All questions are for both separate science and combined science students

Q1.

This question is about energy changes of reactions.

Zinc reacts with copper sulfate solution.

The word equation for the reaction is:

zinc + copper sulfate → zinc sulfate + copper

(a) What type of reaction is the reaction between zinc and copper sulfate solution?

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Displacement ☐

(1)

(b) Calculate the percentage (%) by mass of copper in copper sulfate (CuSO4).

Give your answer to 3 significant figures.

Relative atomic mass (*Ar*): Cu = 63.5

Relative formula mass (*Mr*): $CuSO_4$ = 159.5

_____

_____

_____

_____

_____

Percentage by mass (3 significant figures) = _____ %

(3)

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.

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

Which is a control variable in the investigation?

Tick (✓) **one** box.

Highest temperature reached by the mixture ☐

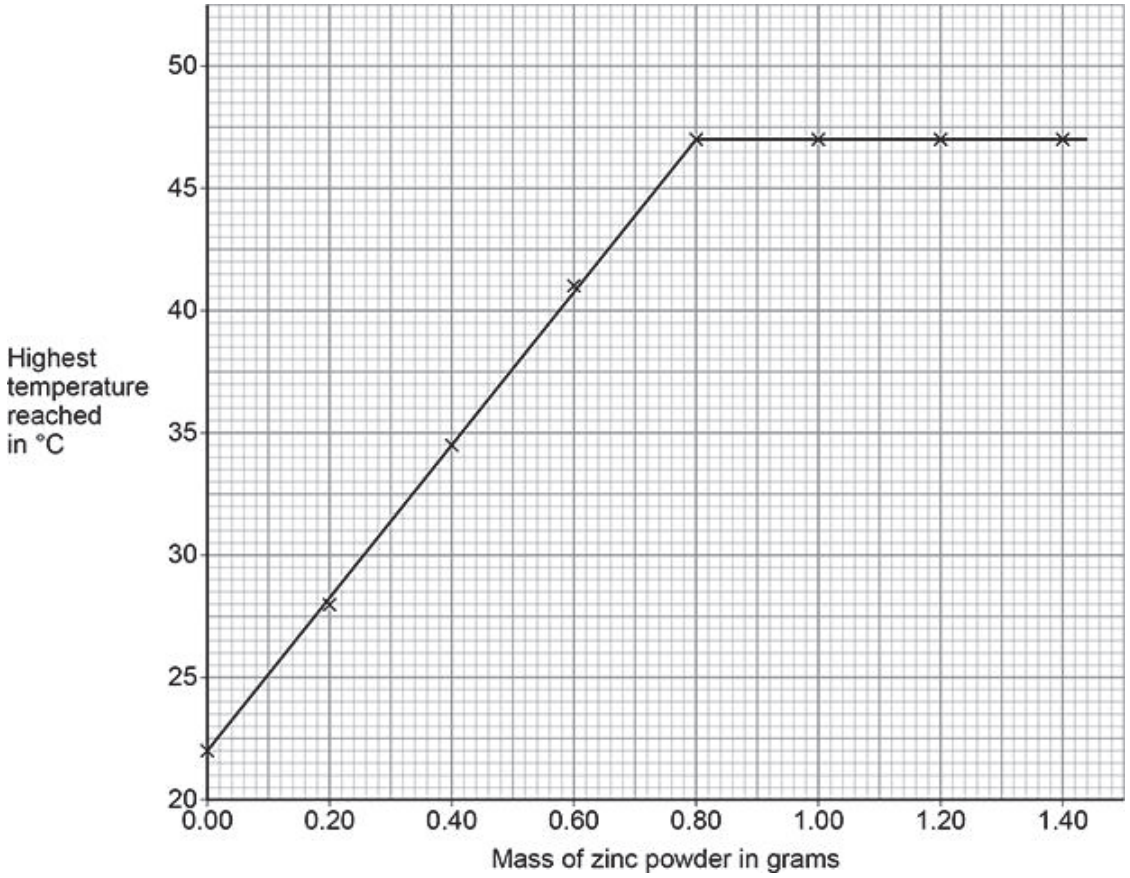
Mass of zinc powder ☐

Volume of copper sulfate solution ☐

(1)

Figure 1 shows the results.

Figure 1



(d) What is the minimum mass of zinc powder needed to react with all the copper sulfate solution?

Use **Figure 1**.

Minimum mass of zinc powder = _____ g

(1)

(e) What is the maximum temperature change in the reaction between zinc powder and 25 cm^3 of copper sulfate solution?

Use **Figure 1**.

_____

_____

_____

Maximum temperature change = _____ °C

(2)

(f) 25 cm^3 of copper sulfate solution contained 6.75 g of copper sulfate.

Calculate the concentration of the solution in g/dm^3.

You should:

- calculate the volume of the solution in dm^3 (1000 cm^3 = 1 dm^3)
- use the equation:

$$\text{concentration of solution in g/dm}^3 = \frac{\text{mass of copper sulfate in grams}}{\text{volume of solution in dm}^3}$$

_____

_____

Volume of solution = _____ dm^3

_____

_____

_____

Concentration of solution = _____ g/dm^3

(3)

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.

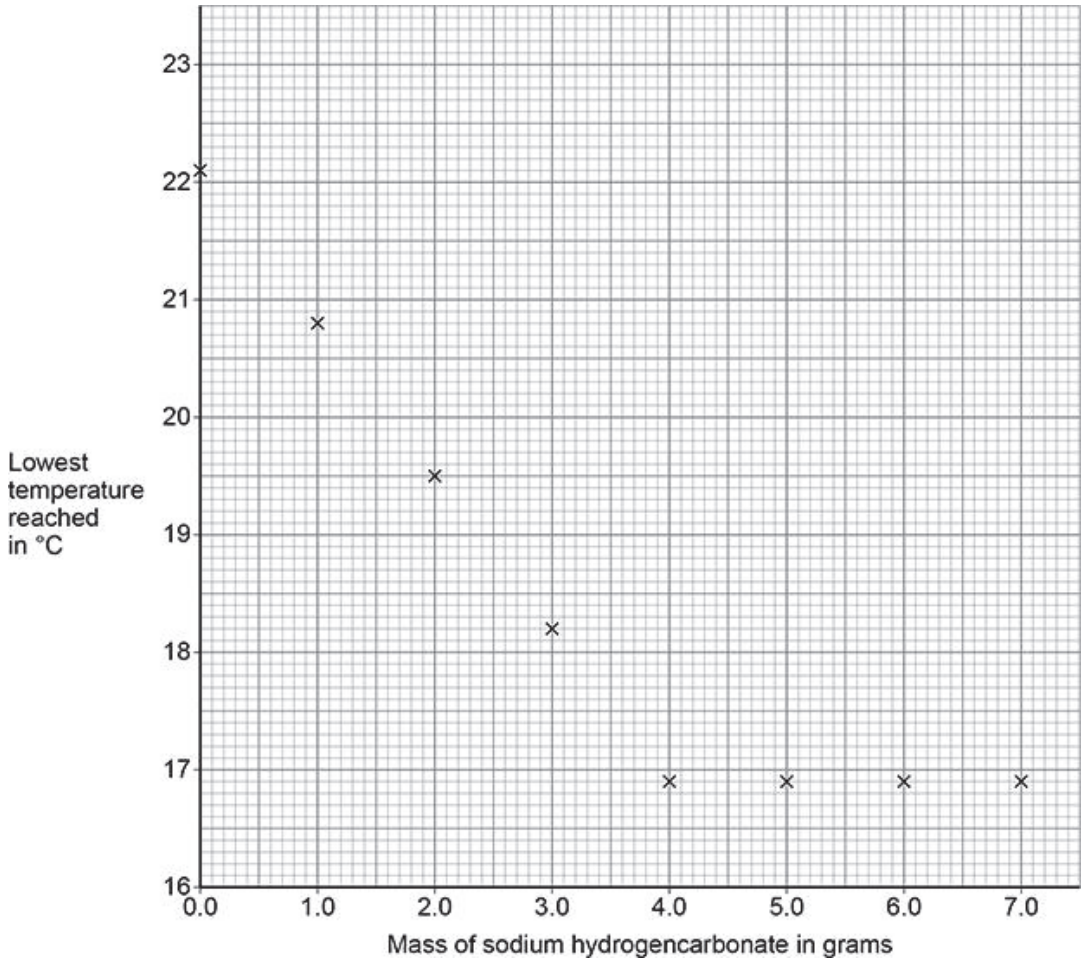
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.

4. Measure the lowest temperature reached by the mixture.

5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 2 shows the results.

Figure 2



(g) Draw **two** straight lines of best fit on **Figure 2**.

The lines should cross.

(2)

(h) Which statement describes the energy change in the reaction shown in **Figure 2**?

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**. ☐

(1)

(Total 14 marks)

Q2.

This question is about a reversible reaction.

A student heated calcium hydroxide to produce calcium oxide and water vapour.

This is the method used.

1. Add 2.00 g of calcium hydroxide into a test tube.

2. Heat the test tube and contents for 1 minute using a Bunsen burner.

3. Allow the test tube and contents to cool.

4. Weigh the test tube and contents.

5. Repeat steps 2 to 4 five more times.

(a) **Table 1** gives the appearance of the reactant and of the products.

Table 1

	Compound	**Appearance**
Reactant	calcium hydroxide	white powder
Products	calcium oxide	white powder
	water vapour	colourless gas

The student looked at the test tube and contents during heating.

The student could **not** tell that a chemical reaction was taking place by looking at the test tube and contents.

Give **two** reasons why.

Use the information in **Table 1**.

1 _____

_____

2 _____

_____

(2)

(b) Accurate results are **not** produced if solid powders escape from the test tube during heating.

Suggest why sealing the test tube with a stopper is **not** a good way of preventing the solid powders from escaping.

_____

_____

(1)

(c) The student wanted to calculate the mass of the contents of the test tube after each minute of heating.

The student weighed the test tube and contents after each minute of heating.

What **other** measurement is also needed to calculate the mass of the contents of the test tube?

Tick (✓) **one** box.

The change in mass of the contents of the test tube at the end	☐
The mass of the contents of the test tube at the start	☐
The mass of the empty test tube	☐

(1)

The student heated 2.00 g of calcium hydroxide to produce calcium oxide and water vapour.

Table 2 shows the results.

Table 2

Total heating time in minutes	Mass of contents of test tube in grams
0	2.00
1	1.76
2	1.64
3	1.56
4	1.52
5	1.51
6	1.51

(d) Complete the sentence.

Choose the answer from the box.

Use **Table 2**.

3 minutes	4 minutes	5 minutes	6 minutes

The minimum heating time needed for all of the calcium hydroxide to be changed into calcium oxide and water vapour is _____.

(1)

(e) Calculate the total mass of water vapour produced by heating the calcium hydroxide.

Use **Table 2**.

_____

_____

Mass = _____ g

(2)

The word equation for the reaction is:

calcium hydroxide ⇌ calcium oxide + water

The reaction is reversible.

When 4.00 g of calcium hydroxide is completely changed into calcium oxide and water:
- 3.03 g of calcium oxide is produced
- 5.90 kJ of energy is taken in from the surroundings.

(f) 3.03 g of calcium oxide reacts completely with water to produce 4.00 g of calcium hydroxide.

How much energy is transferred to the surroundings in this reaction?

Tick (✓) **one** box.

Less than 5.90 kJ ☐

5.90 kJ ☐

More than 5.90 kJ ☐

(1)

(g) The forward reaction takes in energy from the surroundings.

Complete the sentence.

Choose the answer from the box.

combustion	**endothermic**	**exothermic**

The forward reaction is _____.

(1)

(Total 9 marks)

Q3.

A student investigated the change in mass when hydrated cobalt chloride was heated.

The word equation for the reaction is:

hydrated cobalt chloride ⇌ anhydrous cobalt chloride + water

This is the method used.

1. Add 2.0 g of hydrated cobalt chloride to an empty test tube.

2. Measure the mass of the test tube and contents.

3. Heat the test tube and contents gently for 30 seconds.

4. Allow the test tube and contents to cool.

5. Measure the mass of the test tube and contents.

6. Repeat steps 3 to 5 until the mass of the test tube and contents does not change.

The table below shows the results.

Total heating time in seconds	Mass of test tube and contents in grams
0	26.5
30	26.2
60	25.9
90	25.6
120	25.6

(a) Determine the mass of the empty test tube.

_____

_____

Mass of empty test tube = _____g

(1)

(b) Explain why the mass of the test tube and contents decreased.

_____

_____

_____

_____

(2)

(c) Suggest why the test tube and contents were heated until the mass did not change.

_____

_____

(1)

Energy is taken in from the surroundings when hydrated cobalt chloride is heated.

(d) When 238 g of hydrated cobalt chloride is heated until the mass does not change, 88.1 kJ of energy is taken in.

The student heated 2.00 g of hydrated cobalt chloride until the mass did not change.

Calculate the energy taken in during this reaction.

Give your answer to 3 significant figures.

_____

_____

_____

_____

_____

Energy taken in (3 significant figures) = _____kJ

(3)

(e) What type of reaction takes place when hydrated cobalt chloride is heated?

_____

_____

(1)

(Total 8 marks)