

Why some changes heat up and others cool

Grade 8 science (Year 9 · Class 8) · Worksheet answers

Each answer shows the method first and the final result in bold. Check the sign of ΔT and the units, which are joules for Q unless a question asks for kilojoules.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS1-6

Problem 1 Key words

1. An exothermic reaction **releases energy to the surroundings**.
2. An endothermic reaction **absorbs energy from the surroundings**.
3. The temperature of the surroundings **rises in an exothermic reaction and falls in an endothermic reaction**.

Problem 2 Sort the changes

1. Exothermic: **burning charcoal and a hand warmer**. Endothermic: **the cold pack, photosynthesis and melting ice**.

Problem 3 Calculate the change

1. A: $26.5 - 20.0 = +6.5\text{ }^{\circ}\text{C}$. B: $17.5 - 22.0 = -4.5\text{ }^{\circ}\text{C}$.
2. A is **exothermic** (temperature rose). B is **endothermic** (temperature fell).

Problem 4 Hot or cold sachet?

1. Sachet **X** is exothermic.
2. Energy moves **from his hand into the sachet**, so his skin cools.

Problem 5 Where is the energy?

1. The total energy is **conserved**: it is neither created nor destroyed.
2. From the **chemicals** to the **surroundings**.

Problem 6 Energy diagrams

1. Diagram **Q**: the second level is lower, so energy is released.
2. The arrow shows the **energy released to the surroundings**.

Problem 7 Energy in the water

1. $Q = m \times c \times \Delta T = 100 \times 4.2 \times 8.0 = \mathbf{3360\text{ J}}$.

2. $3360 \text{ J} \div 1000 = \mathbf{3.36 \text{ kJ}}$.

Problem 8 A cooling solution

1. $Q = 200 \times 4.2 \times 5.0 = \mathbf{4200 \text{ J}}$.
2. It is **absorbed by the dissolving solid** (4.2 kJ).

Problem 9 Finding the temperature change

1. $\Delta T = Q \div (m \times c)$.
2. $\Delta T = 2520 \div (150 \times 4.2) = 2520 \div 630 = \mathbf{4.0 \text{ }^{\circ}\text{C}}$.

Problem 10 Hand warmer graph

1. The peak is **54 °C at 20 min**.
2. $54 - 20 = \mathbf{34 \text{ }^{\circ}\text{C}}$.
3. About **41 °C**.
4. The iron is being used up, so less energy is released, while the pack loses heat to the cooler air.

Problem 11 Inside a hand warmer

1. **Iron + oxygen → iron oxide**.
2. The reaction needs oxygen from the air, and the sealed bag keeps it out.
3. When all the iron has reacted, no more energy is released and the pack cools to room temperature.

Problem 12 Changes of state

1. Melting and evaporating are **endothermic**. Freezing and condensing are **exothermic**.
2. Sweat evaporates, which is endothermic, so it takes energy from the skin and **cools the body**.

Problem 13 Spot the errors

1. (a) Energy is **conserved**, so it is transferred from stored energy to heat. (b) The temperature **falls**. (c) **Heat flows from the injury into the pack**.

Problem 14 Three processes

1. Respiration: **exothermic**. Photosynthesis: **endothermic**. Combustion: **exothermic**.
2. Respiration releases energy as heat in the body's cells, which keeps us warm.

Problem 15 Neutralising acid

1. $\Delta T = 27.0 - 21.0 = +6.0\text{ }^{\circ}\text{C}$.
2. It is **exothermic**.
3. $Q = 50 \times 4.2 \times 6.0 = 1260\text{ J}$.

Problem 16 Energy per gram

1. $Q = 60 \times 4.2 \times 11.0 = 2772\text{ J}$.
2. $2772 \div 5.0 = 554\text{ J/g}$ (to 3 s.f.).
3. The temperature rises, so it is **exothermic**.

Problem 17 Best solid for each pack

1. A: $50 \times 4.2 \times 12.0 = 2520\text{ J}$. B: $50 \times 4.2 \times 7.5 = 1575\text{ J}$. C: $50 \times 4.2 \times 9.0 = 1890\text{ J}$.
2. A: $2520 \div 4.0 = 630\text{ J/g}$. B: $1575 \div 5.0 = 315\text{ J/g}$. C: $1890 \div 6.0 = 315\text{ J/g}$.
3. For a hand warmer choose **A**, which releases the most energy per gram. The only endothermic solid is **C**, so it is the cold-pack choice.

Problem 18 Comparing hand warmer brands

1. Independent: **brand**. Dependent: **temperature**. Controls: starting room temperature, same position of the thermometer, same insulation, same time of opening.
2. Open each pack, place a thermometer or probe against it in a closed box and read every 5 minutes for two hours.
3. Best means the highest peak and the longest time above a useful temperature such as $40\text{ }^{\circ}\text{C}$, judged from the graphs.

Problem 19 Reaction energy diagram

1. The reactants are at the higher level and the products at the lower level, so it is **exothermic**.
2. $120 - 85 = 35\text{ kJ}$ released.
3. The reverse reaction is endothermic and absorbs **35 kJ**.

Problem 20 Instant pack or ice?

1. $25 - 12 = 13\text{ minutes}$.
2. $25 \div 12 = 2.1\text{ times}$.
3. Ice lasts longer and is cheaper, but needs a freezer. The instant pack works anywhere, so it is better on the touchline if there is no ice, and ice is better when available.