

GCSE Combined Science: Trilogy

Worksheet: Energy transfer during exothermic and endothermic reactions

TIME 30 min	TOTAL 30 marks	CALCULATOR Allowed	DIFFICULTY Easy, Medium
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Topics: Energy transfer during exothermic and endothermic reactions

NAME	CLASS	DATE
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- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Answer all questions in the spaces provided.
- In all calculations, show clearly how you work out your answer.
- The marks for questions are shown in brackets.

0 1

Some products use chemical reactions to heat things up or to cool things down.

0 1 . 1

Which product uses an endothermic reaction?

Tick (✓) **one** box.

A hand warmer

☐

A self-heating can of soup

☐

A cold pack for a sports injury

☐

A camping stove

☐

[1 mark]

0 1 . 2

A self-heating can has a sealed compartment containing two chemicals. When the chemicals are mixed they react exothermically. The compartment is surrounded by the soup.

Explain how the reaction heats the soup.

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.....

.....

.....

[2 marks]

0 1 . 3

The chemicals in a cold pack are kept in two separate compartments until the pack is needed.
Suggest why.

.....

.....

[1 mark]

0 1 . 4

Energy is conserved in chemical reactions.
What does this mean?

.....

.....

[1 mark]

0 2

A student dissolved some anhydrous calcium chloride in water in a polystyrene cup. The student measured the temperature before and during the process.

0 2 . 1

Starting temperature = 19 °C
Highest temperature reached = 31 °C
Calculate the temperature change.

.....

.....

.....

Temperature change = °C

[1 mark]

0 2 . 2

Is this process exothermic or endothermic?
Give a reason for your answer.

.....

.....

.....

.....

[2 marks]

0 3

A student added 25 cm³ of sodium hydroxide solution to 25 cm³ of dilute hydrochloric acid in a polystyrene cup. The student measured the temperature before and during the reaction.

0 3 . 1

Starting temperature = 18 °C

Highest temperature reached = 22 °C

Calculate the temperature change.

.....

.....

.....

Temperature change = °C

[1 mark]

0 3 . 2

Is this reaction exothermic or endothermic?

Give a reason for your answer.

.....

.....

.....

.....

[2 marks]

0 4

A student investigates how the mass of sodium hydrogencarbonate added to citric acid solution affects the temperature change. The student:

1. measures 50 cm³ of citric acid solution into a polystyrene cup and records its temperature
2. adds a weighed mass of sodium hydrogencarbonate powder and stirs
3. records the lowest temperature reached.

The student repeats this with different masses of sodium hydrogencarbonate.

0 4 . 1

The temperature of the mixture decreased.

Is the reaction exothermic or endothermic? Give a reason for your answer.

.....

.....

.....

.....

[2 marks]

0 4 . 2

What is the independent variable in this investigation?

Tick (✓) **one** box.

The volume of citric acid solution

☐

The mass of sodium hydrogencarbonate

☐

The lowest temperature reached

☐

The starting temperature of the solution

☐

[1 mark]

0 4 . 3

What is the dependent variable in this investigation?

.....

.....

[1 mark]

0 4 . 4

Give **two** variables the student should control.

.....

.....

.....

.....

[2 marks]

0 5

A student investigated the temperature change when different metal powders were added to copper sulfate solution.

This is the method used.

1. Measure 25 cm³ of copper sulfate solution into a polystyrene cup.
2. Record the temperature of the solution.
3. Add 1.0 g of metal powder and stir.
4. Record the highest temperature reached.
5. Repeat steps 1 to 4 with each of the other metals.

Table 1 shows the results.

Table 1

Metal	Temperature at start in °C	Highest temperature in °C	Temperature change in °C
Copper	20.0	20.0	0.0
Iron	19.5	30.0	10.5
Magnesium	19.5	57.0	X
Zinc	20.0	36.5	16.5

0 5 . 1

Calculate the value of **X** in Table 1.

.....

.....

.....

X = °C

[1 mark]

0 5 . 2

Describe the relationship between the reactivity of the metal and the temperature change.

.....

.....

[1 mark]

0 5 . 3

Explain why there was no temperature change when copper powder was added.

.....

.....

[1 mark]

0 5 . 4

Why did the student use a polystyrene cup rather than a glass beaker?

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.....

[1 mark]

0 5 . 5

Give **two** variables the student should have kept the same.

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.....

[2 marks]

.....

0 6

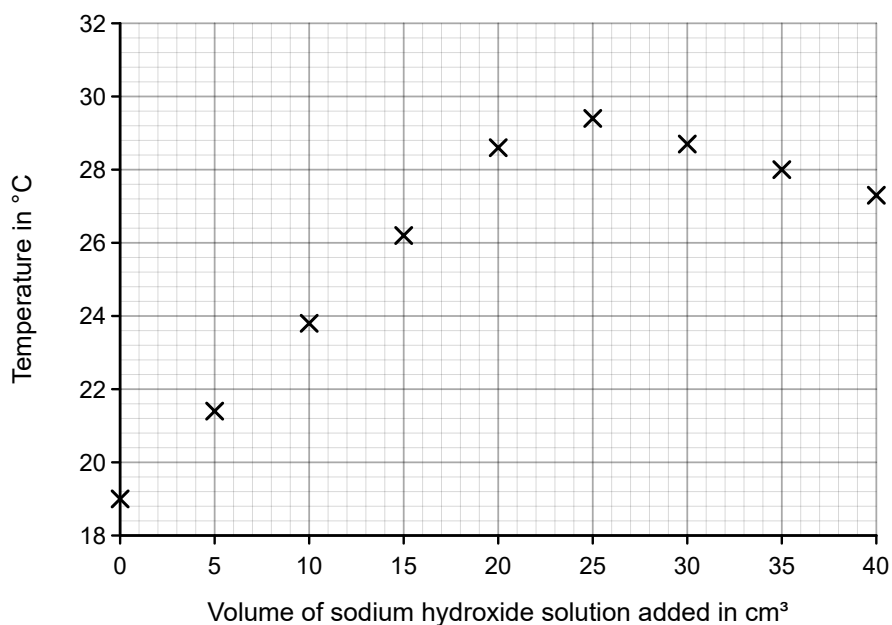
A student investigated the temperature change when sodium hydroxide solution reacts with hydrochloric acid.

This is the method used.

1. Put 25 cm^3 of hydrochloric acid into a polystyrene cup.
2. Record the temperature of the acid.
3. Add 5 cm^3 of sodium hydroxide solution and stir.
4. Record the highest temperature.
5. Repeat steps 3 and 4 until 40 cm^3 of sodium hydroxide solution has been added.

Figure 1 shows the results.

Figure 1



0 6 . 1

Draw **two** straight lines of best fit on Figure 1:

- one through the points from 0 cm^3 to 20 cm^3
- one through the points from 25 cm^3 to 40 cm^3 .

Extend both lines until they cross.

[2 marks]

0 6 . 2

Use your lines to determine the volume of sodium hydroxide solution needed to neutralise the hydrochloric acid.

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.....

Volume = cm³

[1 mark]

0 6 . 3

Explain the shape of the graph.

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.....

[3 marks]

0 6 . 4

The highest temperature the student recorded was 29.4 °C. The two lines of best fit cross at a higher temperature. Suggest **one** reason why.

.....

.....

[1 mark]

END OF QUESTIONS

Original practice questions written to match the specification. Not produced by, affiliated with or endorsed by AQA.

Mark scheme

GCSE Combined Science: Trilogy · Worksheet: Energy transfer during exothermic and endothermic reactions · 30 marks

Question 1 (5 marks)

01.1 [1 mark]

Correct: A cold pack for a sports injury

01.2 [2 marks]

Answer: Energy is transferred from the reacting chemicals to the soup, so the temperature of the soup increases.

- energy is transferred from the reaction (mixture) to the soup / to the surroundings (1)
 - so the temperature of the soup increases (1)
-

01.3 [1 mark]

Answer: So that the reaction only starts when the pack is needed.

- the reaction only starts when the chemicals are mixed / so the pack does not get cold before it is needed (1)
-

01.4 [1 mark]

Answer: The total amount of energy is the same before and after the reaction.

- the total amount of energy is the same before and after the reaction / energy cannot be created or destroyed (1)
-

Notes: Allow 'the energy transferred to the surroundings equals the energy lost by the reacting chemicals'.

Question 2 (3 marks)

02.1 [1 mark]

Answer: 12 °C

- 12 (°C) (1)
-

02.2 [2 marks]

Answer: Exothermic: the temperature increased, because energy was transferred to the surroundings.

- exothermic (1)
 - the temperature increased / energy was transferred to the surroundings (1)
-

Question 3 (3 marks)

03.1 [1 mark]

Answer: 4 °C

- 4 (°C) (1)

03.2 [2 marks]

Answer: Exothermic: the temperature increased, because energy was transferred to the surroundings.

- exothermic (1)
- the temperature increased / energy was transferred to the surroundings (1)

Question 4 (6 marks)

04.1 [2 marks]

Answer: Endothermic, because energy is taken in from the surroundings (the temperature decreases).

- endothermic (1)
- (energy is taken in from the surroundings, so) the temperature of the mixture decreases (1)

Notes: The reason mark depends on 'endothermic'.

04.2 [1 mark]

Correct: The mass of sodium hydrogencarbonate

04.3 [1 mark]

Answer: The temperature change (starting temperature – lowest temperature).

- the temperature change / decrease (starting temperature – lowest temperature) (1)

Notes: Allow 'the lowest temperature reached'.

04.4 [2 marks]

Answer: The volume of citric acid solution; the concentration of the citric acid solution.

- volume of citric acid solution (1)
- concentration of citric acid solution (1)
- starting temperature of the citric acid solution (1)
- type of cup / whether a lid is used (1)
- amount of stirring (1)

Any 2 of the points above.

Question 5 (6 marks)

05.1 [1 mark]

Answer: 37.5 °C

- 37.5 (°C) (1)

05.2 [1 mark]

Answer: The more reactive the metal, the greater the temperature change.

- the more reactive the metal, the greater the temperature change (1)

Notes: Allow the converse. Do not accept 'magnesium had the biggest temperature change' on its own.

05.3 [1 mark]

Answer: No reaction happened because copper cannot displace copper.

- no reaction took place (because copper is not more reactive than the copper in copper sulfate) (1)

05.4 [1 mark]

Answer: Polystyrene is a good thermal insulator, so less energy is transferred to the surroundings.

- polystyrene is a (good thermal) insulator / reduces energy transfer to the surroundings (1)

Notes: Ignore 'keeps the heat in' unless energy transfer or insulation is mentioned.

05.5 [2 marks]

Answer: Any two from: volume of solution, concentration of solution, mass of metal, particle size of metal, starting temperature.

- volume of copper sulfate solution (1)
- concentration of copper sulfate solution (1)
- mass of metal (powder) (1)
- particle size of the metal / all metals used as powders (1)
- starting temperature of the solution (1)

Any 2 of the points above.

Notes: Do not accept 'amount of metal' unless mass is stated.

Question 6 (7 marks)

06.1 [2 marks]

Answer: Two straight lines that cross at about 22.4 cm^3 and $29.8 \text{ }^\circ\text{C}$.

- straight line through (or close to) the points from 0 to 20 cm^3 (1)
- straight line through (or close to) the points from 25 to 40 cm^3 , with the two lines extended so that they cross (1)

06.2 [1 mark]

Answer: 22.4 cm^3 (allow 22.0 to 23.0)

- 22.0 to 23.0 (cm^3) (1)

Notes: Allow a value read correctly from the student's own lines.

06.3 [3 marks]

Answer: Neutralisation is exothermic so the temperature rises; it is highest when all the acid has reacted; after that no more energy is released and the added solution and losses to the surroundings cool the mixture.

- the temperature increases because neutralisation is exothermic / releases energy (1)
- the temperature is highest when all the acid has reacted / neutralisation is complete (1)
- after that no more energy is released, so adding more (cooler) sodium hydroxide solution / energy transfer to the surroundings lowers the temperature (1)

06.4 [1 mark]

Answer: No reading was taken at the exact volume at which neutralisation was complete.

- no reading was taken at the exact volume where neutralisation was complete / some energy was transferred to the surroundings before the reading was taken (1)
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