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Friday 19 November 2021 – Morning

GCSE (9–1) Combined Science
(Chemistry) A (Gateway Science)

J250/03 Paper 3 (Foundation Tier)

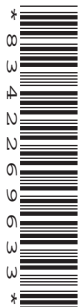
Time allowed: 1 hour 10 minutes

You must have:

- a ruler (cm/mm)
- the Data Sheet for GCSE (9–1) Combined Science (Chemistry) A (inside this document)

You can use:

- a scientific or graphical calculator
- an HB pencil

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **24** pages.

ADVICE

- Read each question carefully before you start your answer.

2
SECTION A

Answer **all** the questions.

You should spend a maximum of 20 minutes on this section.

Write your answer to each question in the box provided.

- 1 In the Periodic Table elements are arranged in Groups and Periods.

Look at the diagram. It shows four elements.

	Be											C					
	Ca																Kr

Which element is in **Group 2** and **Period 4** of the Periodic Table?

- A Be
- B C
- C Ca
- D Kr

Your answer

[1]

3

2 Look at the information about four different substances, **A**, **B**, **C** and **D**.

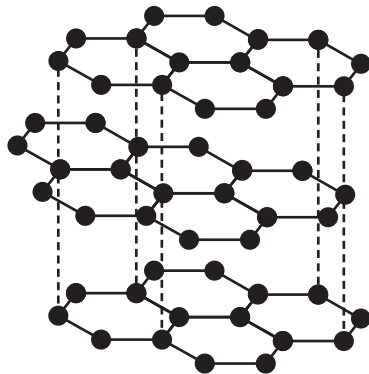
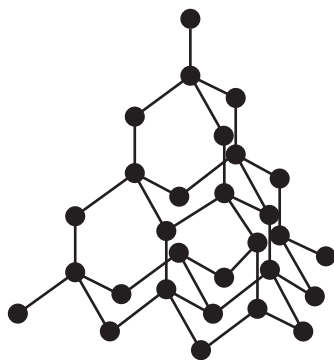
	State at room temperature	Conducts heat?	Conducts electricity?
A	gas	no	no
B	liquid	no	yes
C	solid	yes	no
D	solid	yes	yes

Which substance is a **metal**?

Your answer

[1]

3 The diagrams show two different macromolecules.



Which element are these macromolecules made from?

- A Carbon
- B Hydrogen
- C Oxygen
- D Silicon

Your answer

[1]

4

4 Which substance is a **formulation**?

- A Air
- B An alloy
- C Carbon dioxide
- D Distilled water

Your answer

[1]

5 Which equation shows that the mass of the solid **decreases** as the solid reacts?

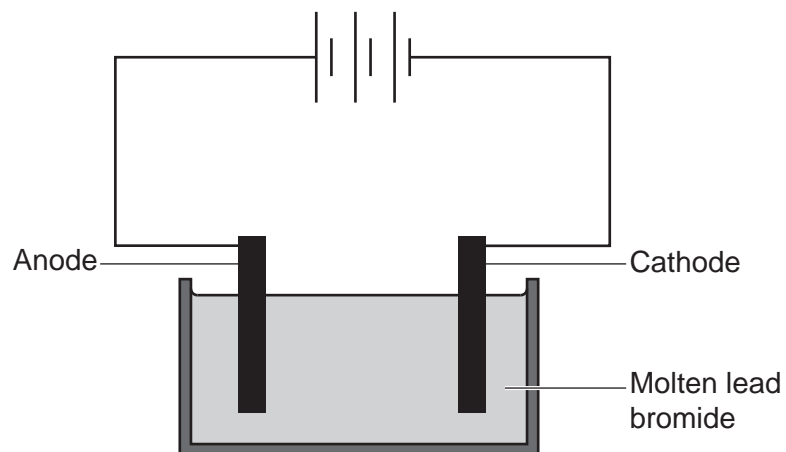
- A $\text{Ca(s)} + \text{Cl}_2\text{(g)} \rightarrow \text{CaCl}_2\text{(s)}$
- B $\text{CaCO}_3\text{(s)} \rightarrow \text{CaO(s)} + \text{CO}_2\text{(g)}$
- C $2\text{Cu(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{CuO(s)}$
- D $2\text{Mg(s)} + \text{TiCl}_4\text{(l)} \rightarrow \text{Ti(s)} + 2\text{MgCl}_2\text{(s)}$

Your answer

[1]

5

6 The diagram shows the electrolysis of molten lead bromide.



Which row in the table shows the products formed at the **anode** and the **cathode**?

	Anode	Cathode
A	bromine	hydrogen
B	bromine	lead
C	lead	hydrogen
D	oxygen	lead

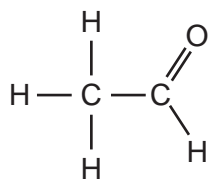
Your answer

[1]

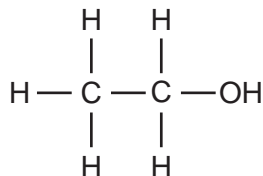
6

7 Which molecule has the **empirical formula** CH_2O ?

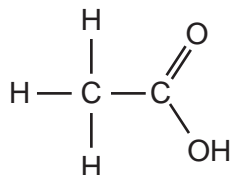
A



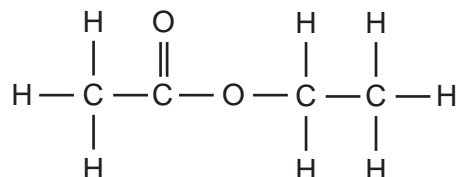
B



C



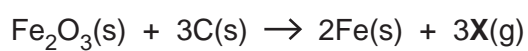
D



Your answer

[1]

8 Iron oxide, Fe_2O_3 , is heated with carbon, C. Iron, Fe, and another product, **X**, are made. Look at the equation for the reaction.



What is the formula of **X**?

A CO

B CO_2 C FeCO_3 D O_2

Your answer

[1]

7

- 9 An atom of an element forms an ion with the formula X^{2-} .

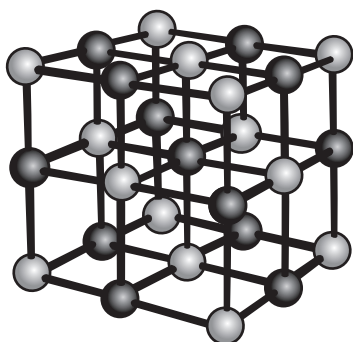
Which **Group** of the Periodic Table is the element found in?

- A Group 0
- B Group 2
- C Group 6
- D Group 7

Your answer

[1]

- 10 The diagram shows the 'ball and stick' model for an ionic compound.



Which statement about the 'ball and stick' model is correct?

- A It shows all the forces between the ions.
- B It shows the arrangement of the ions.
- C It shows the charges on the ions.
- D It shows the sizes of the ions.

Your answer

[1]

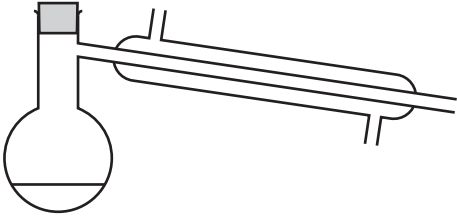
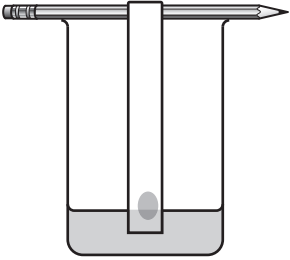

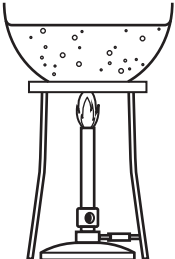
8

SECTION B

Answer **all** the questions.

11 Different separation techniques are used to separate different types of mixtures.

Draw lines to connect each separation technique with its correct description.

Separation technique	Description
 <p data-bbox="304 817 558 846">Simple distillation</p>	<p data-bbox="853 658 1209 719">Separates a solvent from a solution.</p>
 <p data-bbox="312 1171 550 1200">Chromatography</p>	<p data-bbox="858 1005 1220 1066">Separates a dissolved solid from a solution.</p>
 <p data-bbox="368 1523 497 1552">Filtration</p>	<p data-bbox="831 1335 1238 1435">Separates a mixture of dissolved substances from one another.</p>
 <p data-bbox="328 1877 533 1906">Crystallisation</p>	<p data-bbox="850 1711 1222 1771">Separates an insoluble solid from a liquid.</p>

[4]

12 Copper can form many different compounds.

The table shows the formulae of five different compounds of copper.

Compound	Formula
A	CuCl_2
B	Cu_2O
C	CuCO_3
D	Cu_2S
E	CuSO_4

(a) Which compound, **A**, **B**, **C**, **D** or **E**, is made from copper, carbon and oxygen?

..... [1]

(b) Which compound, **A**, **B**, **C**, **D** or **E**, is made when copper is oxidised as copper reacts with oxygen?

..... [1]

(c) Which compound, **A**, **B**, **C**, **D** or **E**, reacts with dilute hydrochloric acid to make carbon dioxide?

..... [1]

(d) Calculate the relative formula mass of compound **D**.

The relative atomic mass, A_r , of Cu is 63.5 and of S is 32.1

Relative formula mass = [2]

- 13 A student investigates how the pH of dilute hydrochloric acid changes as sodium hydroxide solution is added to it.

Fig. 13.1 shows the equipment the student uses.

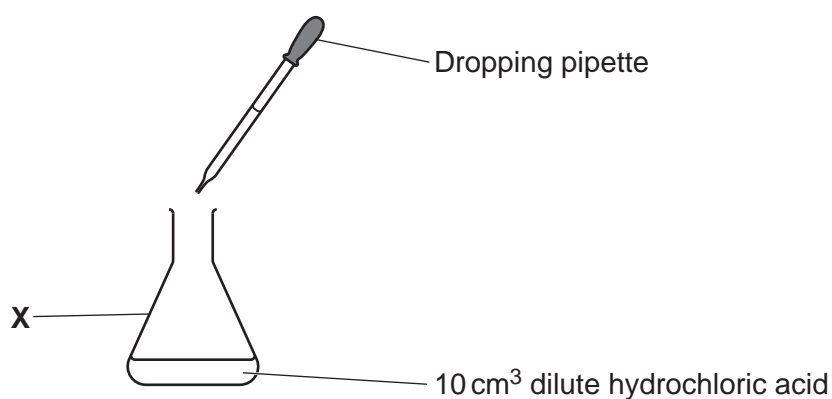


Fig. 13.1

The student:

- Adds 10 cm³ dilute hydrochloric acid to X.
- Adds 0.5 cm³ of the sodium hydroxide solution to the dilute hydrochloric acid.
- Swirls the mixture and measures its pH with a pH probe.
- Repeats adding 0.5 cm³ of the sodium hydroxide solution each time until 10 cm³ of the sodium hydroxide solution has been added.

- (a) What is the name of the piece of equipment labelled X?

..... [1]

- (b) Fig. 13.2 shows two pieces of equipment which could be used to measure 0.5 cm³ of the sodium hydroxide solution.

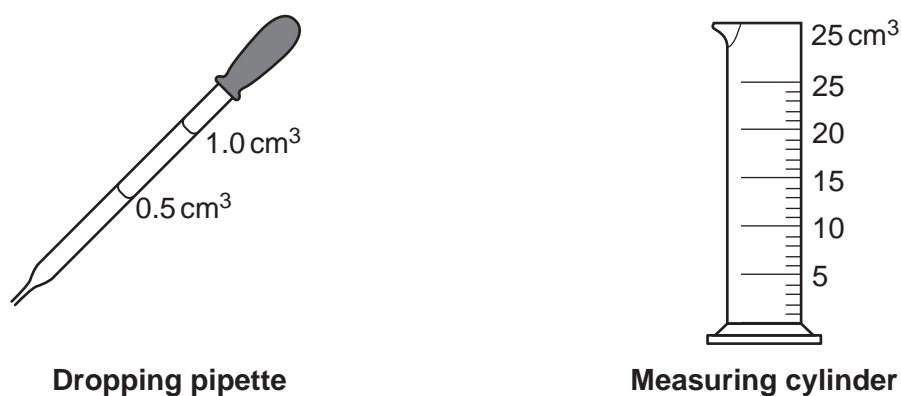


Fig. 13.2

Why did the student use the dropping pipette instead of the measuring cylinder?

..... [1]

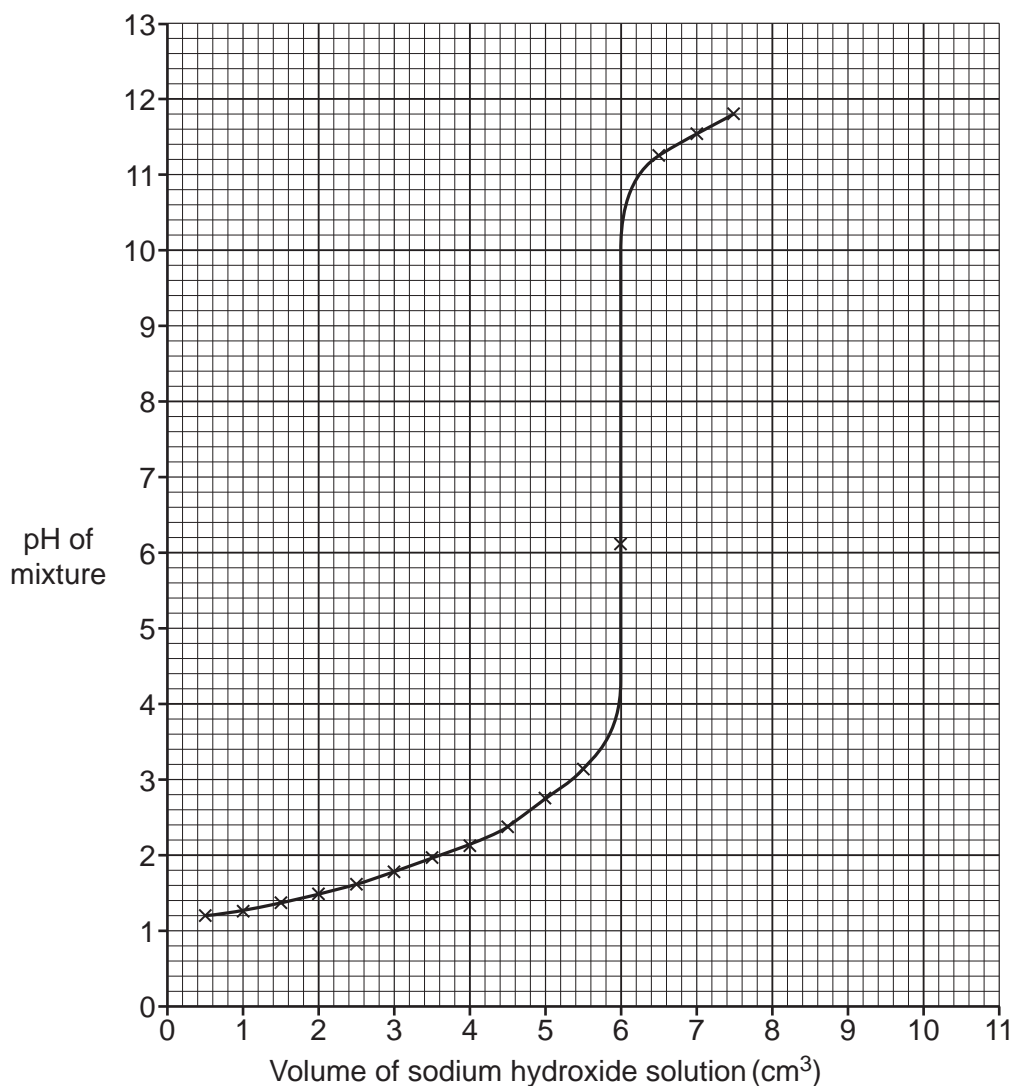
11

(c) The student plots a graph of some of their results.

Look at the table. It shows the rest of the student's results.

Volume of sodium hydroxide solution (cm³)	8.0	8.5	9.0	9.5	10.0
pH of mixture	12.1	12.3	12.4	12.5	12.5

Plot the results on the graph and draw a line of best fit.



[3]

(d) The dilute hydrochloric acid is exactly neutralised when the pH of the mixture is 7.

Use the graph to work out the **volume of sodium hydroxide solution** needed to exactly neutralise the dilute hydrochloric acid.

Volume of sodium hydroxide solution = cm³ [1]

12

- (e) The dilute hydrochloric acid is neutralised by the sodium hydroxide solution.

Complete the sentence using the words shown. You may use each word once, more than once or not at all.

hydrogen ions

hydroxide ions

water molecules

The in the dilute hydrochloric acid react with

the in the sodium hydroxide solution to

make

[2]

13
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14

14 A heating curve shows how the temperature of a substance changes as it is heated.

Fig. 14.1 shows the heating curve for ice.

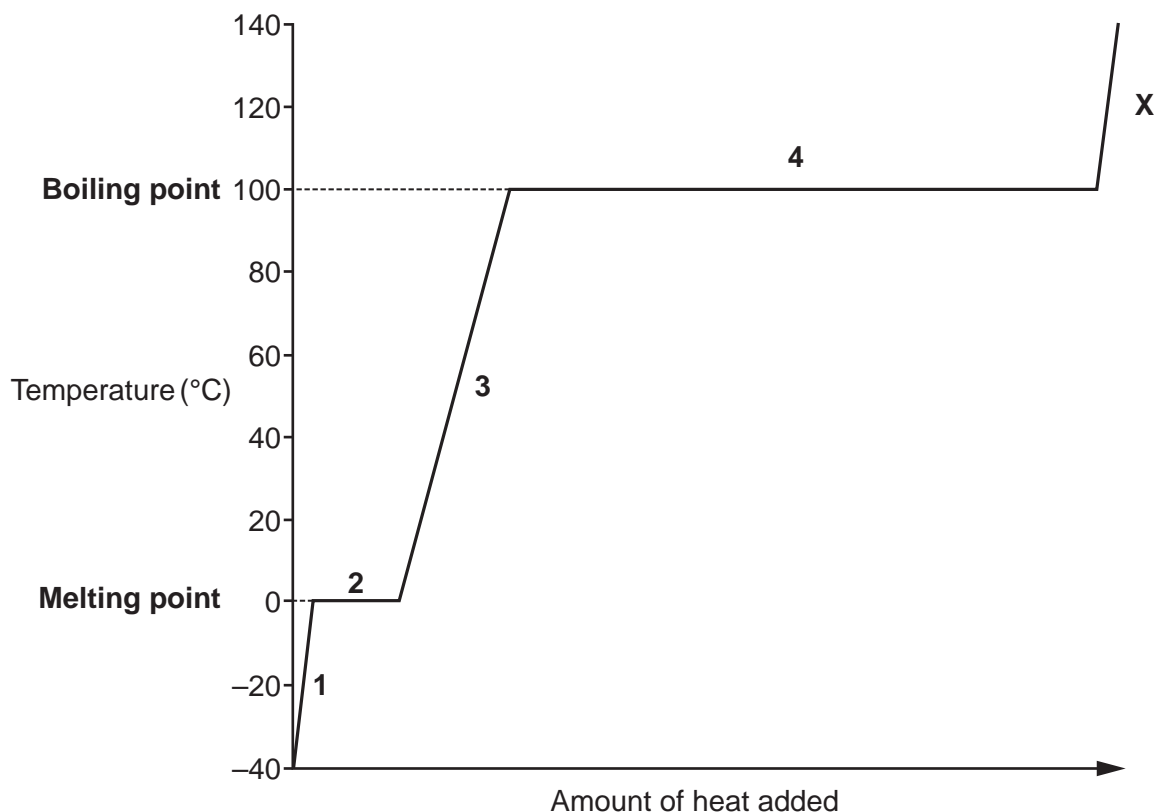


Fig. 14.1

(a) Look at the sentences, **A–D**. They describe sections **1**, **2**, **3** and **4** of the heating curve in Fig. 14.1.

- A** Heat energy is used to break the forces between the particles.
- B** Heat energy is used to loosen the forces between the particles.
- C** Heat energy is used to make the particles move past each other more.
- D** Heat energy is used to make the particles vibrate faster.

Match the sentences **A**, **B**, **C** or **D** to the parts of the heating curve labelled **1**, **2**, **3** and **4** by putting the correct letter in each box.

Part of the heating curve	1	2	3	4
Sentence

[3]

- (b) A student wants to produce the heating curve for ice.

Fig. 14.2 shows the equipment the student uses.

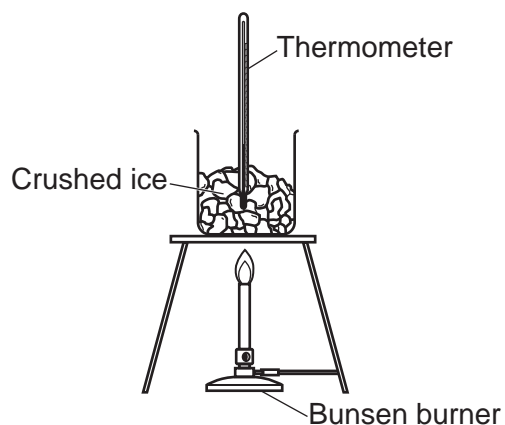


Fig. 14.2

The student slowly heats up the ice and measures the temperature every minute.

The student found they could not produce part X of the heating curve in Fig. 14.1.

Explain why.

.....

.....

..... [1]

- (c) The table shows the melting points of four different substances, A–D.

Substance	Melting point (°C)
A	–14
B	74–79
C	89
D	121–123

- (i) State the letter, A, B, C or D, of **one** pure substance in the table.

..... [1]

- (ii) State a reason for your answer to (c)(i) using information from the table.

.....

..... [1]

15 Sodium and chlorine react to make sodium chloride, NaCl.

Fig. 15.1 shows the structure of sodium chloride.

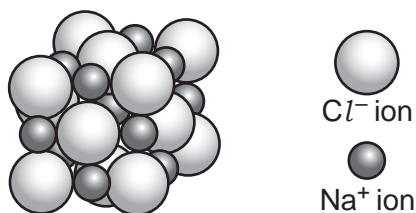
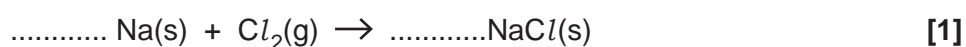
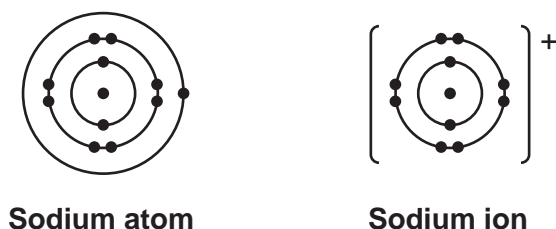


Fig. 15.1

(a) Complete the **balanced symbol** equation for the reaction of sodium and chlorine to make sodium chloride.



(b) Look at Fig. 15.2. It shows a sodium atom, Na, and a sodium ion, Na⁺.



Sodium atom

Sodium ion

Fig. 15.2

Explain how a sodium ion, Na⁺, is formed from a sodium atom, Na.

.....
 [2]

(c) Sodium chloride has a high melting point.

Explain why.

Use ideas about the structure and bonding in sodium chloride in your answer.

.....

 [2]

17

- (d) A student investigates the electrical conductivity of sodium chloride when it is a solid and when it is a solution.

Fig. 15.3 shows the equipment the student uses.

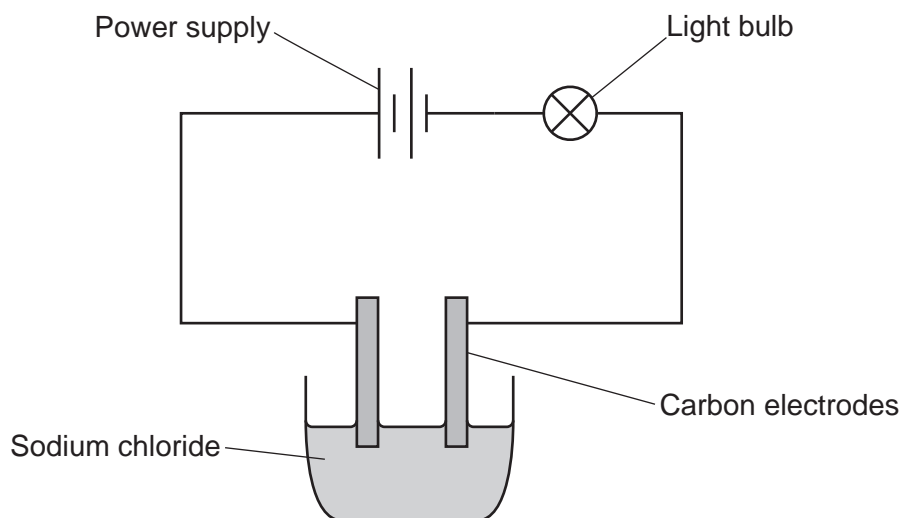


Fig. 15.3

The student produces a table for the results.

	Solid sodium chloride	Solution of sodium chloride
Formula and state symbol	NaCl(s)	$\text{NaCl}(\text{.....})$
Does it conduct electricity?	Yes <input type="checkbox"/> No <input type="checkbox"/>	Yes <input type="checkbox"/> No <input type="checkbox"/>
Explanation

- (i) Write in the table the **state symbol** for the solution of sodium chloride. [1]
- (ii) Tick (✓) **one** box in each column of the table to show if solid sodium chloride and a solution of sodium chloride conduct electricity. [1]
- (iii) Complete the table by writing in the explanation for the student's results.

Use ideas about the structure and bonding in sodium chloride in your answer. [2]

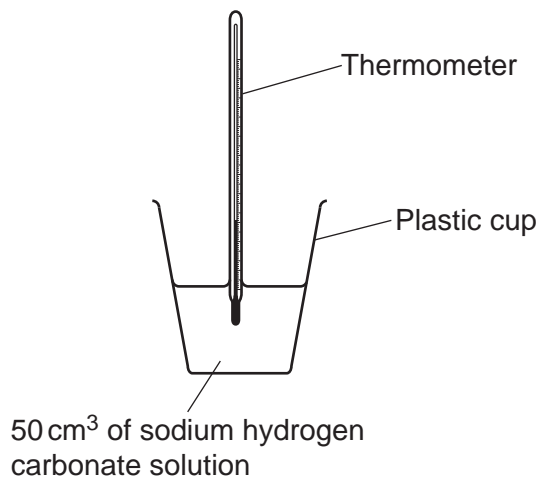
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- 17 The reaction between solid citric acid and sodium hydrogen carbonate solution is an endothermic reaction.

A student investigates the temperature change for the reaction.

The diagram shows the equipment the student uses.



The student adds 0.65 g of solid citric acid to an excess of sodium hydrogen carbonate solution.

The student measures the temperature change. The temperature change is 3.5 °C.

- (a) (i) How does a temperature change show that a reaction is endothermic?

.....
 [1]

- (ii) How should the student have written the temperature change to show that this reaction is endothermic?

.....
 [1]

- (b) Describe how the student performed the experiment so that they could calculate the temperature change.

.....

 [2]

21

- (c) The student repeats the experiment using a different mass of citric acid. This time the student measures a larger temperature change.

The temperature change is 10.0°C .

If 0.65 g of citric acid gives a temperature change of 3.5°C , calculate the mass of citric acid, **in milligrams**, that gives a 10.0°C temperature change.

$1\text{ g} = 1000\text{ mg}$

Give your answer to **3** significant figures.

Mass of citric acid = mg [4]

- (d) When the student washed out the plastic cup at the end of the second experiment they saw some excess solid left.

Explain how this affected the student's result **and** describe how the student could have improved their experiment.

.....

.....

.....

.....

.....

.....

.....

..... [3]

- (e) Citric acid and sodium hydrogen carbonate react to form sodium citrate.

Sodium citrate contains sodium ions, Na^+ , and citrate ions, $\text{C}_6\text{H}_5\text{O}_7^{3-}$.

Write the **formula** of sodium citrate.

..... [1]

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).

A large area of lined paper for writing, consisting of horizontal dotted lines and a vertical solid line on the left side. The lines are evenly spaced and cover most of the page's width and height.

A blank sheet of lined paper. On the left side, there is a solid vertical line that serves as a margin. The rest of the page is filled with horizontal dotted lines, spaced evenly down the page, providing a guide for writing.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines extending across the page, providing a grid for writing answers.



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