(Exothermic and endothermic reactions)

Q1. (2019)

This question is about energy changes in reactions.

Ammonium nitrate dissolves in water.

The change is endothermic.

Which piece of equipment uses this change?

[1 mark]

Tick (✓) **one** box.

Hand warmer ☐

Self-heating can ☐

Sports injury pack ☐

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 cm^3 of potassium hydroxide solution into a glass beaker.

2. Add 5 cm^3 of dilute sulfuric acid.

3. Stir the solution.

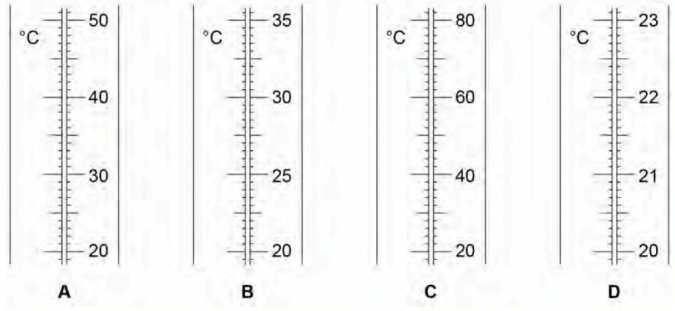
4. Measure the temperature of the solution.

5. Repeat steps 2 to 4 until a total of 30 cm^3 of dilute sulfuric acid has been added.

Q2. a) (2019)

Figure 9 shows part of the scales of four thermometers, **A**, **B**, **C** and **D**.

Figure 9



The student wanted to measure the temperature to a resolution of 0.1 °C

Which thermometer should the student use?

[1 mark]

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

Q2. b) (2019)

Energy is lost to the surroundings during the reaction.

What type of error does this cause in the results?

[1 mark]

Tick (✓) **one** box.

Human error ☐

Random error ☐

Systematic error ☐

Zero error ☐

Q2. c) (2019)

The student used a glass beaker for the reaction.

Name a container the student could use instead of the glass beaker to improve the accuracy of the results.

[1 mark]

_____

_____

Q2. d) (2019)

Table 3 shows the student's results.

Table 3

Volume of dilute sulfuric acid added in cm^3	Temperature in °C
5	21.2
10	22.0
15	22.8
20	23.6
25	24.4
30	25.2

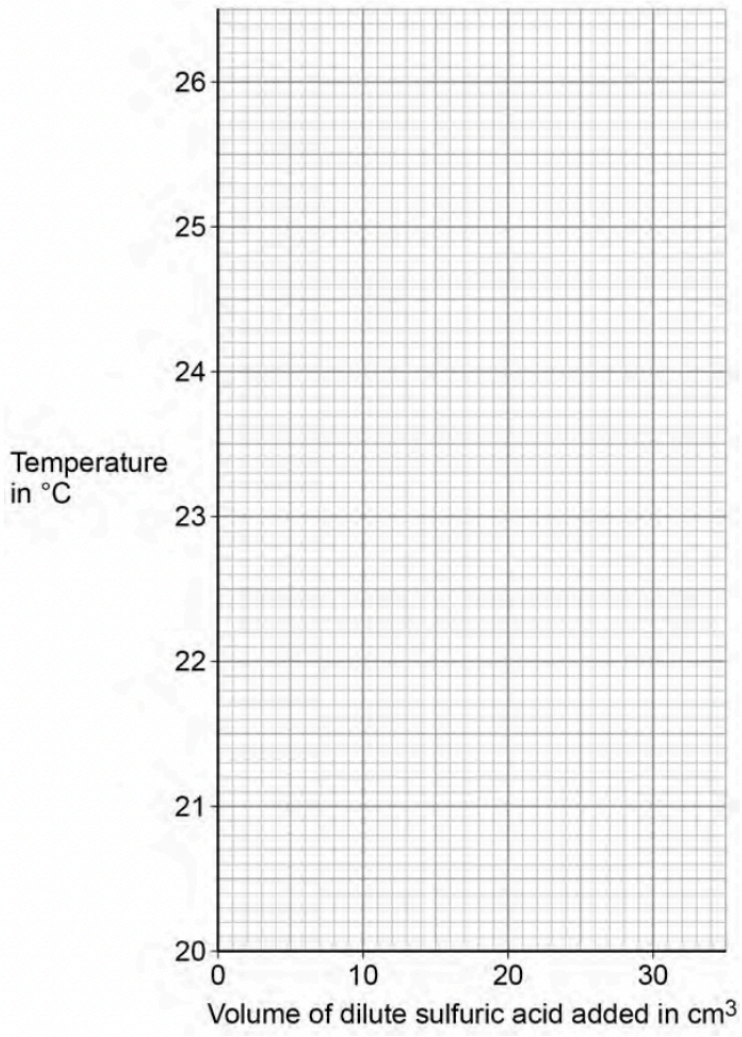
Plot the data from **Table 3** on **Figure 10**.

You should:

- draw a line of best fit
- extend your line of best fit to the y-axis.

[4 marks]

Figure 10



Q2. e) (2019)

The intercept on the y-axis of **Figure 10** shows the starting temperature of the potassium hydroxide solution.

Give the starting temperature of the potassium hydroxide solution.

[1 mark]

Starting temperature = _____ °C

Q2. f) (2019)

Another student repeated the investigation and obtained an anomalous result.

This result was lower than expected.

What could have caused the anomalous result?

[2 marks]

Tick (✓) **two** boxes.

- The mixture was not stirred. ☐
- The temperature in the room increased. ☐
- The thermometer was not accurate. ☐
- Too little sulfuric acid was added. ☐
- Too much potassium hydroxide solution was used. ☐

Q3.(2020)

This question is about chemical reactions and energy.

Hydrogen reacts with oxygen to produce water.

This reaction releases energy.

Complete the word equation for the reaction.

[1 mark]

hydrogen + oxygen → _____

Q4. (2020)

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

Citric acid is a solid.

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 0.25 g of citric acid to the 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.

Table 4 shows some of the student's results.

Table 4

Mass of citric acid added in g	Temperature of solution in °C
0.00	22.6
0.25	22.2
0.50	21.8
0.75	21.4
1.00	21.0
1.25	20.6

How do the results in **Table 4** show that the reaction is endothermic?

[1 mark]

Q5.a) (2020)

Three of the student's results are plotted on **Figure 9**.

A line of best fit for these points is drawn.

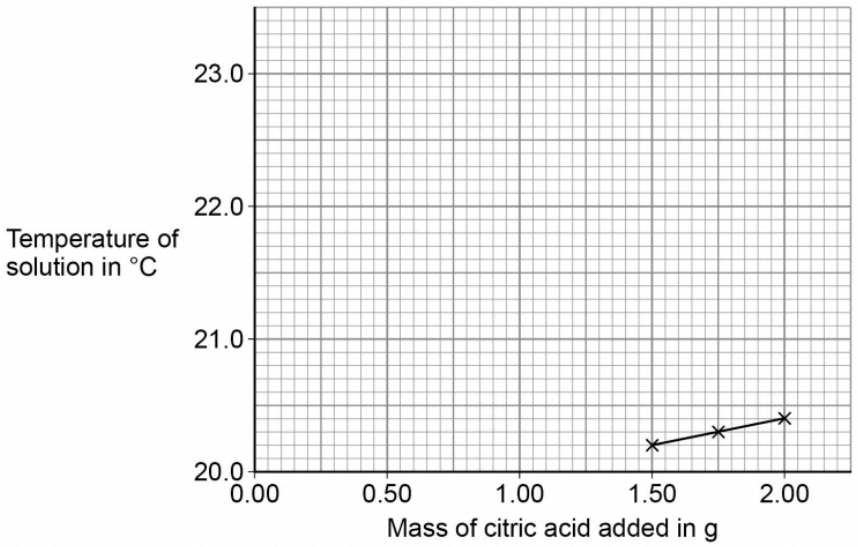
Complete **Figure 9**.

You should:

- plot the data from **Table 4** on **Figure 9**
- draw a line of best fit through the points you have plotted
- extend your line of best fit to meet the line of best fit already drawn on **Figure 9**.

[4 marks]

Figure 9



Q5.b) (2020)

Determine the overall temperature change for the reaction.

Use **Figure 9**.

[2 marks]

Overall temperature change = _____ °C

Q6.(2020)

What is the dependent variable in this investigation?

[1 mark]

Tick (✓) **one** box.

- Mass of citric acid ☐
- Temperature of solution ☐
- Volume of solution ☐

Q7. (2022)

Sodium carbonate reacts with hydrochloric acid in an exothermic reaction.

The equation for the reaction is:

$$Na_2CO_3(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

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

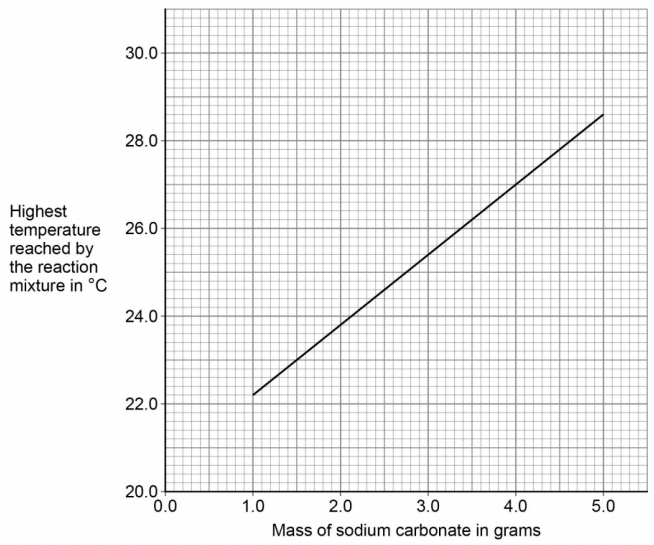
Plan a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached.

[6 marks]

Q8.a) (2022)

Figure 17 shows a line of best fit drawn through the student's results.

Figure 17



Determine the gradient of the line of best fit in **Figure 17**.

Use the equation:

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

Give the unit.

[5 marks]

Gradient = _____ Unit _____

Q8.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 17**.

[2 marks]

Initial temperature of the reaction mixture = _____ °C

Q8.c) (2022)

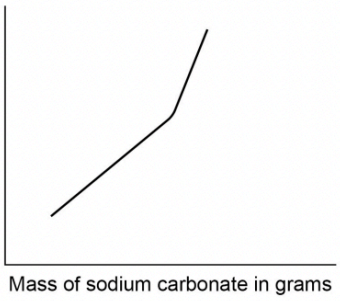
Another student repeated the investigation but added sodium carbonate until the sodium carbonate was in excess.

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

[1 mark]

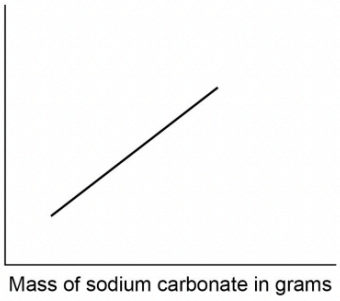
Tick (✓) **one** box.

A



☐

B



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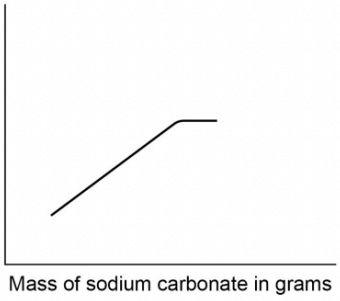
C



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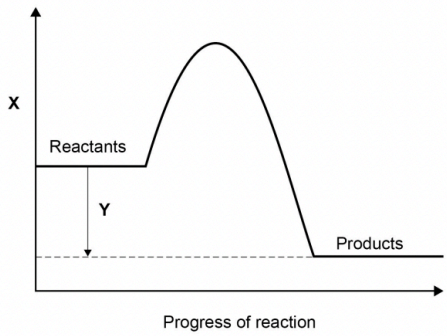
Q9.a)(2022)

Figure 18 shows a reaction profile for the reaction of sodium carbonate with hydrochloric acid.

Figure 18



What do labels **X** and **Y** represent on **Figure 18**?

[2 marks]

X _____

Y _____

Q9.b) (2022)

How does the reaction profile show that the reaction is exothermic?

Use **Figure 18**.

[1 mark]

_____

_____

Q10.a)(2023)

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 cm^3 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 _____

Table 6 shows the results.

Table 6

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

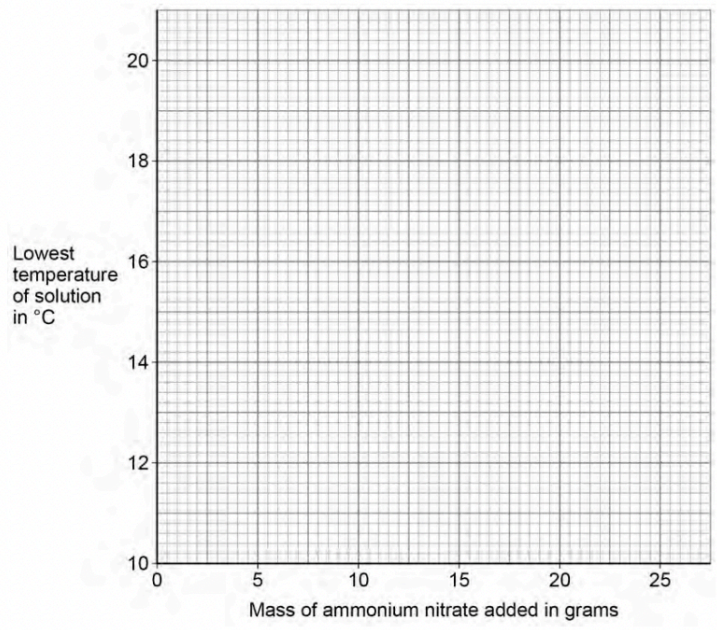
Q10.b)(2023)

Plot the data from **Table 6** on **Figure 11**.

Draw a line of best fit.

[3 marks]

Figure 11



Q10.c)(2023)

Determine the initial temperature of the water.

You should extend your line of best fit on **Figure 11**.

[2 marks]

Initial temperature of the water = _____ °C

Q10.d)(2023)

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

[1 mark]

Q10.e)(2023)

The student repeated the experiment three more times.

Table 7 shows the results for 8.0 g of ammonium nitrate.

Table 7

	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]

Q10.f)(2023)

What type of error is shown by the results in **Table 7**?

[1 mark]

Tick (✓) **one** box.

Random error ☐

Systematic error ☐

Zero error ☐

Q11.(2024)

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

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.
2. Weigh 0.20 g of zinc powder.
3. Add the zinc powder to the copper sulfate solution.
4. Measure the highest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of zinc powder.

Control variables are used to make an investigation a fair test.

Which is a control variable in the investigation?

[1 mark]

Tick (✓) **one** box.

- Highest temperature reached by the mixture ☐
- Mass of zinc powder ☐
- Volume of copper sulfate solution ☐

Q12.a)(2024)

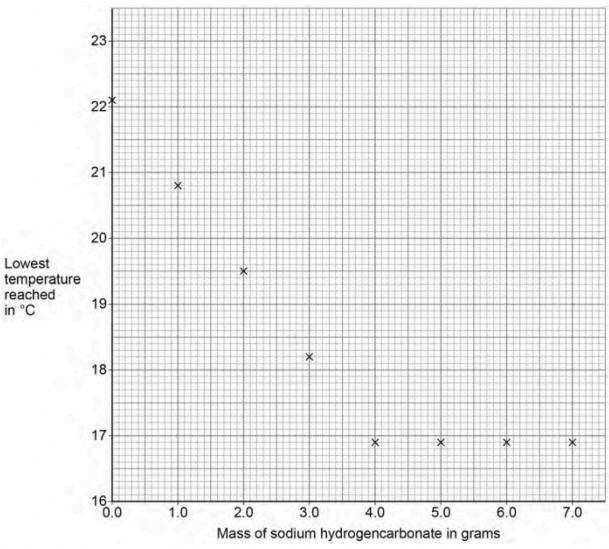
Another student investigated the energy change of the reaction between sodium hydrogencarbonate and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid.
2. Weigh 1.0 g of sodium hydrogencarbonate.
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.
4. Measure the lowest temperature reached by the mixture.
5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 7 shows the results.

Figure 7



Q12.b)(2024)

Which statement describes the energy change in the reaction shown in **Figure 7**?

[1 mark]

Tick (✓) **one** box.

- Energy is **transferred to** the surroundings so the reaction is **endothermic**. ☐
- Energy is **transferred to** the surroundings so the reaction is **exothermic**. ☐
- Energy is **taken in from** the surroundings so the reaction is **endothermic**. ☐
- Energy is **taken in from** the surroundings so the reaction is **exothermic**. ☐