

(Exothermic and endothermic reactions)

Q1. (2018)

The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

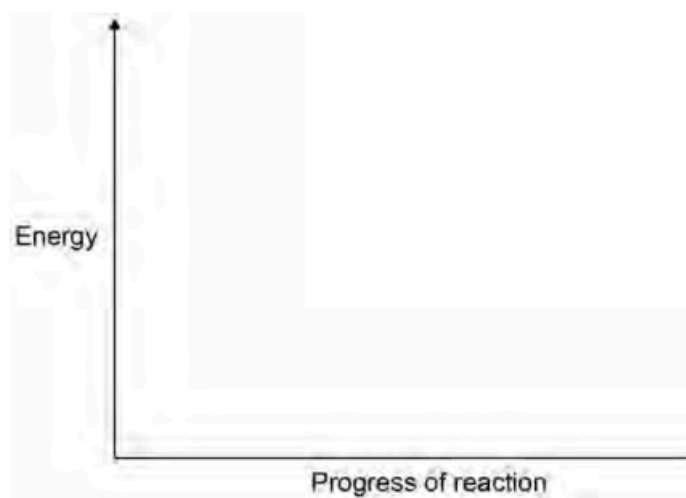
[1 mark]

Q2. (2018)

Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 5**.

[3 marks]

Figure 5



Q3. (2019)

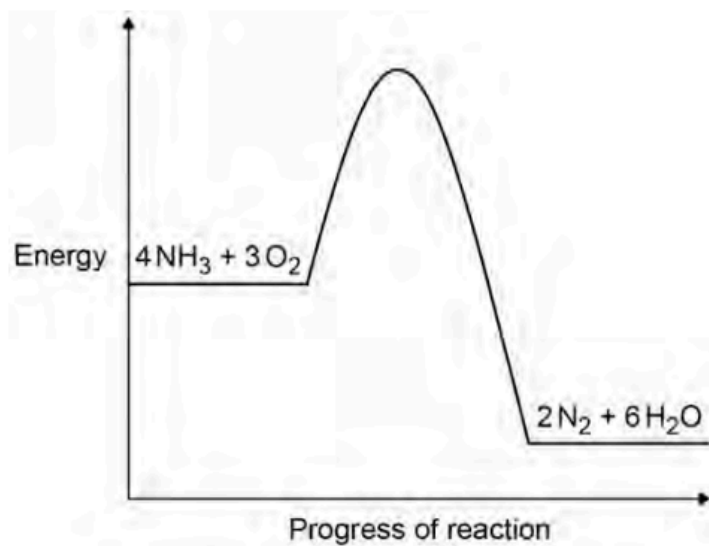
Figure 8 shows the reaction profile for the reaction between ammonia and oxygen.

Complete **Figure 8** by labelling the:

- activation energy
- overall energy change.

[2 marks]

Figure 8



Q4. (2019)

A student investigated the temperature change in the reaction between dilute sulfuric acid and potassium hydroxide solution.

This is the method used.

1. Measure 25.0 cm^3 potassium hydroxide solution into a polystyrene cup.
2. Record the temperature of the solution.
3. Add 2.0 cm^3 dilute sulfuric acid.
4. Stir the solution.
5. Record the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 20.0 cm^3 dilute sulfuric acid has been added.

Suggest why the student used a polystyrene cup rather than a glass beaker for the reaction.

[2 marks]

Q5. a). (2019)

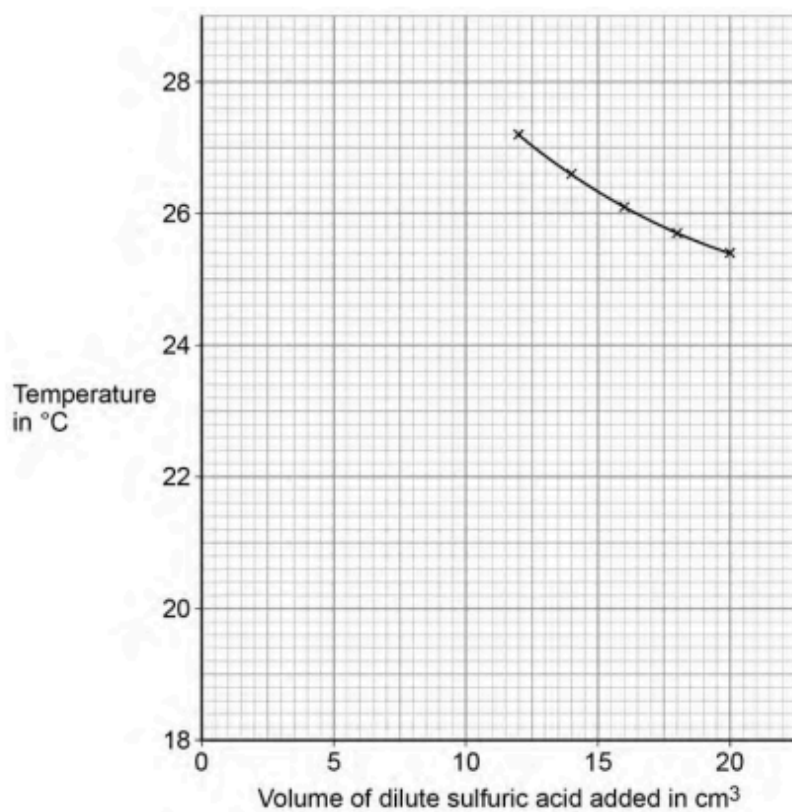
Table 6 shows some of the student's results.

Table 6

Volume of dilute sulfuric acid added in cm^3	Temperature in $^{\circ}\text{C}$
0.0	18.9
2.0	21.7
4.0	23.6
6.0	25.0
8.0	26.1
10.0	27.1

Figure 11 shows some of the data from the investigation.

Figure 11



Complete **Figure 11**:

- plot the data from **Table 6**
- draw a line of best fit through these points
- extend the lines of best fit until they cross.

[4 marks]

Q5. b). (2019)

Determine the volume of dilute sulfuric acid needed to react completely with 25.0 cm^3 of the potassium hydroxide solution.

Use **Figure 11**.

[1 mark]

Volume of dilute sulfuric acid to react completely = _____ cm^3

Q5. c). (2019)

Determine the overall temperature change when the reaction is complete.

Use **Figure 11**.

[1 mark]

Overall temperature change = _____ $^{\circ}\text{C}$

Q6. a). (2020)

This question is about citric acid ($\text{C}_6\text{H}_8\text{O}_7$).

Citric acid is a solid.

A student investigated the temperature change during the reaction between citric acid and sodium hydrogencarbonate solution.

This is the method used.

1. Pour 25 cm^3 of sodium hydrogencarbonate solution into a polystyrene cup.
2. Measure the temperature of the sodium hydrogencarbonate solution.
3. Add 0.20 g of citric acid to the polystyrene cup.
4. Stir the solution.
5. Measure the temperature of the solution.
6. Repeat steps 3 to 5 until a total of 2.00 g of citric acid has been added.

The student plotted the results on a graph.

Figure 6 shows the student's graph.

Figure 6

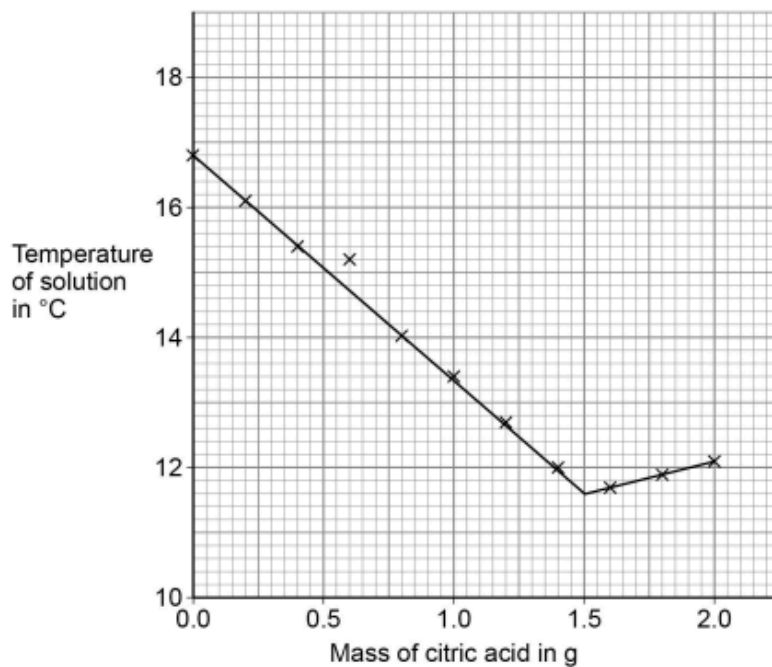


Figure 6 shows an anomalous point when 0.60 g of citric acid was added.
This was caused by the student making an error.

The student correctly:

- measured the mass of the citric acid
- read the thermometer
- plotted the point.

Suggest **one** reason for the anomalous point.

[1 mark]

Q6. b). (2020)

Explain the shape of the graph in terms of the energy transfers taking place.

You should use data from **Figure 6** in your answer.

[3 marks]

Q6. c). (2020)

A second student repeated the investigation using a metal container instead of the polystyrene cup. The container and the cup were the same size and shape.

Sketch a line on **Figure 6** to show the second student's results until 1.00 g of citric acid had been added. The starting temperature of the solution was the same.

Explain your answer.

[3 marks]

Q7. (2021)

Figure 6 shows part of the reaction profile for the reaction.

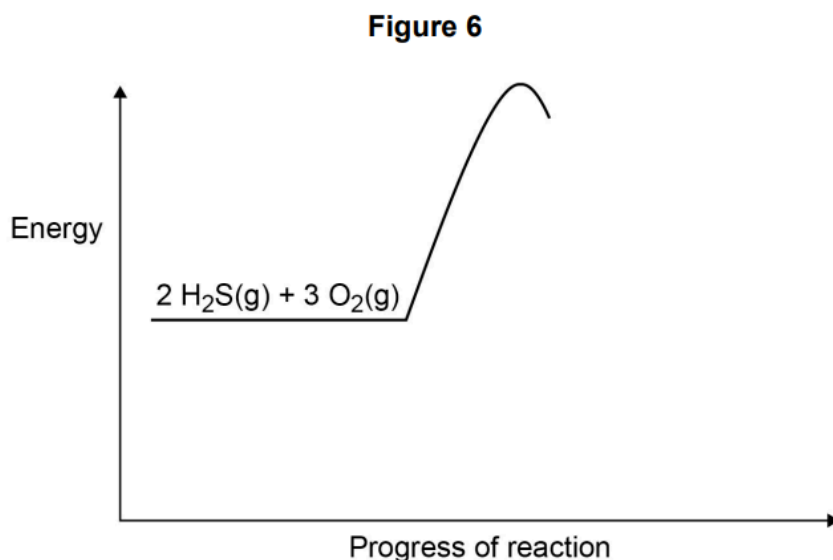
The reaction is exothermic.

Complete **Figure 6**.

You should:

- complete the profile line
- label the activation energy
- label the overall energy change.

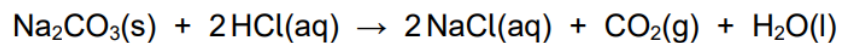
[3 marks]



Q8. (2022)

Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:



A student investigated the effect of changing the mass of sodium carbonate powder on the highest temperature reached by the reaction mixture.

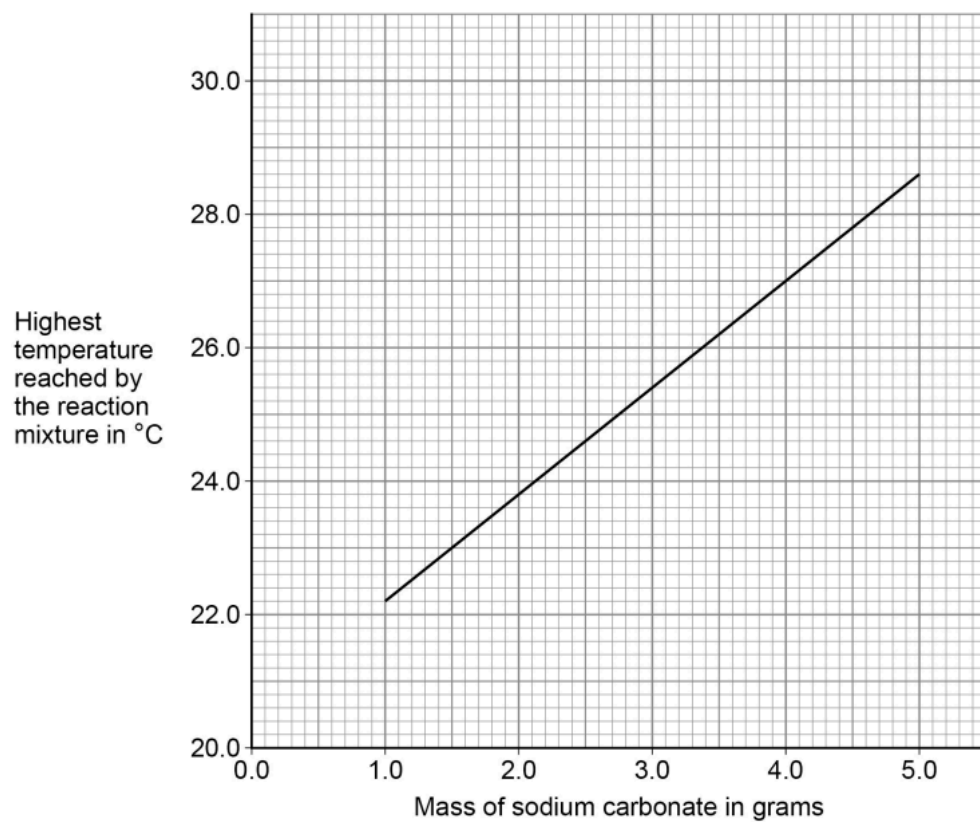
Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

[6 marks]

Q9. a). (2022)

Figure 3 shows a line of best fit drawn through the student's results.

Figure 3



Determine the gradient of the line of best fit in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{Change in highest temperature}}{\text{Change in mass}}$$

Give the unit.

[5 marks]

Gradient = _____ Unit _____

Q9. b). (2022)

The initial temperature of the reaction mixture is where the line of best fit would meet the y-axis.

Determine the initial temperature of the reaction mixture.

Show your working on **Figure 3**.

[2 marks]

Initial temperature of the reaction mixture = _____ °C

Q10. (2022)

Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

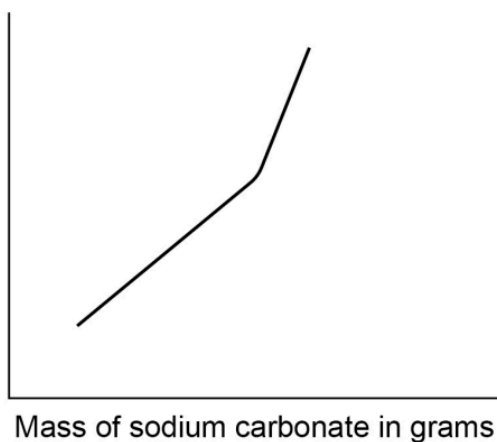
Which sketch graph shows the results obtained when sodium carbonate was added until in excess?

[1 mark]

Tick (✓) **one** box.

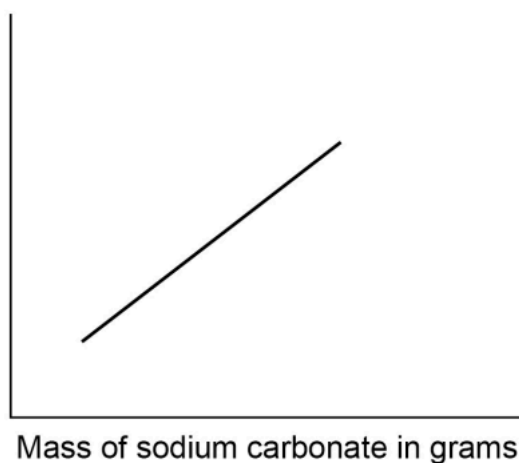
A

Highest
temperature
reached by
the reaction
mixture in °C



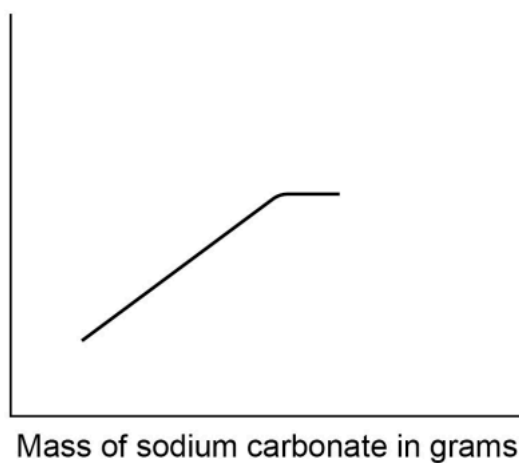
B

Highest
temperature
reached by
the reaction
mixture in °C



C

Highest
temperature
reached by
the reaction
mixture in °C



This question is about temperature changes.

A student investigated the change in temperature of a solution when different masses of ammonium nitrate were dissolved in water.

This is the method used.

1. Measure 200 cm³ of water into a polystyrene cup.
2. Measure the temperature of the water.
3. Add 4.0 g of ammonium nitrate to the water.
4. Stir the solution until all the ammonium nitrate has dissolved.
5. Measure the lowest temperature reached by the solution.
6. Repeat steps 1 to 5 with different masses of ammonium nitrate.

Give the independent variable and the dependent variable in the investigation.

[2 marks]

Independent variable _____

Dependent variable _____

Q12. a). (2023)

Table 2 shows the results.

Table 2

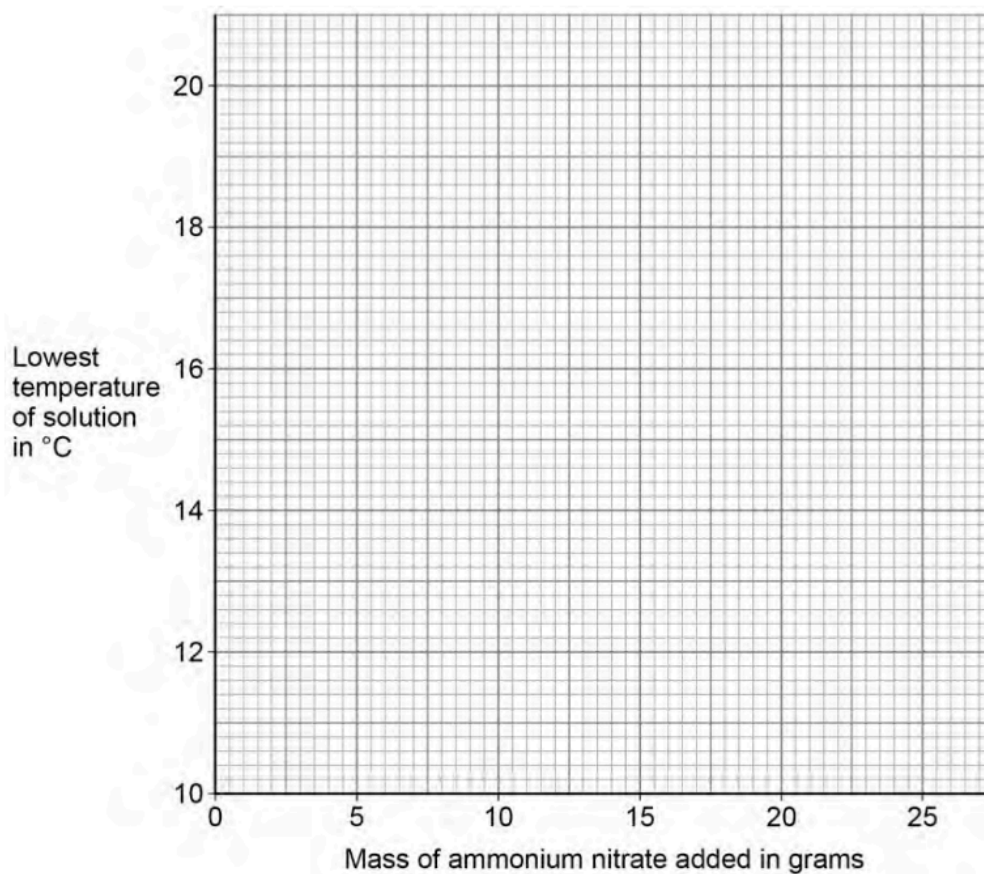
Mass of ammonium nitrate added in grams	Lowest temperature of solution in °C
4.0	18.2
8.0	16.2
12.0	15.2
16.0	13.6
20.0	12.4
24.0	10.6

Plot the data from **Table 2** on **Figure 2**.

Draw a line of best fit.

[3 marks]

Figure 2

Figure 2

Q12. b). (2023)

Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 2**.**[2 marks]**

Initial temperature of the water = _____ °C

Q12. c). (2023)

How do the results show that dissolving ammonium nitrate in water is endothermic?

[1 mark]

Q13. a). (2023)

The student repeated the experiment three more times.

Table 3 shows the results for 8.0 g of ammonium nitrate.

Table 3

	Trial 1	Trial 2	Trial 3	Trial 4	Mean
Lowest temperature of solution in °C	16.2	16.6	16.8	16.4	16.5

The student recorded the mean lowest temperature of the solution for 8.0 g of ammonium nitrate as 16.5 ± 0.3 °C.

Explain why the student included ± 0.3 °C after the mean lowest temperature.

[2 marks]

Q13. b). (2023)

What type of error is shown by the results in **Table 3**?

[1 mark]

Tick (✓) **one** box.

Random error

☐

Systematic error

☐

Zero error

☐

Q14. (2023)

Figure 4 shows part of a reaction profile for the reaction between hydrogen and chlorine.

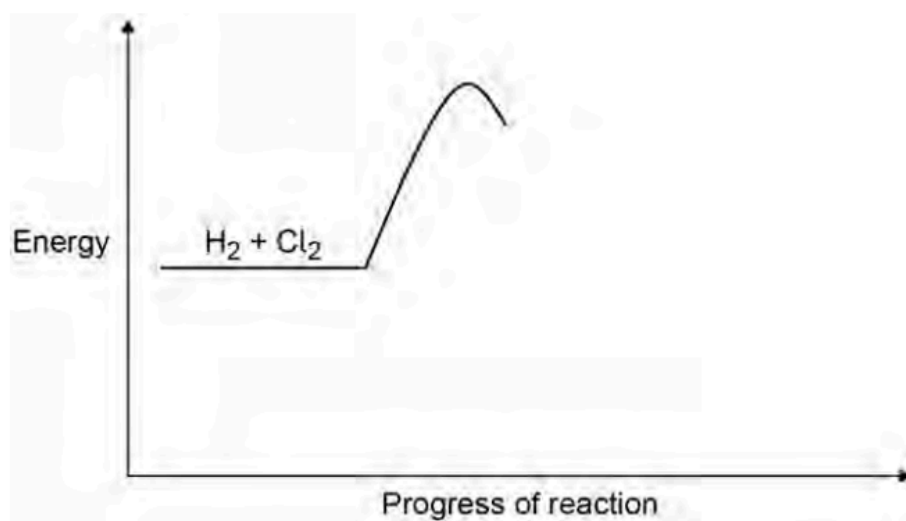
Complete the reaction profile in **Figure 4**.

You should:

- label the activation energy
- label the overall energy change.

[3 marks]

Figure 4



Q15. a). (2024)

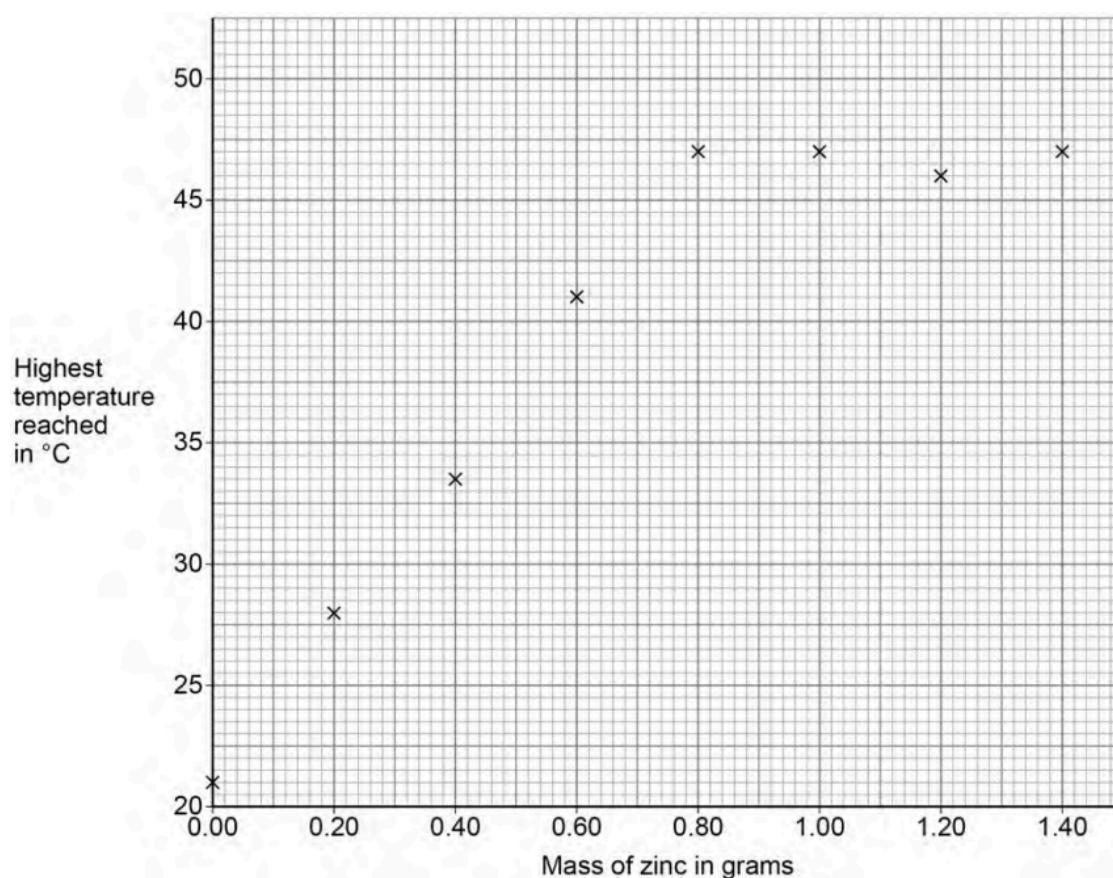
A student investigated the energy change of the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm³ of copper sulfate solution into a polystyrene cup.
2. Measure the temperature of the copper sulfate solution.
3. Add 0.20 g of zinc powder to the copper sulfate solution.
4. Stir the reaction mixture.
5. Record the highest temperature reached.
6. Repeat steps 1 to 5 with different masses of zinc powder.

Figure 3 shows the results.

Figure 3



Draw **two** lines of best fit on **Figure 3**.

The lines should cross.

[2 marks]

Q15. b). (2024)

Explain the results shown in **Figure 3**.

Do **not** refer to anomalous points.

Use data from **Figure 3**.

[4 marks]

Q15. c). (2024)

Explain why using a polystyrene cup gives more accurate results than using a glass beaker.

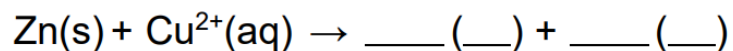
[2 marks]

Q15. d). (2024)

Complete the ionic equation for the reaction between zinc and copper sulfate solution.

Include state symbols.

[2 marks]



Q15. e). (2024)

A different student repeated steps 1 to 5 of the method four times using 0.50 g of zinc powder.

Table 2 shows the results.

Table 2

	Trial 1	Trial 2	Trial 3	Trial 4
Highest temperature reached in °C	37.6	37.2	37.8	37.4

Calculate the mean highest temperature reached.

Include the uncertainty in your answer.

[3 marks]

Mean highest temperature reached = _____ $\pm$ _____ °C

Q15. f). (2024)

The results show random errors.

The student did not make any measuring errors.

Suggest **one** reason for the random errors in this experiment.

[1 mark]

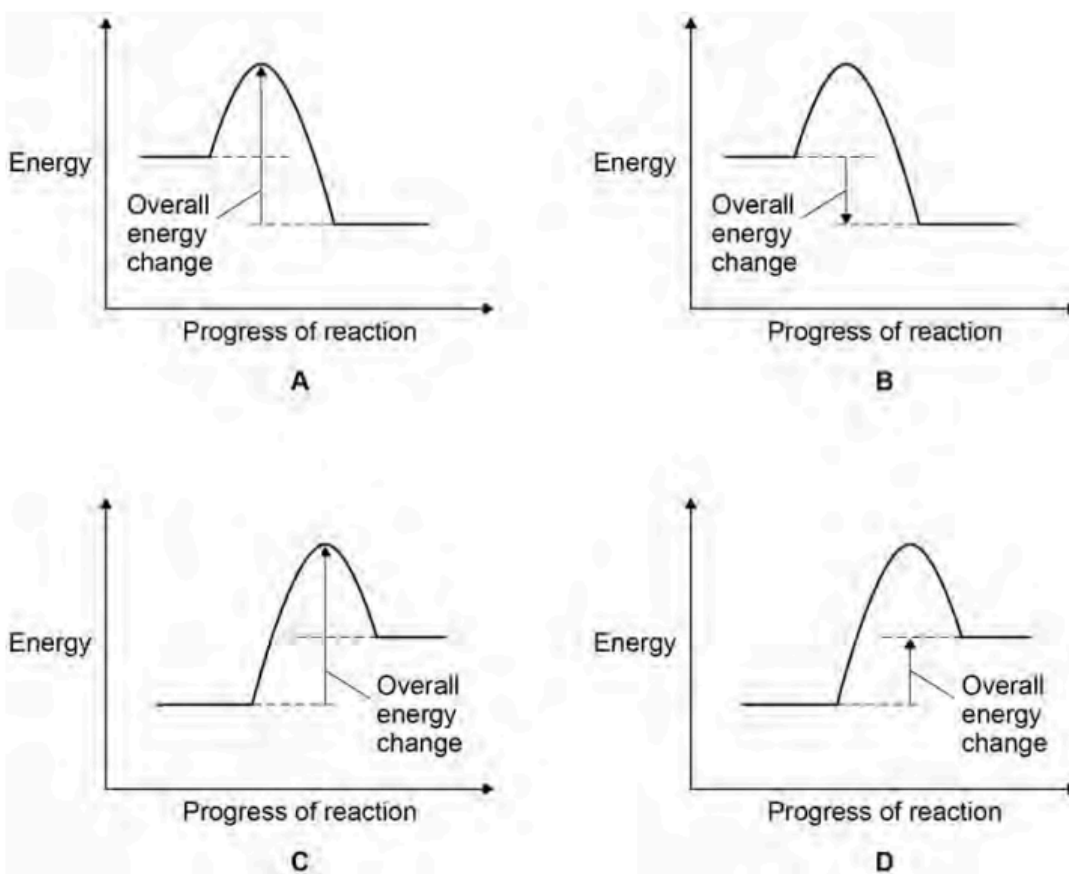
Q16. (2024)

Propane reacts with oxygen to produce carbon dioxide and water.

The reaction is exothermic.

Figure 8 shows four reaction profiles.

Figure 8



Which is the correct reaction profile and labels for the reaction between propane and oxygen?

Tick (✓) **one** box.

[1 mark]

A ☐

B ☐

C ☐

D ☐