-bromobutane by reacting butan-1-ol with sulfuric acid and sodium bromide. The student boils the mixture for one hour.

The equation is shown below.



The student obtains a reaction mixture containing an organic layer (density = 1.27 g cm<sup>-3</sup>) and an aqueous layer (density = 1.00 g cm<sup>-3</sup>).

- (i)\* Draw a labelled diagram to show how you would safely set up apparatus for the preparation. Outline a method to obtain a pure sample of 1-bromobutane from the reaction mixture. Use the space below. [6]

[illegible]

- (ii) The student used 0.150 mol of butan-1-ol. The student obtained a 61.4% percentage yield of 1-bromobutane.

Calculate the mass of 1-bromobutane obtained.

Give your answer to THREE significant figures.

mass = \_\_\_\_\_ g [2]

**BLANK PAGE**

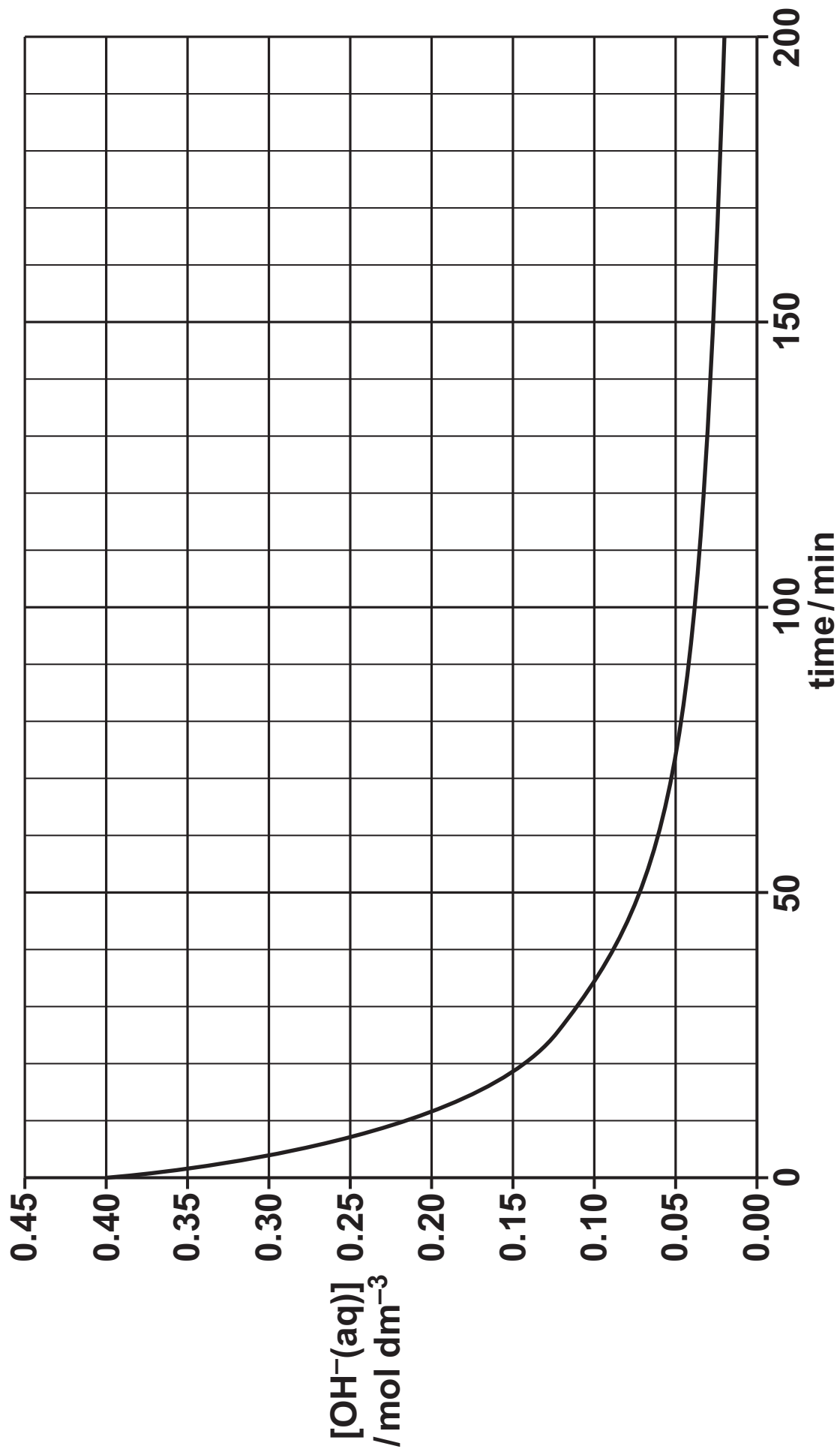
- (b) A student investigates the rate of reaction of 1-bromobutane with aqueous hydroxide ions.

The graph opposite shows how the hydroxide ion concentration,  $[\text{OH}^-(\text{aq})]$ , changes during the reaction.

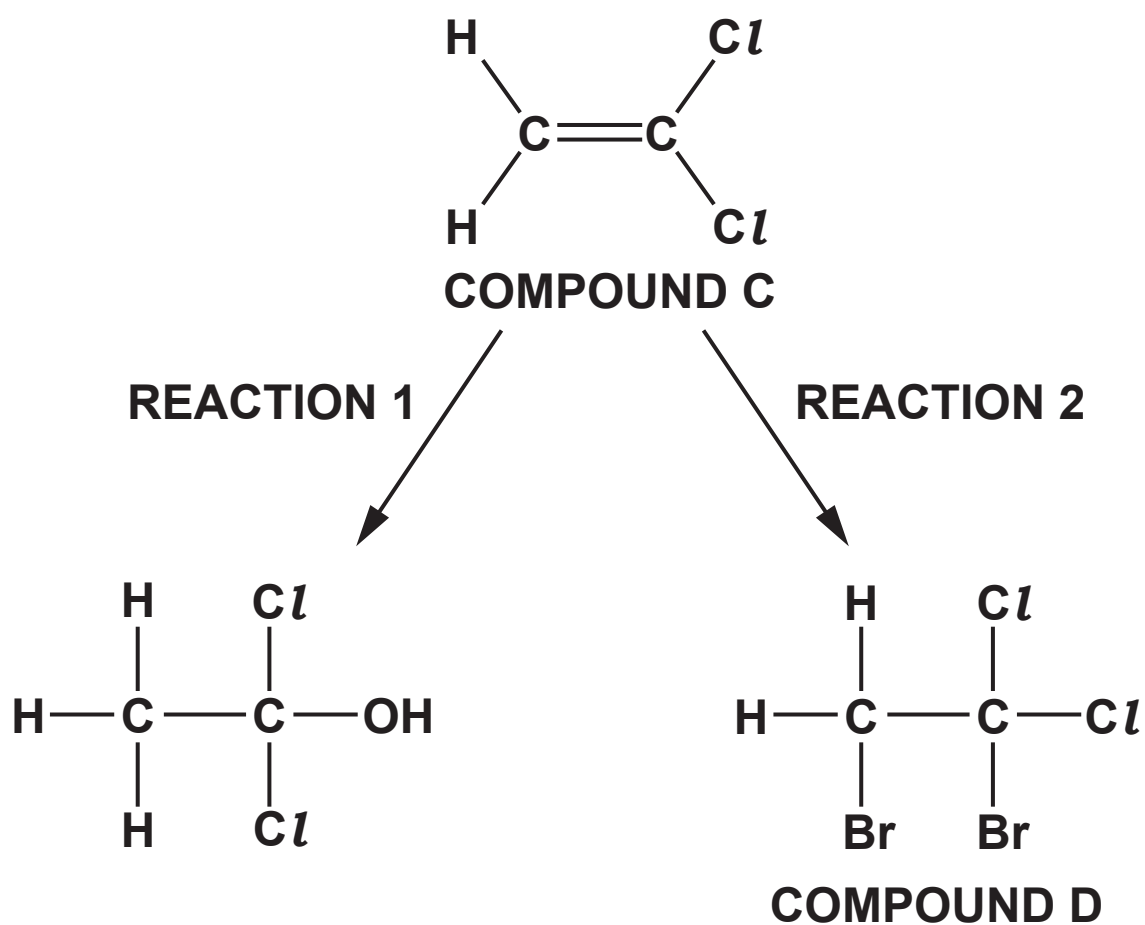
Using the graph, calculate the rate of reaction, in  $\text{mol dm}^{-3} \text{ min}^{-1}$ , at 30 minutes.

Show your working on the graph and in the space below.

rate of reaction = \_\_\_\_\_  $\text{mol dm}^{-3} \text{ min}^{-1}$  [2]



- 6 Two reactions of compound C are shown in the flowchart below.



- (a) State the reagents and conditions for REACTION 1.

\_\_\_\_\_

\_\_\_\_\_ [1]

**(b) In REACTION 2, compound C reacts with bromine to form compound D.**

**(i) Give the systematic name of compound D.**

\_\_\_\_\_ **[1]**

**(ii) Outline the mechanism for REACTION 2.**

**Include curly arrows, charges and relevant dipoles. Use the space below. [3]**

**(c) Compound C forms an addition polymer E.**

**(i) Write a balanced equation for this reaction.**

**Show displayed formulae. Use the space below. [2]**

**(ii) State ONE advantage and ONE disadvantage of using combustion as a method for the disposal of waste polymer E.**

**Advantage** \_\_\_\_\_

\_\_\_\_\_

**Disadvantage** \_\_\_\_\_

\_\_\_\_\_ **[2]**

**7\* Compound F is a *trans* stereoisomer which is a useful intermediate in organic synthesis.**

**The results of elemental and spectral analysis of compound F are shown on the Loose Sheet.**

**Percentage composition by mass: C, 68.6 %; H, 8.6 %; O, 22.8 %.**

**In the mass spectrum, the peak with the greatest relative intensity is caused by the loss of a functional group from the molecular ion of compound F.**

**Determine the structure of compound F.**

**Explain your reasoning and show your working. [6]**

---

---

---

---

---

---

---

---

---

---

---

---

---

---

---

**END OF QUESTION PAPER**

### ADDITIONAL ANSWER SPACE

**If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).**

[illegible]









## **Copyright Information**

**OCR is committed to seeking permission to reproduce all third-party content that it uses in its assessment materials. OCR has attempted to identify and contact all copyright holders whose work is used in this paper. To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced in the OCR Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download from our public website ([www.ocr.org.uk](http://www.ocr.org.uk)) after the live examination series.**

**If OCR has unwittingly failed to correctly acknowledge or clear any third-party content in this assessment material, OCR will be happy to correct its mistake at the earliest possible opportunity.**

**For queries or further information please contact the Copyright Team, First Floor, 9 Hills Road, Cambridge CB2 1GE.**

**OCR is part of the Cambridge Assessment Group; Cambridge Assessment is the brand name of University of Cambridge Local Examinations Syndicate (UCLES), which is itself a department of the University of Cambridge.**