AQA GCSE Combined Science - Trilogy | 8464

SPECIFICATION POINT 5.5.1.1

# Energy transfer during exothermic and endothermic reactions

## Past-paper questions

| | |
|---|---|
| Tier | **Foundation** |
| Question groups | **20** |
| Available paper years | **2018–2025** |

## Using this booklet

1. Answer the questions in order and show your working.
2. Original question numbers and marks are retained.
3. Print at actual size (100%) for measuring questions.
4. Use the companion answer booklet to check your work.

**Name:** _____ **Date:** _____

Whole questions are retained for context, so some parts assess other specification points. Current and legacy sources are labelled. Continue on extra paper if needed.

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 01**

June 2018 | 8464/C/1F | Original Q2

**0 2** This question is about the halogens.

**0 2 . 1** Which group in the periodic table is known as the halogens?

**[1 mark]**

Tick **one** box.

Group 1 ☐

Group 2 ☐

Group 7 ☐

Group 0 ☐

**0 2 . 2** A fluorine atom has 7 electrons in the outer shell.

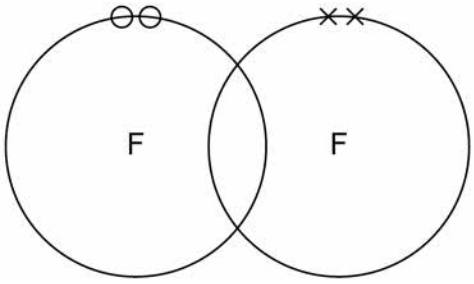
**Figure 8** shows part of a dot and cross diagram to represent a molecule of fluorine ($F_2$).

Complete the dot and cross diagram.

You should show only the electrons in the outer shells.

**[2 marks]**

**Figure 8**




**0 2 . 3** Chlorine reacts with potassium bromide solution.

Complete the word equation.

**[2 marks]**

chlorine + potassium bromide → _____ + _____

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 01 · continued



**0 2 . 4** What type of reaction happens when chlorine reacts with potassium bromide solution?

**[1 mark]**

Tick **one** box.

- decomposition ☐
- displacement ☐
- neutralisation ☐
- precipitation ☐

**0 2 . 5** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | | |
|---|---|---|---|
| **an atom** | **an electron** | **a neutron** | **a proton** |

Chlorine is more reactive than bromine.

This is because chlorine gains _____ more easily.

**0 2 . 6** How does the size of a chlorine atom compare with the size of a bromine atom?

Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **bigger than** | **the same size as** | **smaller than** |

A chlorine atom is _____ a bromine atom.

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 01 · continued**



**0 2 . 7** Give a reason for your answer to question **02.6**

**[1 mark]**

Reason _____

_____

**0 2 . 8** Fluorine reacts with chlorine to produce $ClF_3$

Balance the chemical equation for the reaction.

**[1 mark]**

$Cl_2 +$ _____ $F_2 \rightarrow 2\ ClF_3$

**0 2 . 9** Explain why fluorine is a gas at room temperature.

Use the following words in your answer:

**energy** **forces** **molecules** **weak**

**[3 marks]**

13

5.5.1.1 Energy transfer during exothermic and endothermic reactions

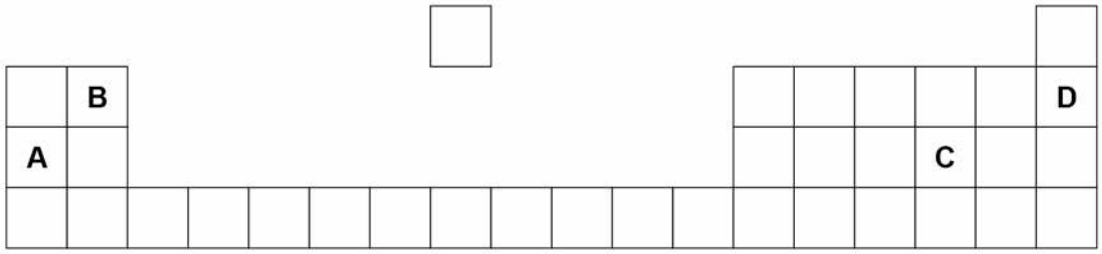
Question 02

June 2018 | 8464/C/1F | Original Q4

**0 4** This question is about the elements in Group 2 of the periodic table.

**0 4 . 1** **Figure 9** shows the positions of four elements, **A**, **B**, **C**, and **D**, in the periodic table.

**Figure 9**




Which element is in Group 2?

**[1 mark]**

Tick **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**Question 4 continues on the next page**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 02 · continued** June 2018 | 8464/C/1F | Original Q4

Group 2 metal carbonates break down when heated to produce a metal oxide and a gas.

metal carbonate → metal oxide + gas

**0 4 . 2** Name the two products when calcium carbonate ($CaCO_3$) is heated.

**[2 marks]**

_____ and _____

**0 4 . 3** What type of reaction happens when a compound breaks down?

**[1 mark]**

Tick **one** box.

- burning ☐
- decomposition ☐
- neutralisation ☐
- reduction ☐

**0 4 . 4** The metal carbonate takes in energy from the surroundings to break down.

What type of reaction takes in energy from the surroundings?

**[1 mark]**

Tick **one** box.

- combustion ☐
- electrolysis ☐
- endothermic ☐
- exothermic ☐

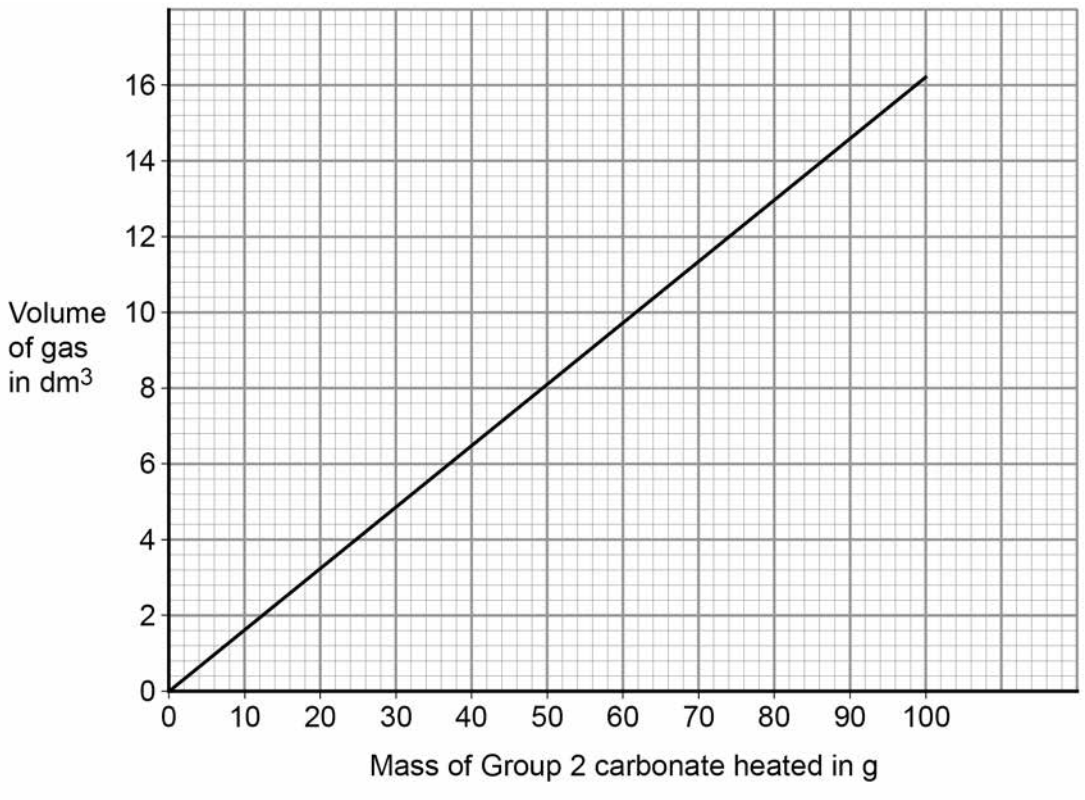
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 02 · continued



**0 4 . 5** **Figure 10** shows the volume of gas produced when a Group 2 metal carbonate is heated.

**Figure 10**




The student collected 5.2 $dm^3$ of gas.

What mass of the Group 2 metal carbonate is heated?

**[1 mark]**

Mass = _____ g

**0 4 . 6** Calculate the mass of the Group 2 carbonate needed to produce 24 $dm^3$ of gas.

Use your answer from question **04.5** to help you.

**[2 marks]**

_____

_____

_____

_____

Mass = _____ g

Question 02 · continued



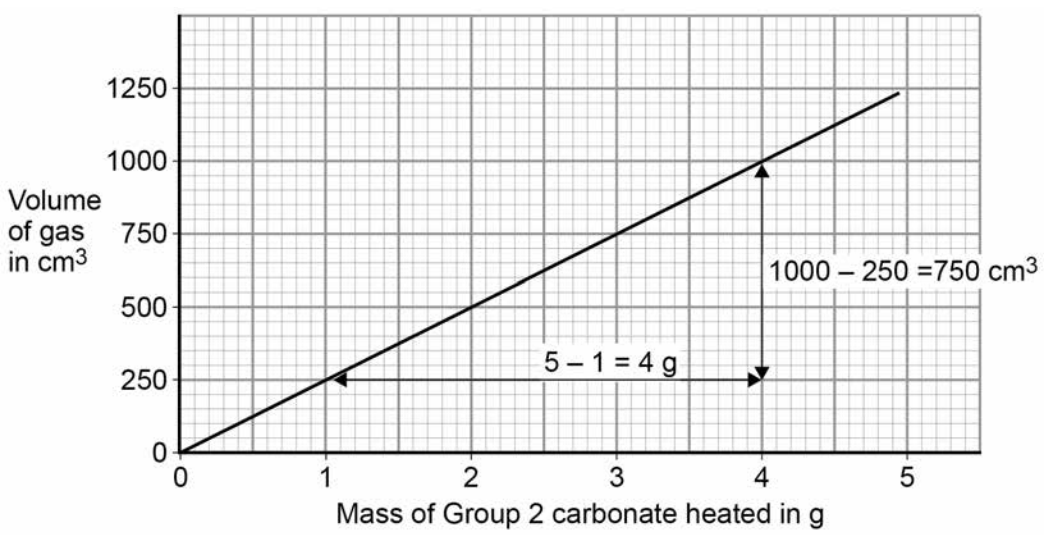
**0 4 . 7** A student heated different masses of a Group 2 carbonate. The student measured the volume of gas produced.

**Figure 11** shows a graph of the student's results.

The student calculates the gradient of the line in **Figure 11**

The student makes **two** mistakes.

**Figure 11**




Correct formula for gradient = $\frac{\text{Increase in volume of gas}}{\text{Increase in mass of Group 2 metal carbonate heated}}$

Student's calculation = $\frac{4}{750}$ = 0.00533 $cm^3$ per g

Identify the **two** mistakes the student makes.

Calculate the correct gradient of the line.

**[4 marks]**

Mistake 1 _____

_____

Mistake 2 _____

_____

Calculation _____

_____

Gradient = _____ $cm^3$ per g

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 02 · continued



**0 4 . 8** A student repeated the experiment with a different Group 2 metal carbonate (**X**$CO_3$).

The relative formula mass ($M_r$) of **X**$CO_3$ is 84

Relative atomic masses ($A_r$): C = 12 O = 16

Calculate the relative atomic mass ($A_r$) of **X**.

Name metal **X**.

Use the periodic table.

**[4 marks]**

Relative atomic mass ($A_r$) = _____

Metal **X** is _____

16

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

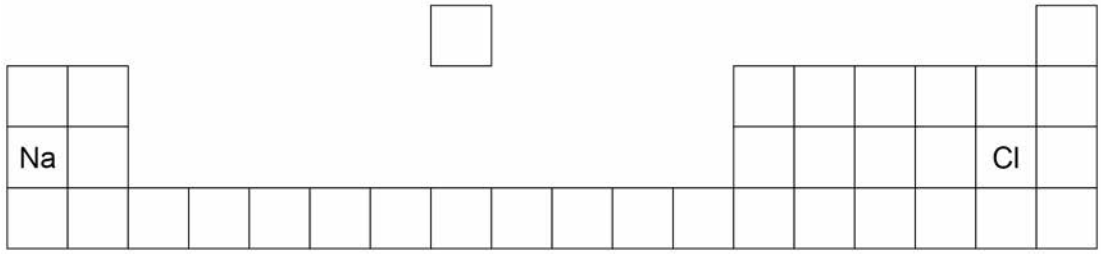
**Question 03**

June 2018 | 8464/C/1F | Original Q6

**0 6** This question is about sodium and chlorine.

**Figure 13** shows the positions of sodium and chlorine in the periodic table.

**Figure 13**




**0 6 . 1** State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

**[2 marks]**

Difference _____

Similarity _____

**0 6 . 2** Sodium atoms react with chlorine atoms to produce sodium chloride (NaCl).

Describe what happens when a sodium atom reacts with a chlorine atom.

Write about electron transfer in your answer.

**[4 marks]**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 03 · continued

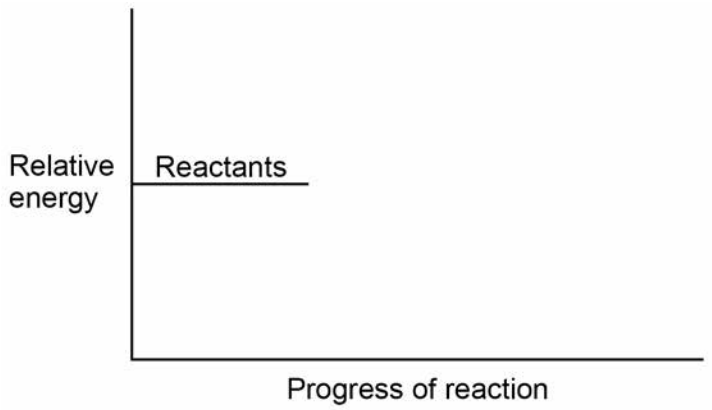


**0 6 . 3** The reaction between sodium and chlorine is an exothermic reaction.

Complete the reaction profile for the reaction between sodium and chlorine.

**[2 marks]**

**Figure 14**

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### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 04**

June 2019 | 8464/C/1F | Original Q1

**0 1** This question is about energy changes.

**0 1 . 1** Which of these items uses an endothermic reaction?

**[1 mark]**

Tick (✓) **one** box.

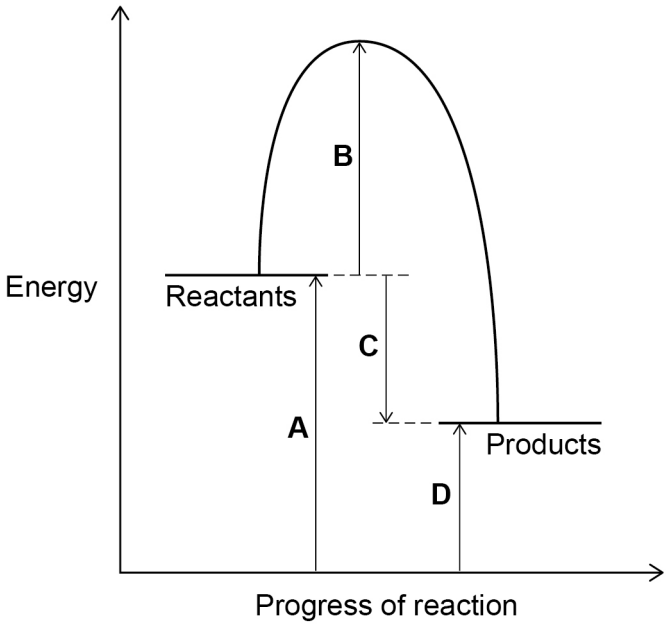
Hand warmer ☐

Sports injury pack ☐

Self-heating can ☐

**Figure 1** shows the reaction profile for an exothermic reaction.

**Figure 1**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 04 · continued



**0 1 . 2** Which letter represents the activation energy for the reaction?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 1 . 3** Which letter represents the overall energy change for the reaction?

**[1 mark]**

Tick (✓) **one** box.

**A** ☐ **B** ☐ **C** ☐ **D** ☐

**0 1 . 4** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **lower than** | **the same as** | **higher than** |

In an exothermic reaction the energy of the products

is _____ the energy of the reactants.

**0 1 . 5** A student measured the temperature at the start and at the end of a reaction.

Name the apparatus used to measure the temperature.

**[1 mark]**

_____

**Question 1 continues on the next page**

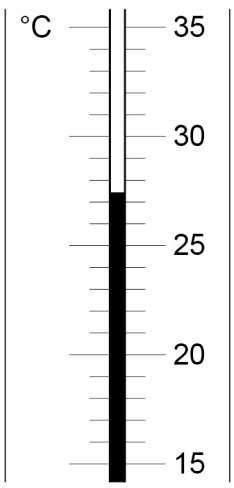
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 04 · continued



**0 1 . 6** **Figure 2** shows the temperature at the end of the reaction.

**Figure 2**




Complete **Table 1**.

Use **Figure 2**.

**[2 marks]**

**Table 1**

| | |
|---|---|
| Temperature at start in °C | 14.3 |
| Temperature at end in °C | |
| Change in temperature in °C | |

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### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 05**

June 2019 | 8464/C/2F | Original Q1

**0 1 . 1** This question is about gases.

Draw **one** line from each substance to the description of the substance.

**[3 marks]**

| Substance | Description of substance |
|---|---|
| | Compound |
| Air | Element |
| Carbon dioxide | Hydrocarbon |
| Oxygen | Metal |
| | Mixture |

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 05 · continued



**0 1 . 2** What is used to test for each of the gases?

Draw **one** line from each gas to the test for the gas.

**[2 marks]**

| Gas | Test |
|---|---|
| Carbon dioxide | A glowing splint |
| | A lighted splint |
| Oxygen | Limewater |
| | Litmus paper |

**0 1 . 3** Give **two** reasons why the percentage of carbon dioxide in the air has decreased in the last 2.7 billion years.

**[2 marks]**

Tick (✓) **two** boxes.

- Combustion ☐
- Dissolved in oceans ☐
- Intense volcanic activity ☐
- Photosynthesis ☐
- Respiration ☐

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 05 · continued



Oxygen reacts with sulfur dioxide.

The reaction is reversible.

**0 1 . 4** What is the symbol for a reversible reaction?

**[1 mark]**

_____

**0 1 . 5** Complete the sentence.

**[1 mark]**

In a reversible reaction the forward reaction is exothermic, so the

reverse reaction is _____ .

**0 1 . 6** A reversible reaction happens in apparatus which stops the escape of reactants and products.

Complete the sentence.

**[1 mark]**

Equilibrium is reached when the forward and reverse reactions happen at

exactly the same _____ .

**10**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 06**

November 2020 | 8464/C/1F | Original Q2

**0 2** A student investigated the temperature change when metal **X** was added to copper sulfate solution.

This is the method used.

1. Add 25 $cm^3$ of copper sulfate solution to a beaker.

2. Measure the temperature of the copper sulfate solution.

3. Add 1.0 g of metal **X** and stir.

4. Measure the highest temperature reached when metal **X** is added to copper sulfate solution.

5. Repeat steps 1 to 4 with different metals.

**Figure 1** shows the apparatus used.

**Figure 1**

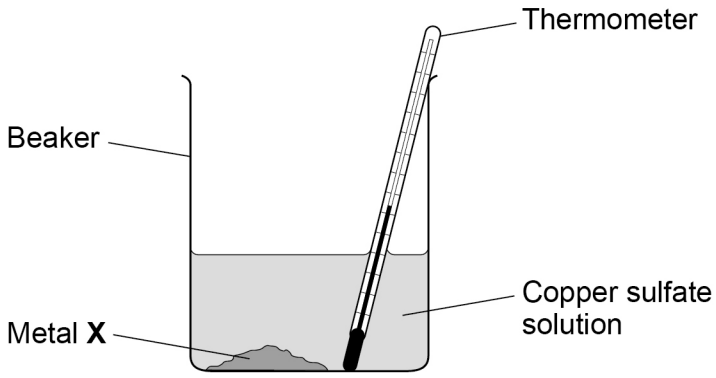
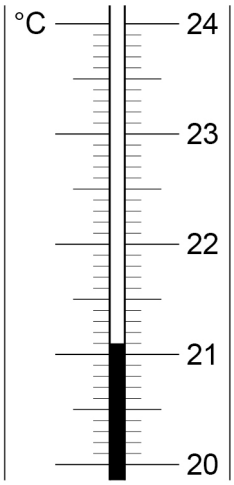



**Figure 2** shows the thermometer reading of the copper sulfate solution at the start of the investigation.

**Figure 2**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 06 · continued



**0 2 . 1** The highest temperature reached when metal **X** was added to copper sulfate solution was 35.5 °C

Determine the temperature change when metal **X** is added to copper sulfate solution.

Use **Figure 2**.

**[2 marks]**

Highest temperature = 35.5 °C

Temperature at start = _____ °C

Temperature change = _____ °C

**0 2 . 2** Give **two** variables the student should keep the same in this investigation.

**[2 marks]**

1 _____

_____

2 _____

_____

**0 2 . 3** The student repeated the experiment with metal **Y**.

**Table 1** shows four results for metal **Y**.

**Table 1**

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| **Temperature change in °C** | 9.2 | 7.3 | 9.5 | 9.2 |

Calculate the mean temperature change for metal **Y**.

Do **not** include the anomalous result in your calculation.

**[2 marks]**

_____

_____

_____

_____

Mean temperature change = _____ °C

5.5.1.1 Energy transfer during exothermic and endothermic reactions

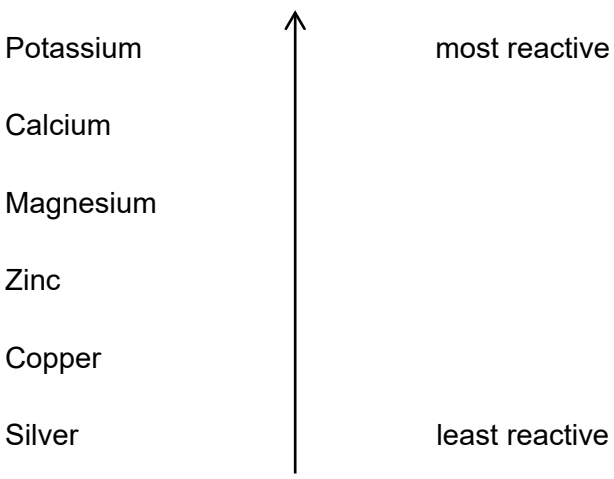
Question 06 · continued



The more reactive the metal added to copper sulfate solution, the greater the temperature change.

**Figure 3** shows a reactivity series.

**Figure 3**




**0 2 . 4** The student repeated the experiment.

The student added:

- magnesium to copper sulfate solution
- an unknown metal **A** to copper sulfate solution.

**Table 2** shows the results.

**Table 2**

| Metal | Temperature change in °C |
|---|---|
| Magnesium | 12 |
| Metal **A** | 8 |

The student concludes metal **A** is zinc.

Give **one** reason why the student is correct.

Use **Figure 3** and **Table 2**.

**[1 mark]**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 06 · continued



**0 2 . 5** The student did the experiment with silver and copper sulfate solution.

What happens to the temperature of the mixture?

Use **Figure 3**.

**[1 mark]**

Tick (✓) **one** box.

Decreases ☐

Increases ☐

Stays the same ☐

**0 2 . 6** Suggest **one** reason why the student should **not** add potassium metal to copper sulfate solution.

**[1 mark]**

**0 2 . 7** 100 $cm^3$ of the copper sulfate solution contains 1.8 g of copper sulfate.

Calculate the mass of copper sulfate in 25 $cm^3$ of this copper sulfate solution.

**[2 marks]**

Mass = _____ g

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### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 07**

November 2020 | 8464/C/2F | Original Q4

**0 4** This question is about hydrogen peroxide.

**0 4 . 1** The symbol equation for the decomposition of hydrogen peroxide ($H_2O_2$) is:

$$2\ H_2O_2 \rightarrow 2\ H_2O + O_2$$

Complete the word equation for the decomposition of hydrogen peroxide.

**[2 marks]**

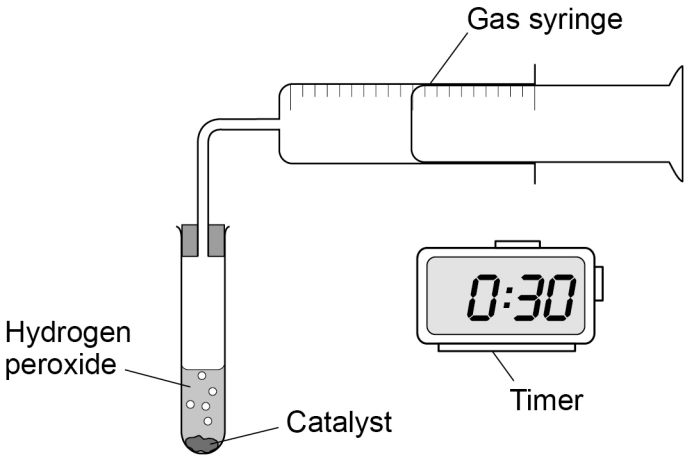
hydrogen peroxide → _____ + _____

A student investigated the effect of different catalysts on the decomposition of hydrogen peroxide.

The student measured the volume of gas collected every 30 seconds for 5 minutes.

**Figure 5** shows the apparatus used.

**Figure 5**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 07 · continued



**0 4 . 2** Which **two** variables should the student keep the same to make the investigation a fair test?

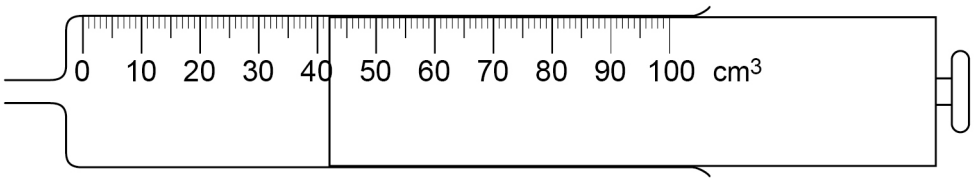
**[2 marks]**

Tick (✓) **two** boxes.

- Concentration of hydrogen peroxide ☐
- Mass of catalyst ☐
- Size of gas syringe ☐
- Type of catalyst ☐
- Volume of gas collected ☐

**0 4 . 3** **Figure 6** shows a gas syringe.

**Figure 6**




What is the volume of gas in the syringe?

**[1 mark]**

Volume = _____ $cm^3$

**Question 4 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 07 · continued



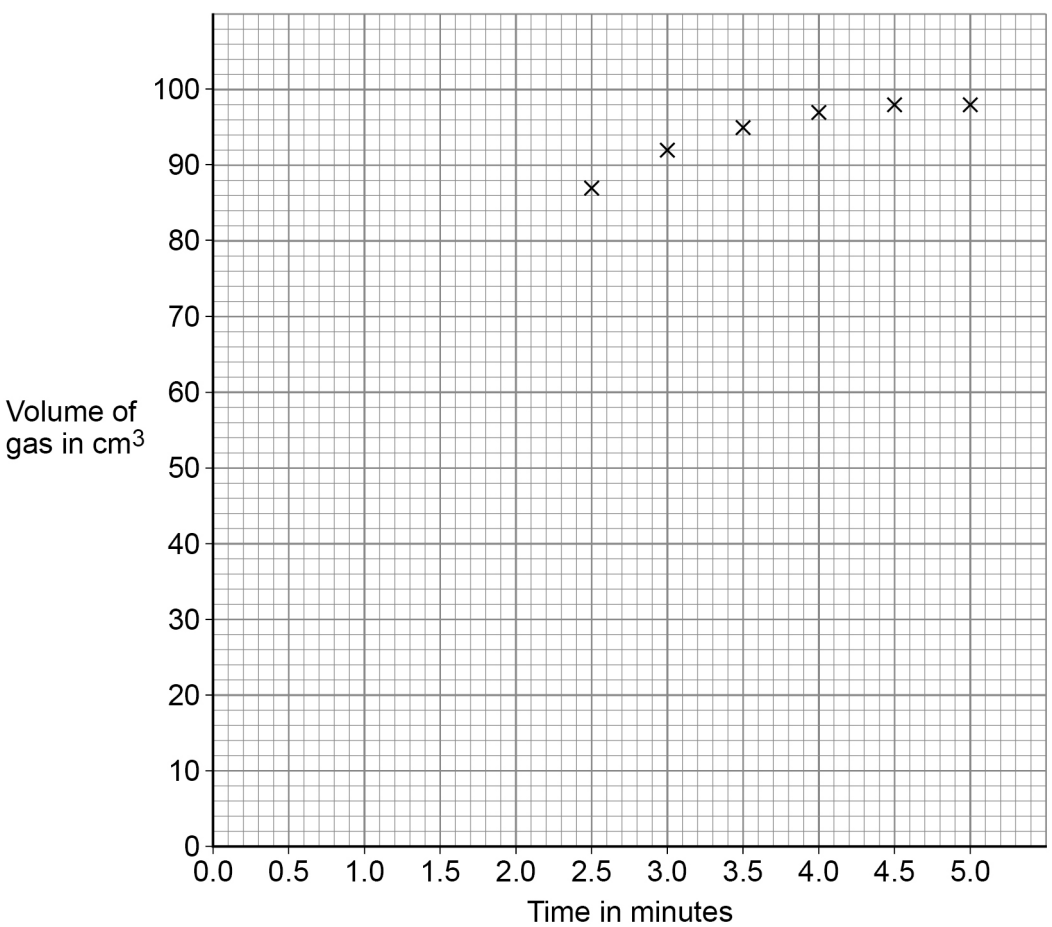
**Table 3** shows the student's results for one catalyst.

**Table 3**

| **Time in minutes** | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 |
|---|---|---|---|---|---|
| **Volume of gas in $cm^3$** | 0 | 34 | 54 | 68 | 78 |

**0 4 . 4** Six of the other results have been plotted on **Figure 7**.

**Figure 7**




Complete the graph in **Figure 7**.

You should:

- plot the results from **Table 3**
- draw a line of best fit for all of the results.

**[3 marks]**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 07 · continued



The student repeated the experiment with other catalysts and plotted a graph for each of the catalysts used.

**0 4 . 5** Suggest how the student could use these graphs to identify the best catalyst.

**[1 mark]**

**0 4 . 6** All the graphs level off at the same volume of gas.

Suggest why.

**[1 mark]**

**0 4 . 7** In another investigation, a student increased the temperature of the hydrogen peroxide.

Why is the rate of reaction faster when the temperature of the hydrogen peroxide is increased?

**[2 marks]**

Tick (✓) **two** boxes.

- The concentration of hydrogen peroxide decreases. ☐
- The particles are moving more slowly. ☐
- The particles have more energy. ☐
- There are more particle collisions per second. ☐
- There are more particles per unit volume. ☐

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### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 08**



**0 7** Some students investigated the effect of temperature on the rate of reaction.

**0 7 . 1** The students reacted sodium thiosulfate solution with hydrochloric acid.

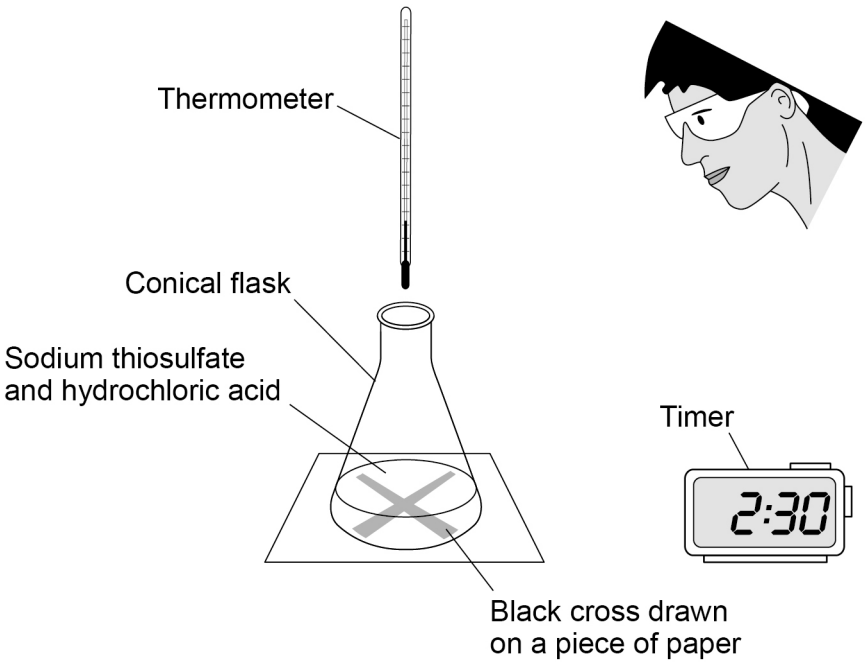
This is the method used.

1. Use a beaker to measure 50 $cm^3$ of heated sodium thiosulfate solution into a conical flask.
2. Measure the temperature of the room.
3. Put the conical flask on a black cross drawn on a piece of paper.
4. Start a timer.
5. Use the same beaker to measure 10 $cm^3$ of hydrochloric acid into the conical flask.
6. Stop the timer when the cross is no longer visible.

The students repeated the experiment at a different room temperature.

**Figure 10** shows the apparatus.

**Figure 10**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 08 · continued**



The method contains errors and does **not** produce accurate results.

Describe a method the students should use to produce accurate results.

You do **not** need to write about safety precautions.

**[6 marks]**

**Question 7 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 08 · continued

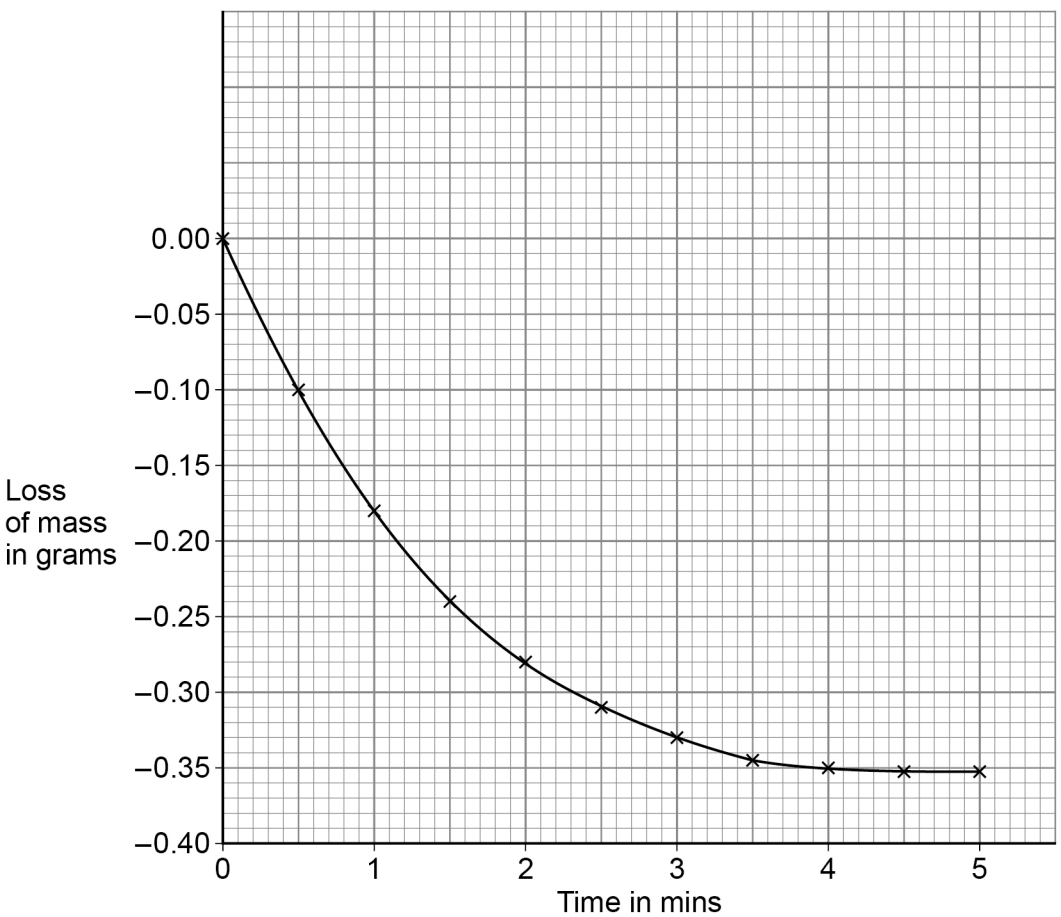


Some students investigated the effect of temperature on the rate of a different reaction.

They recorded the loss of mass from their apparatus at 40 °C

**Figure 11** shows the results.

**Figure 11**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 08 · continued



**0 7 . 2** Calculate the mean rate of reaction between 1 minute and 3 minutes at 40 °C

Use **Figure 11** and the equation:

$$\text{Mean rate of reaction} = \frac{\text{change in mass of gas in g}}{\text{time in mins}}$$

**[3 marks]**

Mean rate of reaction = _____ g/min

**0 7 . 3** Draw a curve on **Figure 11** for the results you would expect at a temperature of 50 °C instead of 40 °C

**[2 marks]**

11

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 09**

November 2021 | 8464/C/1F | Original Q5

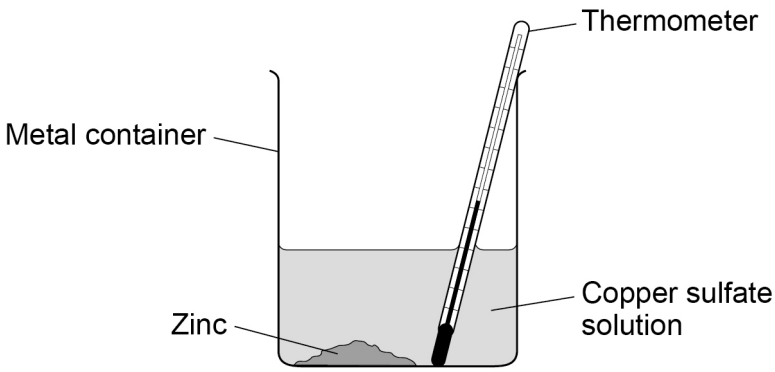
**0 5** A student investigated the change in temperature when different masses of zinc were added to copper sulfate solution.

This is the method used.

1. Measure the volume of copper sulfate solution using a measuring cylinder.
2. Pour the copper sulfate solution into a metal container.
3. Add 2 g of zinc.
4. Measure the temperature of the solution.
5. Repeat steps 1 to 4 with different masses of zinc.

**Figure 7** shows the apparatus.

**Figure 7**




**0 5 . 1** Give **three** improvements to the investigation to make the results more accurate.

**[3 marks]**

1 _____

_____

2 _____

_____

3 _____

_____

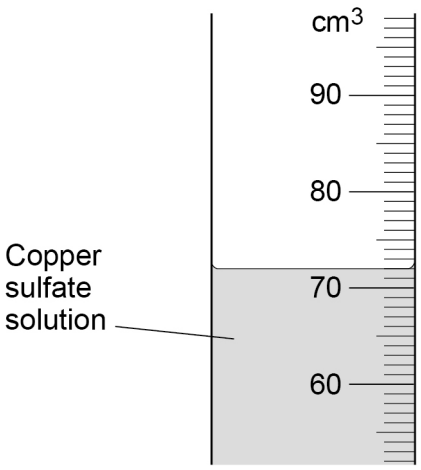
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 09 · continued



**0 5 . 2** **Figure 8** shows part of the measuring cylinder.

**Figure 8**




What is the volume of copper sulfate solution in **Figure 8**?

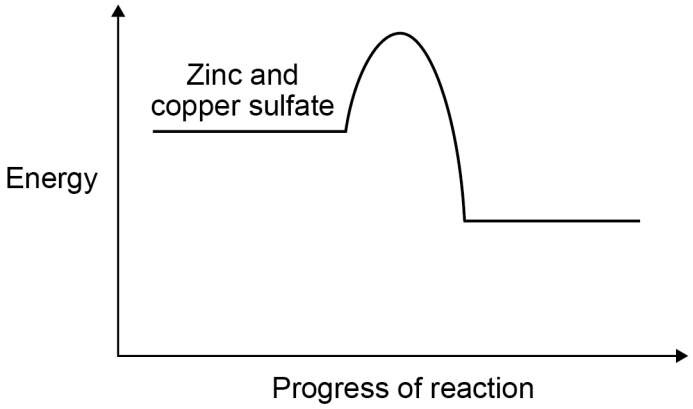
**[1 mark]**

Volume = _____ $cm^3$

**0 5 . 3** When zinc was added to copper sulfate solution the temperature increased.

**Figure 9** shows the reaction profile.

**Figure 9**




What type of reaction is shown in **Figure 9**?

**[1 mark]**

Tick (✓) **one** box.

Endothermic ☐ Exothermic ☐ Neutralisation ☐

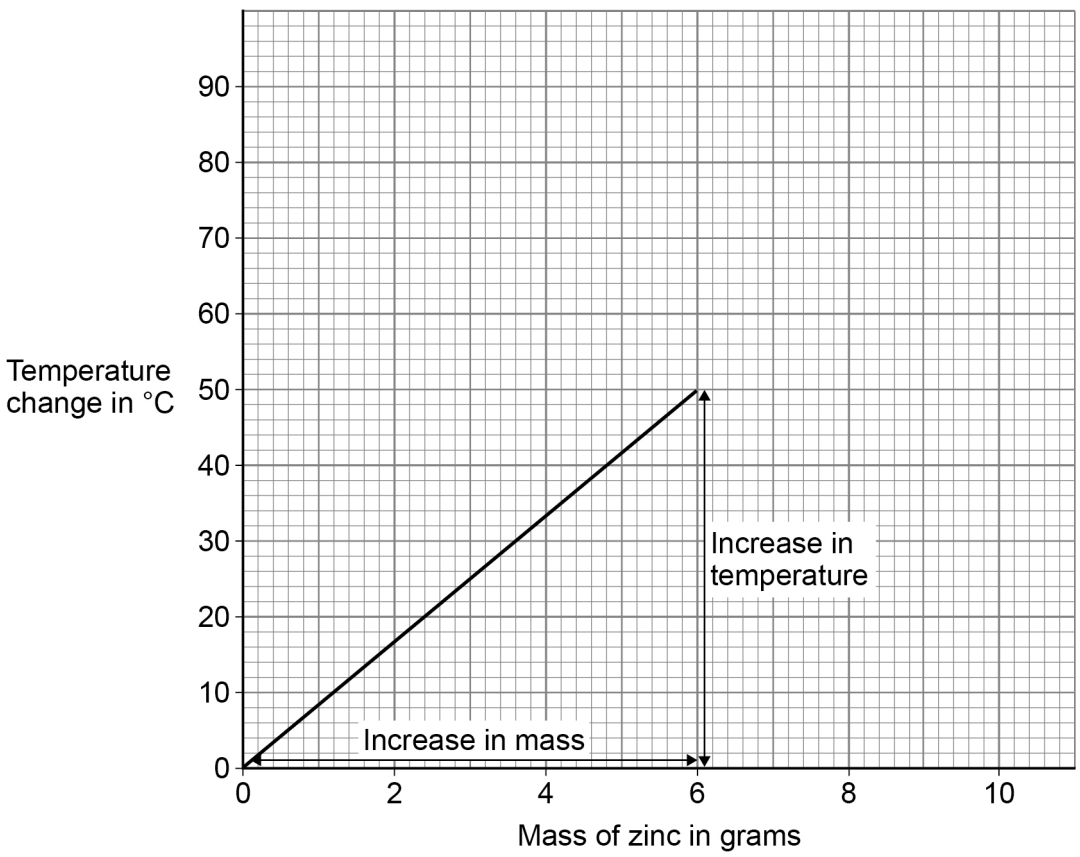
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 09 · continued



**Figure 10** shows the results.

**Figure 10**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 09 · continued



**0 5 . 4** Determine the gradient of the line in **Figure 10**.

Use the equation:

$$\text{gradient} = \frac{\text{increase in temperature in °C}}{\text{increase in mass in grams}}$$

**[4 marks]**

Gradient = _____ °C per g

**0 5 . 5** Suggest why the student should **not** use more than 10 g of zinc.

Use **Figure 10**.

You should extend the graph line.

**[2 marks]**

11

5.5.1.1 Energy transfer during exothermic and endothermic reactions

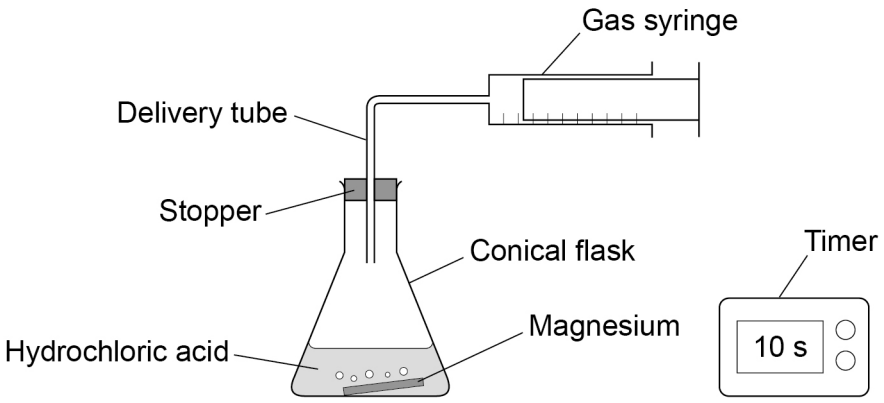
Question 10

November 2021 | 8464/C/2F | Original Q6

**0 6** A student investigated the reaction between magnesium and excess hydrochloric acid.

**Figure 5** shows the apparatus.

**Figure 5**




This is the method used.

1. Pour 50 $cm^3$ of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

**0 6 . 1** Give the independent variable and **one** control variable in this investigation.

**[2 marks]**

Independent variable _____

Control variable _____

**Question 6 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 10 · continued



**Table 3** shows the results from the first experiment using hydrochloric acid with a low concentration.

**Table 3**

| **Time in seconds** | 0 | 20 | 40 | 60 | 80 | 100 | 120 |
|---|---|---|---|---|---|---|---|
| **Volume of gas in cm$^3$** | 0 | 48 | 72 | 90 | 97 | 98 | 98 |

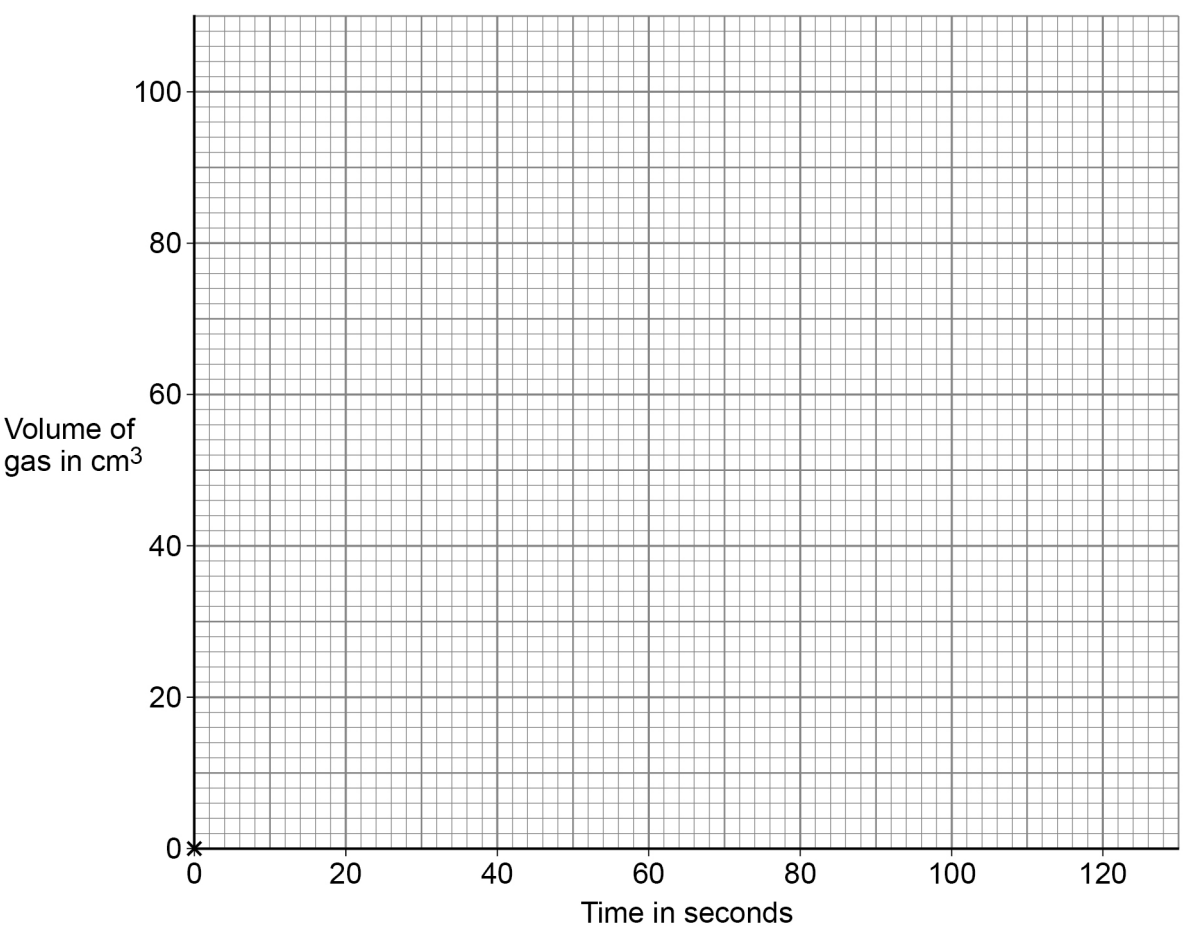
**0 6 . 2** Complete **Figure 6**.

You should:

- plot the data from **Table 3** (the point 0,0 has been plotted for you)
- draw a line of best fit.

**[3 marks]**

**Figure 6**



5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 10 · continued



**0 6 . 3** How does the **rate** of this reaction change with time?

Use **Table 3**.

**[1 mark]**

Tick (✓) **one** box.

The rate decreases. ☐

The rate stays the same. ☐

The rate increases. ☐

**0 6 . 4** The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

**[1 mark]**

Tick (✓) **one** box.

The activation energy for the reaction was higher. ☐

The magnesium reacted more quickly. ☐

The reaction finished at the same time. ☐

The total volume of gas collected was smaller. ☐

**Question 6 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 10 · continued



**0 6 . 5** Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

**[3 marks]**

10

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 11**

June 2022 | 8464/C/1F | Original Q2

**0 2** This question is about hydrogen chloride and sodium hydroxide.

**0 2 . 1** A chlorine atom has 7 electrons in the outer shell.

A hydrogen atom has 1 electron in the outer shell.

**Figure 4** represents part of a dot and cross diagram for a molecule of hydrogen chloride.

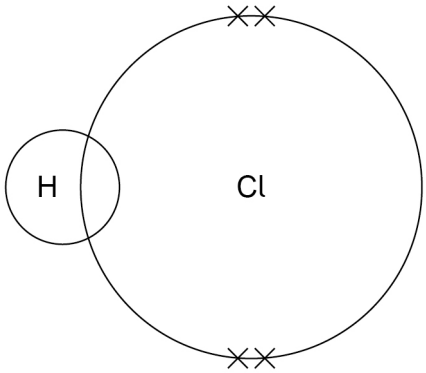
Complete the dot and cross diagram.

Use dots (o) and crosses (x) to represent electrons.

You should show only the electrons in the outer shells.

**[2 marks]**

**Figure 4**




**0 2 . 2** Hydrogen chloride dissolves in water to produce hydrochloric acid.

Hydrochloric acid reacts with sodium hydroxide solution.

Complete the word equation for the reaction between hydrochloric acid and sodium hydroxide.

**[1 mark]**

hydrochloric acid + sodium hydroxide → _____ + water

**Question 2 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 11 · continued



Solutions of hydrochloric acid and sodium hydroxide are reacted and the temperature change is recorded.

**0 2 . 3** In the reaction, 3.65 g of hydrogen chloride reacts with 4.00 g of sodium hydroxide.

1.80 g of water is produced.

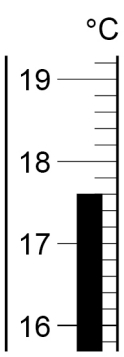
Calculate the mass of the other product.

**[1 mark]**

Mass = _____ g

**0 2 . 4** **Figure 5** shows part of the thermometer used to measure the temperature.

**Figure 5**




What is the temperature reading on the thermometer?

**[1 mark]**

Temperature = _____ °C

**0 2 . 5** In the reaction, the temperature increases.

What type of reaction is happening when the temperature increases?

**[1 mark]**

**0 2 . 6** Sodium hydroxide is an alkali.

Which **two** ions are in sodium hydroxide solution?

**[2 marks]**

Tick (✓) **two** boxes.

$Cl^-$ ☐ $H^+$ ☐ $Na^+$ ☐ $O^{2-}$ ☐ $OH^-$ ☐

8

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 12**

June 2022 | 8464/C/1F | Original Q5

**0 5** This question is about salts.

Green copper carbonate and sulfuric acid can be used to produce blue copper sulfate crystals.

**0 5 . 1** **Excess** copper carbonate is added to sulfuric acid.

Give **three** observations you would make.

**[3 marks]**

1 _____

_____

2 _____

_____

3 _____

_____

**0 5 . 2** How can the excess copper carbonate be removed?

**[1 mark]**

_____

_____

**0 5 . 3** The pH of the solution changes during the reaction.

What is the pH of the solution at the end of the reaction?

**[1 mark]**

pH = _____

**0 5 . 4** Copper carbonate and sulfuric acid react to produce copper sulfate.

What type of reaction is this?

**[1 mark]**

_____

5.5.1.1 Energy transfer during exothermic and endothermic reactions

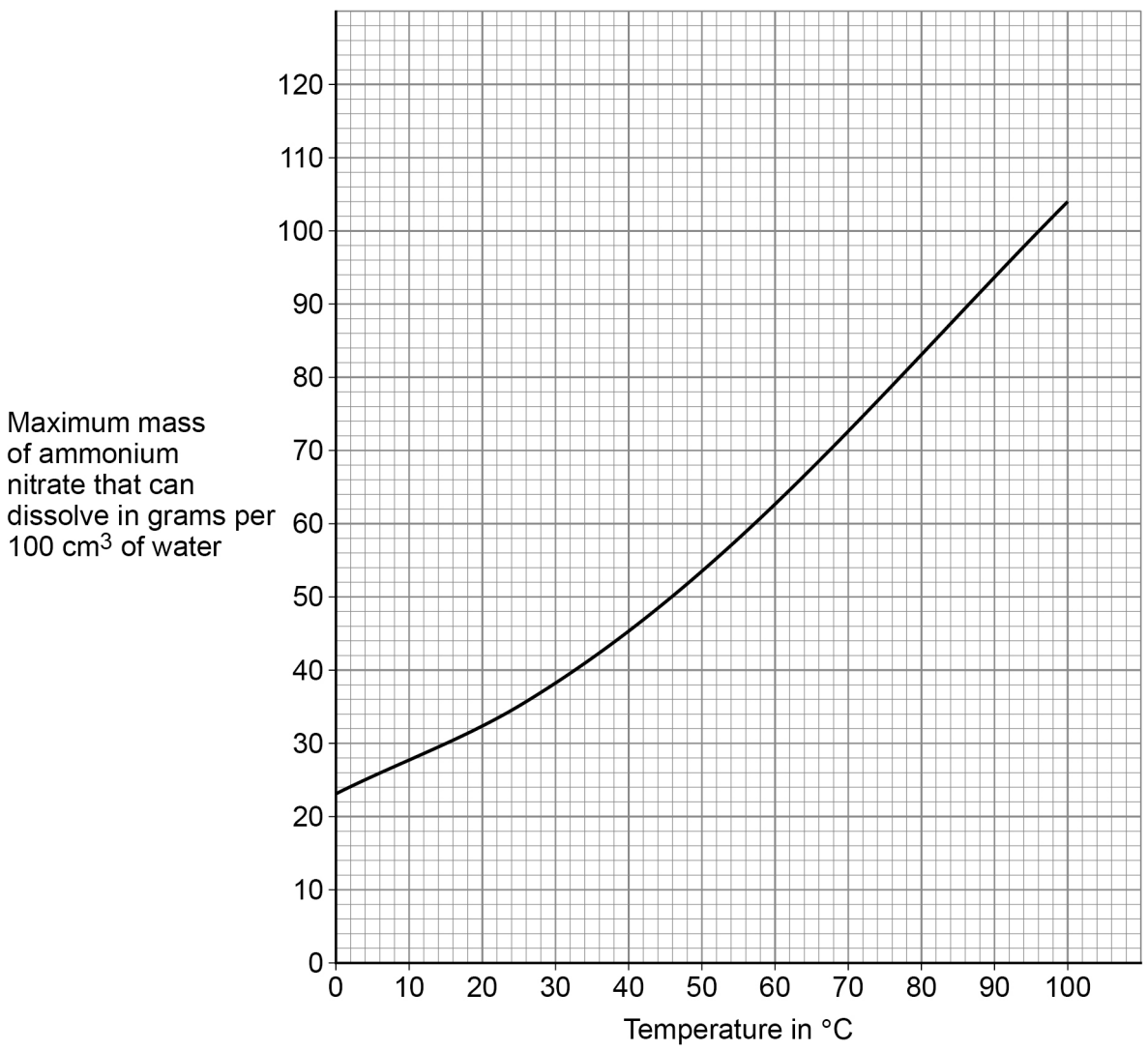
Question 12 · continued



**0 5 . 5** Ammonium nitrate is a salt.

**Figure 13** shows the maximum mass of ammonium nitrate that can dissolve in 100 $cm^3$ of water at different temperatures.

**Figure 13**



**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 12 · continued**



A student adds ammonium nitrate to water at 80 °C until no more dissolves.

The student cools 100 $cm^3$ of this solution of ammonium nitrate from 80 °C to 20 °C to produce crystals of ammonium nitrate.

Determine the mass of ammonium nitrate that crystallises on cooling 100 $cm^3$ of this solution from 80 °C to 20 °C

**[3 marks]**

Mass = _____ g

9

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 13**

June 2022 | 8464/C/1F | Original Q7

**0 7** Plan an investigation to find the order of reactivity of three metals.

You should use the temperature change when each metal reacts with hydrochloric acid.

**[6 marks]**

6

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 14**

June 2022 | 8464/C/2F | Original Q3

**0 3** This question is about ammonia and its compounds.

A student heated a sample of ammonium chloride.

The equation for the reaction is:

$$\underset{\text{ammonium chloride}}{NH_4Cl} \rightleftharpoons \underset{\text{ammonia}}{NH_3} + HCl$$

**0 3 . 1** One product is ammonia.

What is the name of the product with the formula HCl?

**[1 mark]**

_____

**0 3 . 2** Ammonia is a gas.

What is the state symbol for ammonia?

**[1 mark]**

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

**0 3 . 3** How does the equation show that the reaction is reversible?

**[1 mark]**

_____

_____

**0 3 . 4** Complete the sentence.

**[1 mark]**

The forward reaction is endothermic,

so the reverse reaction is _____ .

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 14 · continued



**0 3 . 5** Complete the sentence.

Choose the answer from the box.

**[1 mark]**

| | | |
|---|---|---|
| **concentration** | **rate** | **temperature** |

Equilibrium is reached when the forward and reverse reactions happen at exactly the same _____ .

**Question 3 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

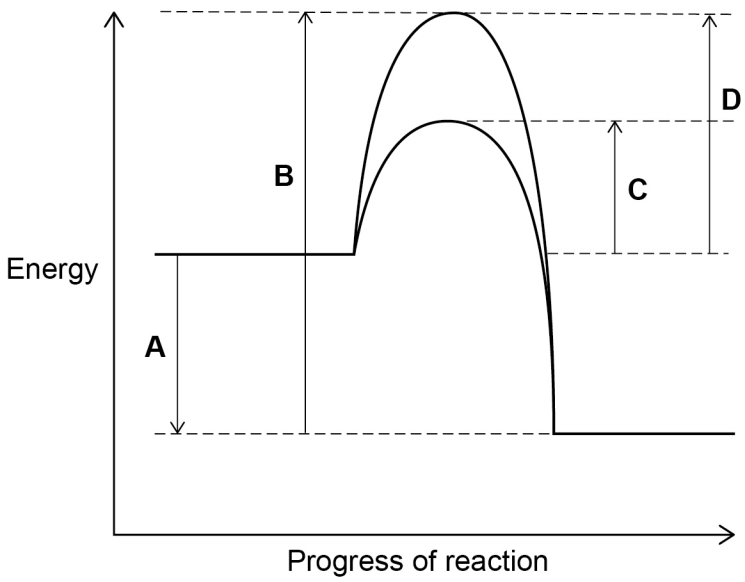
Question 14 · continued



The industrial process to produce ammonia uses a catalyst.

0 3 . 6 **Figure 5** shows the reaction profile for the reaction with and without a catalyst.

**Figure 5**




Which letter represents the activation energy for the reaction with a catalyst?

**[1 mark]**

Tick (✓) **one** box.

A ☐ B ☐ C ☐ D ☐

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 14 · continued



**0 3 . 7** Give **one** reason why using a catalyst reduces costs.

Do **not** answer in terms of activation energy.

**[1 mark]**

**0 3 . 8** Ammonia is in a mixture that is used as a household cleaner.

What is a mixture that has been designed as a useful product called?

**[1 mark]**

8

**Turn over for the next question**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 15**

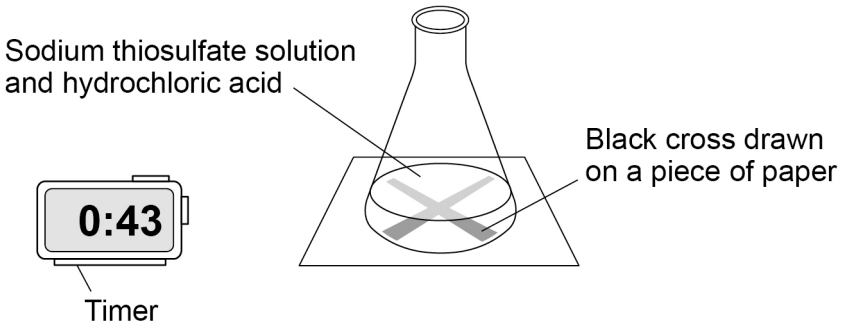
June 2022 | 8464/C/2F | Original Q4

**0 4** A student investigates the effect of concentration on the rate of the reaction between sodium thiosulfate solution and hydrochloric acid.

**Figure 6** shows the experiment.

The experiment was done in a fume cupboard.

**Figure 6**




This is the method used.

1. Pour 50 $cm^3$ of sodium thiosulfate solution into a conical flask.
2. Put the conical flask on a black cross drawn on a piece of paper.
3. Pour 10 $cm^3$ of hydrochloric acid into the conical flask and start a timer.
4. Stop the timer when the cross can no longer be seen.
5. Repeat the experiment with different concentrations of sodium thiosulfate solution.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 15 · continued



**0 4 . 1** Draw **one** line from each type of variable to the correct example of the variable in this investigation.

**[2 marks]**

| Type of variable | Example of variable |
|---|---|
| | Concentration of sodium thiosulfate solution |
| Dependent | |
| | Temperature of reaction mixture |
| | Time taken for the cross to no longer be seen |
| Independent | |
| | Volume of acid |
| | Volume of the flask |

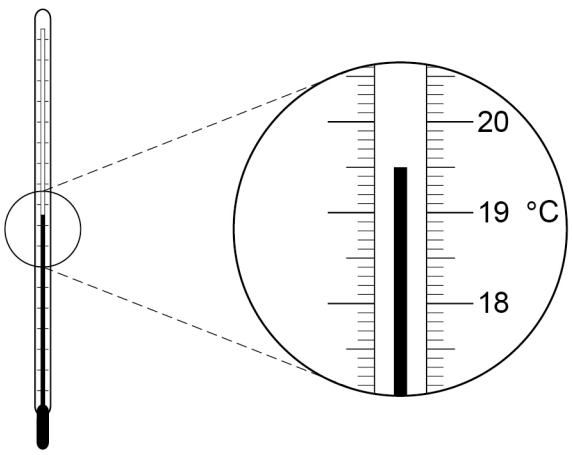
**Question 4 continues on the next page**

Question 15 · continued



**0 4 . 2** The experiment is done at room temperature.

**Figure 7**




What is the temperature shown on the thermometer in **Figure 7**?

**[1 mark]**

Temperature = _____ °C

**Table 1** shows the student's results.

**Table 1**

| Concentration of sodium thiosulfate solution in mol/dm$^3$ | Time in seconds |
|---|---|
| 0.1 | 82 |
| 0.2 | 40 |
| 0.3 | 20 |
| 0.4 | 13 |
| 0.5 | 10 |
| 0.6 | 8 |

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 15 · continued

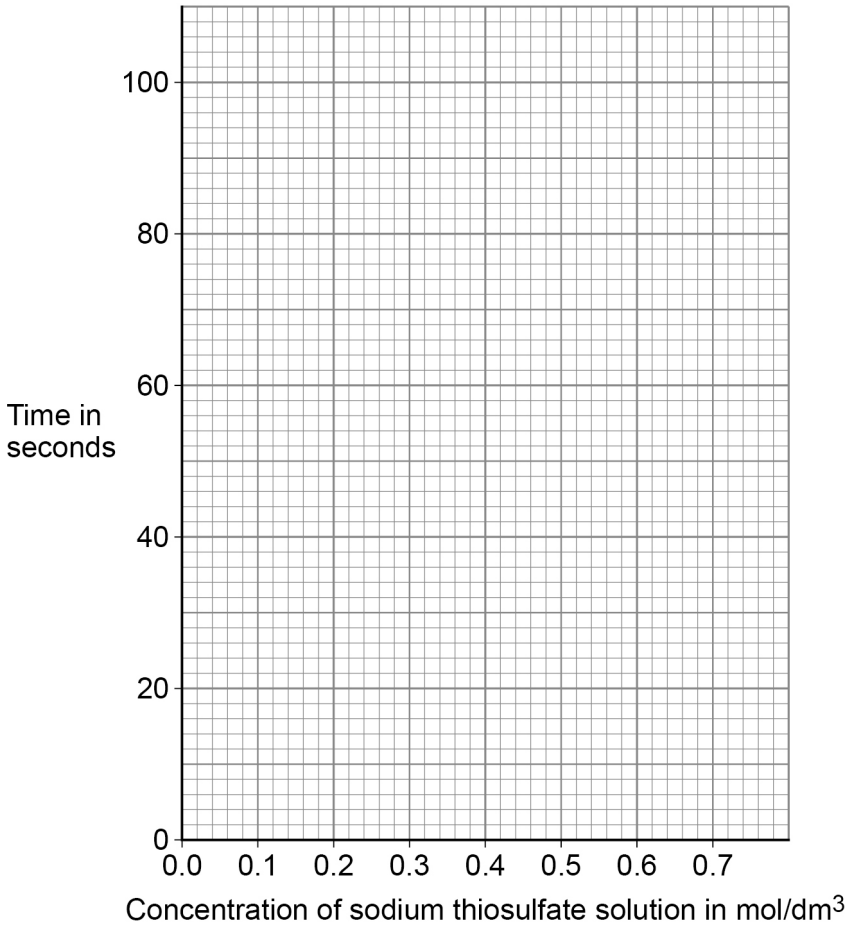


**0 4 . 3** Plot the data from **Table 1** on **Figure 8**.

Draw a line of best fit.

**[3 marks]**

**Figure 8**




**0 4 . 4** Predict the time taken for the cross to no longer be seen at a concentration of 0.7 mol/dm$^3$

Use your graph in **Figure 8**.

**[1 mark]**

Time = _____ s

**0 4 . 5** Complete the sentence.

**[1 mark]**

As the concentration of sodium thiosulfate solution increases, the time taken for the cross to no longer be seen _____ .

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 15 · continued** June 2022 | 8464/C/2F | Original Q4

**0 4 . 6** In one experiment 0.725 g of sulfur is produced in 20 seconds.

Calculate the mean rate of the reaction from 0 to 20 seconds.

Use the equation:

$$\text{mean rate of reaction} = \frac{\text{mass of sulfur produced in grams}}{\text{time in seconds}}$$

**[2 marks]**

Mean rate of reaction = _____

**0 4 . 7** What is the unit for the mean rate of reaction calculated in Question **04.6**?

**[1 mark]**

Tick (✓) **one** box.

g ☐ g/s ☐ s ☐ s/g ☐

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 15 · continued



**0 4 . 8** The student did the experiment with 0.15 mol/dm$^3$ sodium thiosulfate solution and repeated the experiment three more times.

**Table 2** shows the results.

**Table 2**

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| Time in seconds for the cross to no longer be seen | 60.5 | 63.2 | 82.3 | 65.7 |

Calculate the mean time for this reaction.

Do **not** include the anomalous result in your calculation.

Give your answer to 3 significant figures.

**[3 marks]**

Mean time for the reaction (3 significant figures) = _____ s

14

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

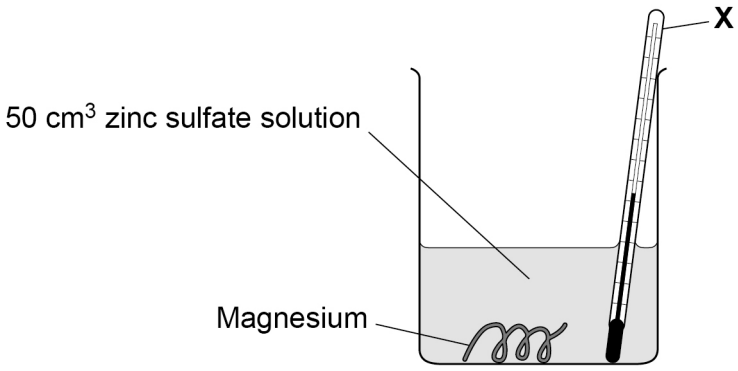
**Question 16**

June 2023 | 8464/C/1F | Original Q2

**0 2** A student investigated the temperature change when magnesium was added to zinc sulfate solution.

**Figure 5** shows the apparatus.

**Figure 5**




**0 2 . 1** Which piece of equipment is labelled **X**?

**[1 mark]**

Tick (✓) **one** box.

Beaker ☐

Ruler ☐

Thermometer ☐

**0 2 . 2** Which piece of equipment is the best to use to measure volumes of solution?

**[1 mark]**

Tick (✓) **one** box.

Conical flask ☐

Evaporating basin ☐

Measuring cylinder ☐

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 16 · continued



The student added 1.0 g of magnesium to 50 $cm^3$ of zinc sulfate solution and measured the temperature increase.

The student repeated the experiment two more times.

**Table 1** shows the results.

**Table 1**

| Temperature increase in °C | | | |
|---|---|---|---|
| **Experiment 1** | **Experiment 2** | **Experiment 3** | **Mean** |
| 7.6 | 7.3 | 7.6 | **Y** |

**0 2 . 3** Calculate value **Y** in **Table 1**.

**[2 marks]**

**Y** = _____ °C

**0 2 . 4** The student then added 1.2 g of magnesium to 50 $cm^3$ of zinc sulfate solution.

The temperature increased by 9.0 °C.

Calculate the temperature increase when the student adds 0.40 g of magnesium to 50 $cm^3$ of zinc sulfate solution.

**[2 marks]**

Temperature increase = _____ °C

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 16 · continued**



**0 2 . 5** What is the name given to a reaction which causes the temperature to increase?

**[1 mark]**

Tick (✓) **one** box.

Endothermic ☐

Exothermic ☐

Thermal decomposition ☐

**0 2 . 6** The student repeated the experiment with 1.2 g of copper and 50 $cm^3$ of zinc sulfate solution.

The temperature did **not** increase.

Give **one** reason why.

**[1 mark]**

_____

_____

**8**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

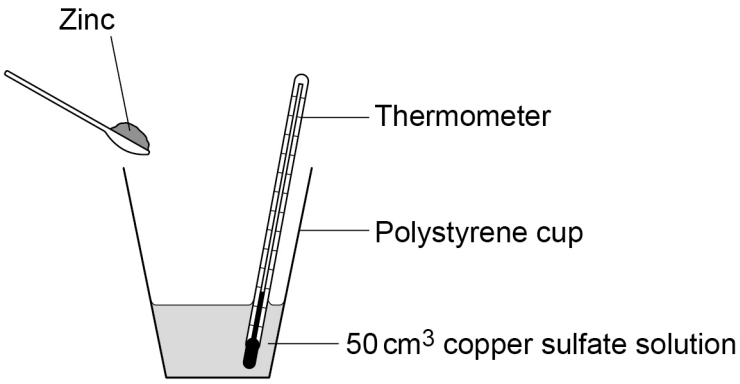
**Question 17**

June 2024 | 8464/C/1F | Original Q3

**0 3** A student investigated the temperature change when different masses of zinc were added to copper sulfate solution.

**Figure 5** shows the apparatus.

**Figure 5**




This is the method used.

1. Pour 50 $cm^3$ of copper sulfate solution into a polystyrene cup.
2. Measure the starting temperature of the copper sulfate solution.
3. Add 1.0 g of zinc.
4. Stir the mixture.
5. Measure the highest temperature reached.
6. Repeat steps 1 to 5 two more times.
7. Repeat steps 1 to 6 with different masses of zinc.

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17 · continued

June 2024 | 8464/C/1F | Original Q3

**0 3 . 1** The student varied the mass of zinc.

What type of variable is the mass of zinc?

**[1 mark]**

Tick (✓) **one** box.

Control ☐

Dependent ☐

Independent ☐

**Question 3 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17 · continued



Zinc reacts with copper sulfate solution to produce salt **A** and copper.

The word equation for the reaction is:

zinc + copper sulfate → salt **A** + copper

**0 3 . 2** What is the name of salt **A**?

**[1 mark]**

**0 3 . 3** The temperature of the solution increases when zinc reacts with copper sulfate solution.

Give **two** other observations that can be made when zinc reacts with copper sulfate solution.

**[2 marks]**

1 _____

_____

2 _____

_____

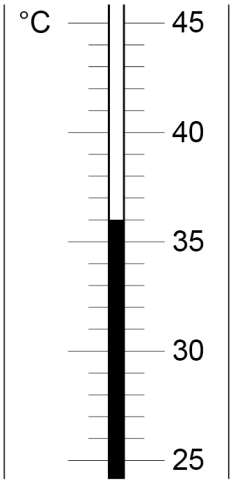
5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17 · continued



**0 3 . 4** **Figure 6** shows the highest temperature reached in one experiment.

**Figure 6**




Complete **Table 3**.

Use **Figure 6**.

**[2 marks]**

**Table 3**

| | |
|---|---|
| Starting temperature in °C | 21 |
| Highest temperature reached in °C | |
| Temperature increase in °C | |

**Question 3 continues on the next page**

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17 · continued



A teacher repeated the investigation using a digital thermometer.

**Table 4** shows the results.

**Table 4**

| Mass of zinc in grams | Temperature increase in °C | | | |
|---|---|---|---|---|
| | Experiment 1 | Experiment 2 | Experiment 3 | **Mean** |
| 1.0 | 7.8 | 7.3 | 7.7 | **B** |
| 2.0 | 13.1 | 13.8 | 13.3 | 13.4 |
| 3.0 | 20.4 | 12.9 | 20.2 | 20.3 |

**0 3 . 5** Calculate value **B** in **Table 4**.

**[2 marks]**

**B** = _____ °C

**0 3 . 6** The range of the results is the minimum value of temperature increase to the maximum value of temperature increase.

What is the range of temperature increase for the experiment with **2.0 g** of zinc?

**[1 mark]**

Range = _____ °C to _____ °C

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 17 · continued



**0 3 . 7** One of the results for **3.0 g** of zinc is anomalous.

Which result is anomalous?

Suggest **one** reason why this result is anomalous.

**[2 marks]**

Anomalous result _____

Reason _____

_____

_____

11

**Turn over for the next question**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 18**

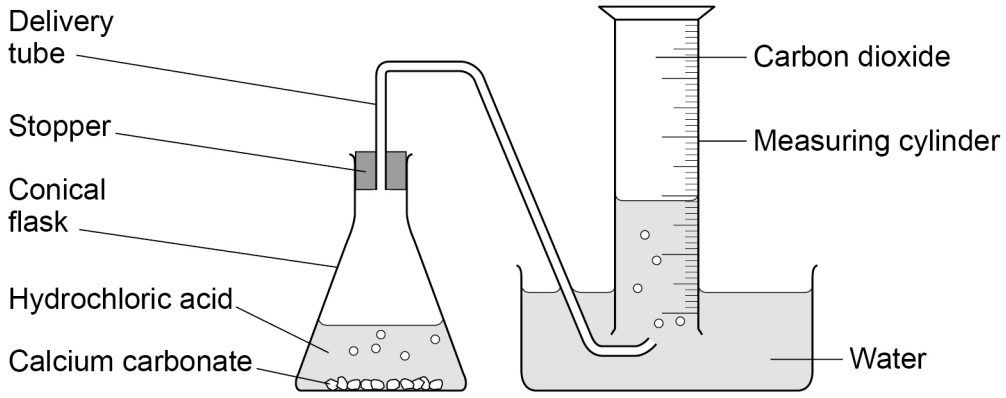
June 2024 | 8464/C/2F | Original Q7

**0 7** Some factors affect the rates of chemical reactions.

**0 7 . 1** A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

**Figure 6** shows the apparatus.

**Figure 6**




Describe a method the student could use to produce valid results.

**[6 marks]**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 18 · continued**



**0 7 . 2** The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

**[3 marks]**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 18 · continued**



Catalysts affect the rate of reactions.

**0 7 . 3** What is meant by a 'catalyst'?

**[2 marks]**

**0 7 . 4** What are catalysts in biological systems called?

**[1 mark]**

**12**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 19**

June 2025 | 8464/C/1F | Original Q7

**0 7** A student investigated an exothermic reaction.

The student reacted solid calcium oxide with water to produce calcium hydroxide.

**0 7 . 1** What is meant by an 'exothermic' reaction?

**[1 mark]**

**0 7 . 2** The formula of calcium hydroxide is $Ca(OH)_2$

Calculate the percentage by mass of oxygen in calcium hydroxide.

Relative atomic mass ($A_r$): O = 16

Relative formula mass ($M_r$): $Ca(OH)_2$ = 74

**[3 marks]**

Percentage = _____ %

**Question 7 continues on the next page**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 19 · continued**



**0 7 . 3** When solid calcium oxide is added to water, the temperature of the reaction mixture changes.

Plan a method to investigate how changing the mass of calcium oxide affects the temperature change of the reaction mixture.

**[6 marks]**

Extra space

**10**

### 5.5.1.1 Energy transfer during exothermic and endothermic reactions

**Question 20**

June 2025 | 8464/C/2F | Original Q3

**0 3** Screenwash is a mixture designed to keep car windscreens clean.

The components in screenwash include glycerol, methanol and water.

**0 3 . 1** Screenwash is made by mixing the components in carefully measured quantities so that the product has the required properties.

What name is given to this type of mixture?

**[1 mark]**

Tick (✓) **one** box.

Catalyst ☐

Formulation ☐

Polymer ☐

**0 3 . 2** Glycerol has the formula $C_3H_8O_3$

How many atoms are there in one molecule of glycerol?

**[1 mark]**

Tick (✓) **one** box.

3 ☐ 8 ☐ 11 ☐ 14 ☐

**Question 3 continues on the next page**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 20 · continued**



**0 3 . 3** Incomplete combustion happens when glycerol burns in limited oxygen.

Incomplete combustion produces carbon monoxide gas.

Why can the production of carbon monoxide gas be a problem?

**[1 mark]**

Tick (✓) **one** box.

Carbon monoxide is a greenhouse gas. ☐

Carbon monoxide is a toxic gas. ☐

Carbon monoxide is an acidic gas. ☐

**0 3 . 4** Complete combustion happens when methanol ($CH_4O$) burns in excess oxygen.

Balance the equation for the reaction.

**[1 mark]**

$$2\,CH_4O + 3\,O_2 \rightarrow ____ CO_2 + 4\,H_2O$$

5.5.1.1 Energy transfer during exothermic and endothermic reactions

Question 20 · continued



Methanol can be produced by the reaction of carbon dioxide with hydrogen.

**0 3 . 5** Describe the test for hydrogen gas.

Give the result of the test.

**[2 marks]**

Test _____

_____

Result _____

_____

**0 3 . 6** Carbon dioxide is a greenhouse gas.

An increase in greenhouse gases in the atmosphere has led to an increase in average global temperature.

The increase in average global temperature has caused global climate change.

Give **two** effects of global climate change.

**[2 marks]**

1 _____

_____

2 _____

_____

**Question 3 continues on the next page**

**5.5.1.1 Energy transfer during exothermic and endothermic reactions**

**Question 20 · continued**



Anhydrous cobalt chloride can be used to test for water.

The word equation for the reaction is:

anhydrous cobalt chloride (blue) + water ⇌ hydrated cobalt chloride (pink)

**0 3 . 7** Suggest **one** observation that could be made when water is added to anhydrous cobalt chloride.

**[1 mark]**

**0 3 . 8** The reaction between anhydrous cobalt chloride and water is exothermic.

What type of reaction is the reverse reaction?

**[1 mark]**

**10**