Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

S24-3430U50-1

3430U50-1

FRIDAY, 17 MAY 2024 – MORNING

SCIENCE (Double Award)
Unit 5 – CHEMISTRY 2
FOUNDATION TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**11**	
3.	**7**	
4.	**5**	
5.	**5**	
6.	**6**	
7.	**15**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this examination paper you will need a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

Question **6** is a quality of extended response (QER) question where your writing skills will be assessed.

The Periodic Table is printed on the back cover of this paper and the formulae for some common ions on the inside of the back cover.

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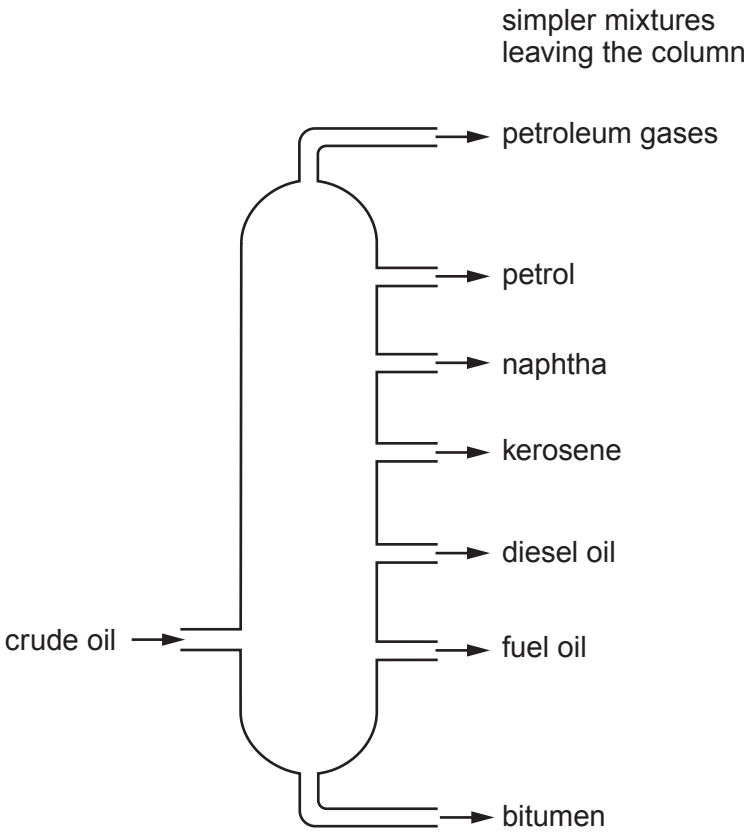
Answer **all** questions.

1. (a) The diagram shows a fractionating column where crude oil is separated into simpler mixtures.



(i) Underline the correct word in the brackets to complete each sentence about the separation process.

I. Before the crude oil mixture enters the column it must be (**boiled / melted / filtered**). [1]

II. Inside the column, the simpler mixtures (**evaporate / condense / solidify**). [1]

III. The simpler mixtures that leave the fractionating column are called (**monomers / polymers / fractions**). [1]

IV. The reason the simpler mixtures are separated from one another is that they have different (**masses / densities / boiling points**). [1]

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(ii) The table shows some information about the simpler mixtures obtained from crude oil.

Simpler mixture	Number of carbon atoms in the compounds	Use
petroleum gases	1–4	cooking
petrol	4–12	cars
naphtha	7–14	making chemicals
kerosene	11–15	aircraft
diesel oil	15–19	lorries
fuel oil	20–30	power stations
bitumen	more than 30	roads

I. Give the name of a mixture **not** used as a fuel. [1]

.....

II. Give the names of the **two** mixtures that contain compounds with **13 carbon** atoms.

..... and ..... [1]

Examiner only

(b) One of the compounds found in petrol is octane, C_8H_{18}.

$A_r(C) = 12$

(i) Give the **total** relative mass of the carbon atoms in one molecule of octane. [1]

Mass = ...

(ii) The relative molecular mass of octane is **114**. Use your answer to part (i) to calculate the percentage by mass of carbon in octane. [1]

Percentage = ... %

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(c) Fuel, heat and oxygen are the three factors needed to start and maintain a fire.

The photographs show three different methods used to put out fires or stop them from spreading.

Method	Reason
	**removes heat**
	**removes oxygen**
	**removes fuel**

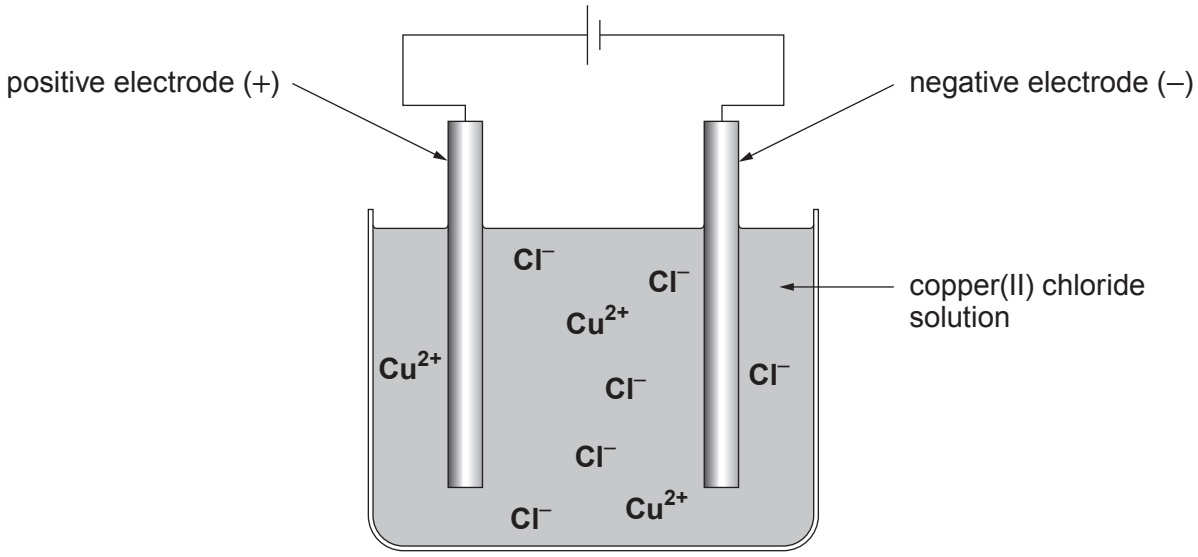
(i) Draw **one** line from each method to the reason it puts out a fire. [2]

(ii) Underline the type of fire that would be unsafe to put out using water. [1]

bonfire **electrical fire** **forest fire**

Examiner only

2. (a) Corey and Bailey used the following apparatus to obtain copper from copper(II) chloride solution.



(i)

electrolysis	**copper**	**anode**
cathode	**chlorine**	**displacement**
copper(II) chloride		**neutralisation**

Choose words from the box to complete the following sentences. [3]

The electrolyte used in this process is ..... .

Copper is formed at the negative electrode. This electrode is called the

..... .

The breaking down of a compound using an electric current is called

..... .

Examiner only

(ii) Copper(II) chloride contains the ions Cu^{2+} and Cl^{-}.

Give the formula of copper(II) chloride. [1]

.....

(iii) During the process, copper ions become copper atoms by gaining electrons.

Tick (✓) the box next to the equation that shows this. [1]

$Cu - 2e^{-} \longrightarrow Cu^{2+}$ ☐

$Cu + 2e^{-} \longrightarrow Cu^{2+}$ ☐

$Cu^{2+} + 2e^{-} \longrightarrow Cu$ ☐

$Cu^{2+} - 2e^{-} \longrightarrow Cu$ ☐

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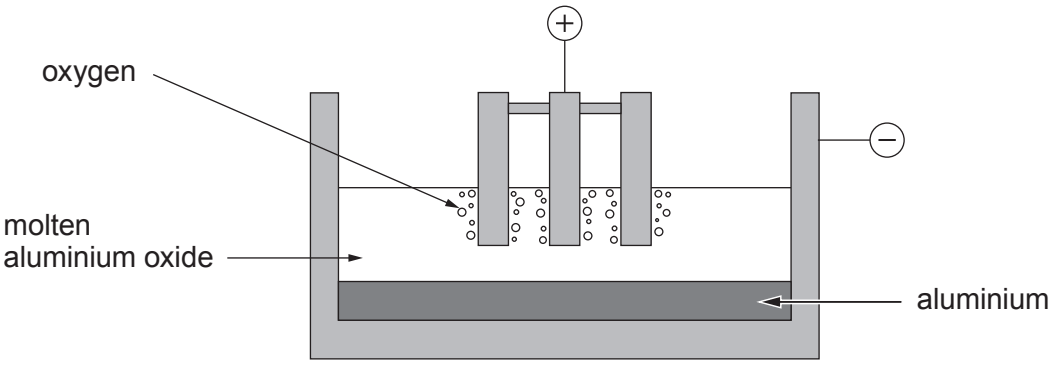
(b) The diagram represents the industrial extraction of aluminium from its ore.



(i) Give the reason why the aluminium oxide must be molten during the extraction.

Tick (✓) the correct box. [1]

to release the oxygen gas from the aluminium oxide ☐

to allow the aluminium ions and oxide ions to move ☐

to allow the aluminium to leave the cell ☐

to speed up the process ☐

(ii) Put a number in the box to balance the equation that represents the overall reaction taking place. [1]

$$2\,Al_2O_3 \longrightarrow \square\ Al + 3\,O_2$$

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(iii) Tick (✓) the boxes next to the **two** factors that are important when choosing the location for aluminium plants in the UK. [2]

Aluminium plants in the UK should be close to

landfill sites	☐
power stations	☐
limestone quarries	☐
oil refineries	☐
coastal ports	☐
coal mines	☐

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(c) Aluminium is commonly used to make overhead power cables.

Other than being a good electrical conductor, give **two** properties which make aluminium a suitable material for making overhead power cables. [2]

Property 1 .....

Property 2 .....

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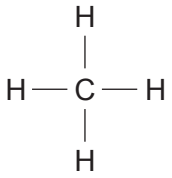
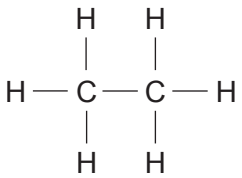
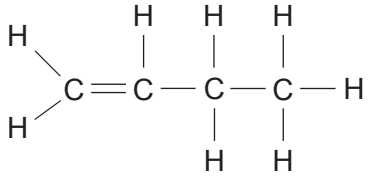
3. (a) The table shows the names, molecular formulae and structural formulae of some alkanes and alkenes.

Name	Molecular formula	Structural formula
methane	CH_4	
.....	C_2H_6	
propene	C_3H_6	
butene	.....	

Complete the table by filling in the missing name, molecular formula and structural formula. [3]

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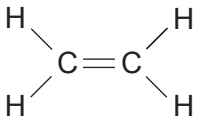
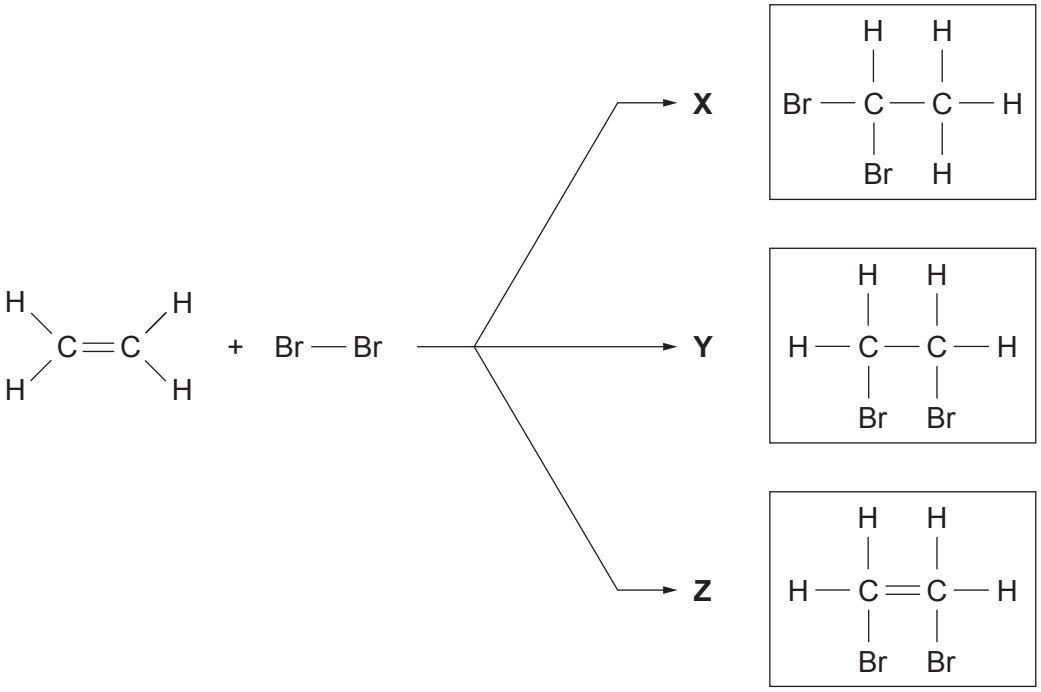
(b) The structure of ethene, C_2H_4, is shown below.



(i) Underline the correct word in brackets to complete the sentence. [1]

When orange bromine water is added to ethene, the solution becomes
(**darker / milky / colourless**).

(ii) I. Give the letter, **X**, **Y** or **Z**, that shows the product formed when bromine reacts with ethene. [1]



Letter .....

II. Give the reason why the product of the reaction between bromine and ethene is **not** a hydrocarbon. [1]

.....

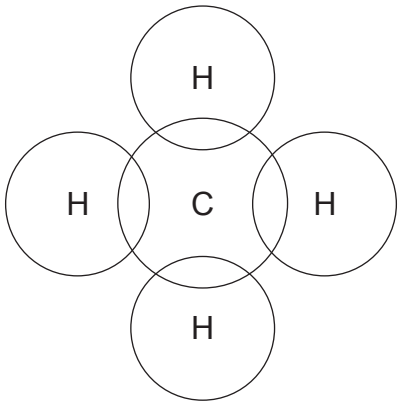
.....

Examiner only

(c) The electronic structures of carbon and hydrogen are shown in the table.

Element	Electronic structure
carbon	2,4
hydrogen	1

Use this information to complete the diagram to show how the atoms bond in a molecule of methane, CH_4. [1]



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4. (a) A group of students were investigating the temperature changes during four reactions, **A**, **B**, **C** and **D**.

Two chemicals were mixed together for each reaction and the temperature change calculated.

The results of their experiment are shown in the table.

Reaction	Temperature before mixing (°C)	Temperature after mixing (°C)	Temperature change (°C)
A	21	31	+10
B	19	37	+18
C	19	.....	−4
D	21	16	−5

(i) **Complete the table** by giving the temperature after mixing for reaction **C**. [1]

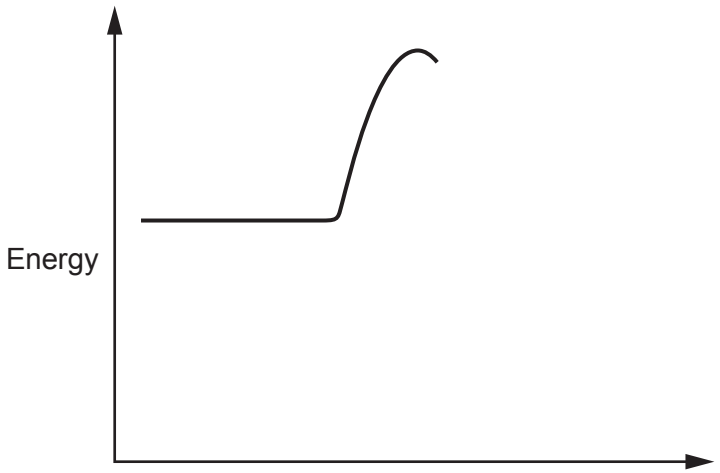
(ii) Give the letters, **A**, **B**, **C** or **D**, of the **two exothermic** reactions. Give the reason for your choice. [1]

Reactions ..... and .....

Reason .....

Examiner only

(b) Complete the energy profile diagram to show an exothermic reaction. [1]



(c) In experiment **B**, aluminium powder was mixed with zinc chloride solution. The reaction produced zinc metal and aluminium chloride solution.

Complete the symbol equation for the reaction by [2]

- writing the formula of aluminium chloride on the dotted line
- putting a number in the box to balance the equation

$$2\,Al + \square\ ZnCl_2 \longrightarrow 2\ \ldots\ldots\ldots\ldots + 3\,Zn$$

5

5. The Red Metals

Copper, brass and bronze are known as the 'red metals'. This is because they stand out against other metals due to their characteristic reddish colour.

From construction and architecture to telecommunications and machinery, there is no denying the importance of these 'red metals' in our daily lives.

However, whilst they might all look similar, copper, brass and bronze have very different compositions and properties.

Copper

- Most of the world's copper is extracted from copper ores. Once extracted, copper has many uses in its pure form.
- In addition to its various applications, copper is present in the other red metals – brass and bronze.
- Copper is best known for its electrical and thermal conductivity, malleability and ductility, and resistance to corrosion.
- Today it is most commonly found in electrical materials, roofing, plumbing and industrial machinery.

Brass

- Brass is made by adding varying amounts of zinc to copper.
- Depending on the zinc content, different types of brass can be created and used for different applications.
- The more zinc that is added to the brass, the stronger, more ductile, more malleable and lighter in colour it becomes.
- Brass is commonly used in architecture for its decorative features as well as in manufacturing, construction and in the electrical and plumbing industries.

Bronze

- Bronze is made by mixing copper with tin and other metals such as aluminium, zinc and manganese.
- The properties of bronze vary, depending on its specific composition.
- Bronze is commonly known for its hardness, as well as being highly ductile, brittle and corrosion resistant.
- Bronze is used in architecture as well as for making sculptures, electrical contacts, machine tools and coins.

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(a) Tick (✓) to show whether the properties of copper, brass and bronze are fixed or can vary. [2]

	Properties are fixed	Properties can vary
copper		
brass		
bronze		

(b) Tick (✓) the correct statement. [1]

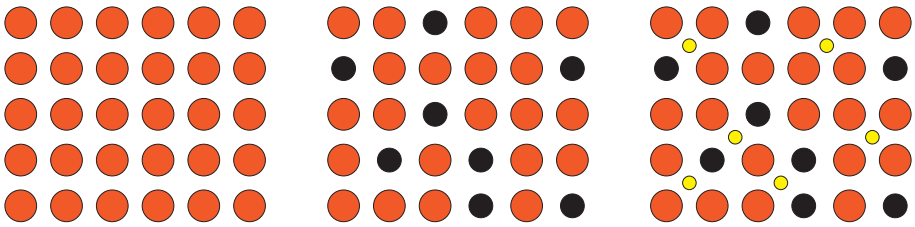
copper, bronze and brass are all metal alloys ☐

copper and bronze are both metal alloys ☐

copper and brass are both metal alloys ☐

bronze and brass are both metal alloys ☐

(c) Give the letter of the structure, **A**, **B** or **C**, that best represents brass. [1]



A **B** **C**

Structure .....

(d) State whether you agree with the following statement. Give a reason for your answer. [1]

'Copper is a good electrical conductor whereas brass and bronze are not'

Agree **Yes** / **No**

Reason .....

.....

5

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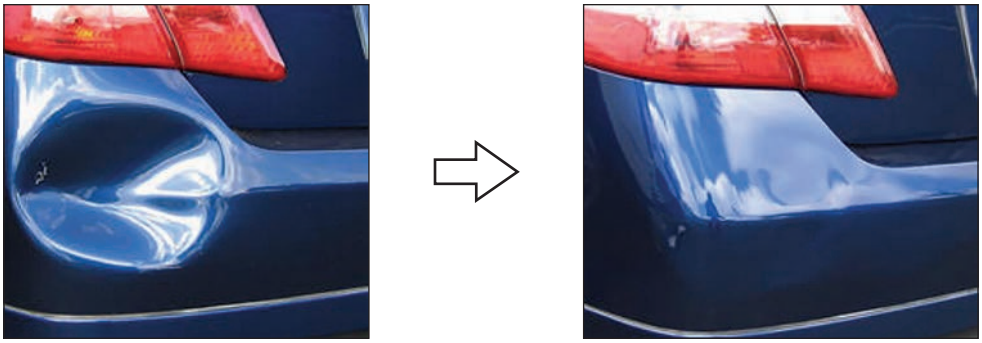
6. Shape-memory polymers are a type of smart material that can regain their original shape when heated. They are commonly used in car bumpers as shown in the photographs.



Before heating **After heating**

Other types of smart materials include thermochromic pigments, photochromic pigments and hydrogels (polymer gels).

Describe the properties and uses of these **three** types of smart materials. [6 QER]

.....

.....

.....

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.....

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.....

.....

6

Examiner only

7. (a) Carys and Pavel prepared crystals of zinc sulfate by reacting zinc carbonate with an acid.

(i) Give the name of the acid they used. [1]

.....

(ii) In the first stage of their preparation, they added excess zinc carbonate to the acid.

I. Give the observation that **immediately** shows a reaction is taking place. [1]

.....

II. State why they added **excess** zinc carbonate. [1]

.....

(iii) Describe the remaining two stages they carried out to obtain a **pure** sample of zinc sulfate crystals. [2]

.....

.....

.....

(iv) Give the chemical formula of zinc sulfate. [1]

.....

(b) In another experiment, Carys and Pavel investigated the temperature rise when dilute hydrochloric acid neutralises sodium hydroxide solution.

The acid was added 5 cm^3 at a time to 25 cm^3 of sodium hydroxide solution. They recorded the highest temperature reached after each addition using a digital thermometer.

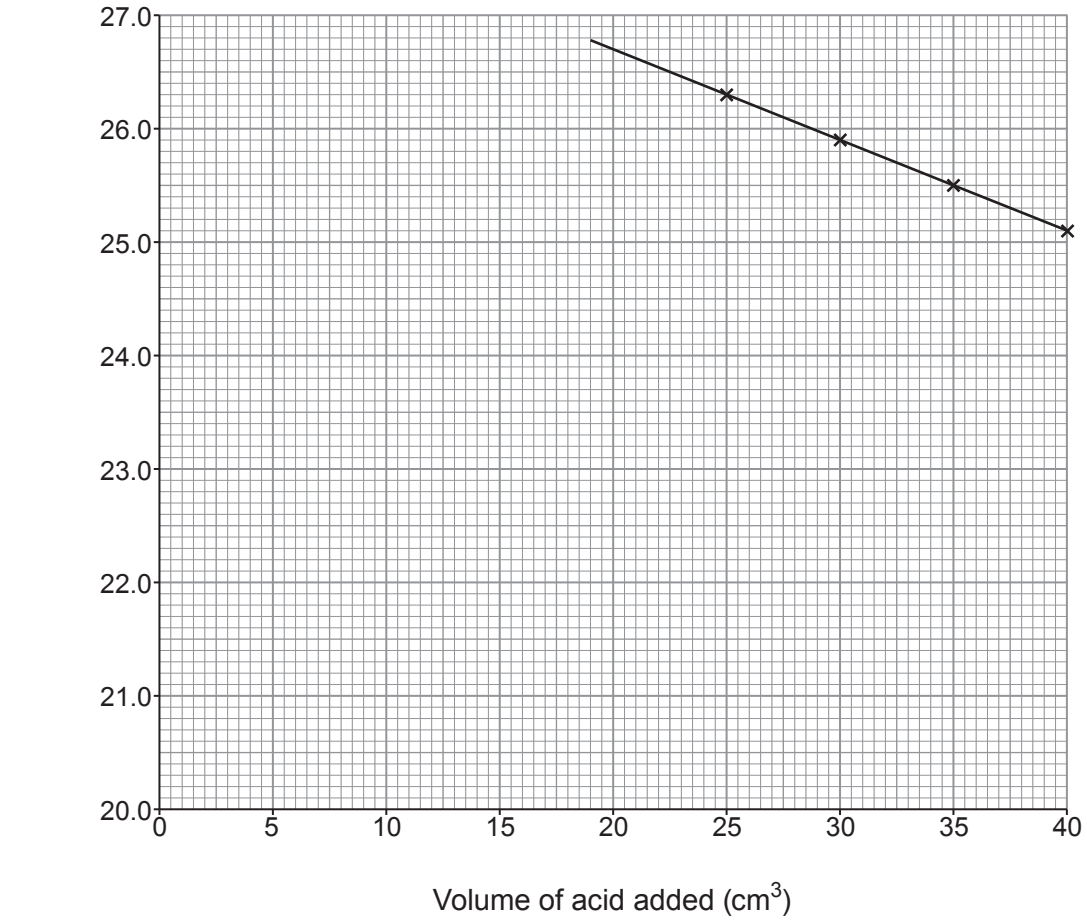
They obtained the following results. The result for 15 cm^3 of acid is missing.

Volume of acid added (cm^3)	Temperature (°C)
0	20.4
5	21.9
10	23.4
15	
20	26.4
25	26.3
30	25.9
35	25.5
40	25.1

Examiner only

(i) The last four results have been plotted on the grid below and a straight line drawn through the points.

Plot the remaining four points and draw a **straight line** through them so that it intersects the line already drawn. [3]



(ii) I. Use your graph to give the temperature that would have been recorded when 15 cm^3 of acid was added. [1]

..... °C

II. Carys and Pavel concluded that the volume of acid needed to just neutralise all the sodium hydroxide solution was somewhere between 20 cm^3 and 25 cm^3.

Use the graph to suggest the exact volume of acid needed. [1]

..... cm^3

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(iii) The temperatures recorded are slightly **lower** than expected.

Tick (✓) to show which **two** improvements to the method would enable Carys and Pavel to obtain results closer to the expected values. [2]

use a beaker instead of a flask	☐
repeat the method	☐
add the acid in smaller intervals	☐
wrap cotton wool around the flask	☐
use a larger flask	☐
place a lid on the flask	☐

(c) In a different experiment, it was found that the maximum temperature was reached when 40 cm^3 of hydrochloric acid was added to 20 cm^3 of sodium hydroxide solution.

State what this means in terms of the relative concentrations of the solutions used. [2]

.....

.....

.....

15

END OF PAPER

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

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FORMULAE FOR SOME COMMON IONS

POSITIVE IONS		NEGATIVE IONS	
Name	**Formula**	**Name**	**Formula**
aluminium	Al^{3+}	bromide	Br^{-}
ammonium	NH_4^{+}	carbonate	CO_3^{2-}
barium	Ba^{2+}	chloride	Cl^{-}
calcium	Ca^{2+}	fluoride	F^{-}
copper(II)	Cu^{2+}	hydroxide	OH^{-}
hydrogen	H^{+}	iodide	I^{-}
iron(II)	Fe^{2+}	nitrate	NO_3^{-}
iron(III)	Fe^{3+}	oxide	O^{2-}
lithium	Li^{+}	sulfate	SO_4^{2-}
magnesium	Mg^{2+}		
nickel	Ni^{2+}		
potassium	K^{+}		
silver	Ag^{+}		
sodium	Na^{+}		
zinc	Zn^{2+}		

THE PERIODIC TABLE

Group 1	2											3	4	5	6	7	0
						1 H Hydrogen 1											4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	63.5 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
86 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	179 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key