Your notes

GCSE Physics: revision notes

Specific heat capacity

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Start here: why some things heat up faster

- Heat the same mass of water and of oil with the same heater, and the oil gets hot faster. Different materials need different amounts of energy to warm up.
- **Specific heat capacity** is the energy needed to raise the temperature of 1 kg of a material by 1 °C. Water's is high: 4200 J/kg °C.
- The equation: change in **thermal energy** = mass × **specific heat capacity** × **temperature change**, or $\Delta E = m\ c\ \Delta\theta$.

Specific heat capacity

- The **specific heat capacity** of a substance is the amount of energy needed to raise the temperature of 1 kg of the substance by 1 °C.
- $\Delta E = m\ c\ \Delta\theta$, where ΔE is the change in **thermal energy** (J), m the mass (kg), c the **specific heat capacity** (J/kg °C) and $\Delta\theta$ the **temperature change** (°C).
- Water has a high **specific heat capacity** (4200 J/kg °C), so it takes a lot of energy to heat and cools slowly. This makes it good for central heating systems.

Rearranging the equation

- To find c: $c = \Delta E \div (m\ \Delta\theta)$.
- To find the **temperature change**: $\Delta\theta = \Delta E \div (m\ c)$.
- The **temperature change** is the final temperature minus the starting temperature.

Required practical: finding specific heat capacity

- Measure the mass of a metal block (such as 1 kg of aluminium) and wrap it in insulation to reduce energy loss.
- Put an electric heater and a thermometer into the holes in the block. Record the starting temperature.
- Switch on the heater and measure the energy transferred with a **joulemeter** (or calculate it from E = V I t) and the temperature every minute.
- Plot temperature against energy transferred. The gradient = 1 ÷ (m c), so c = 1 ÷ (gradient × m).
- The measured value is usually too high, because some energy heats the surroundings instead of the block.

Thermal insulation

- The higher the **thermal conductivity** of a material, the faster energy is transferred through it by conduction.
- The rate of cooling of a building depends on the thickness of its walls and their **thermal conductivity**: thicker walls with lower **thermal conductivity** cool more slowly.
- Loft insulation, cavity wall insulation, double glazing and draught excluders all reduce energy loss from homes.

Exam tip

- In $\Delta E = m\ c\ \Delta\theta$, $\Delta\theta$ means the change in temperature. Work it out first.
- For the practical, mention insulation to reduce energy lost to the surroundings.

Common mistakes

- Using the final temperature, not the change.
- Mixing it up with latent heat, where the temperature doesn't change.
- Leaving mass in grams.

Worked examples

How much energy heats 2 kg of water from 20 °C to 70 °C? (Specific heat capacity of water = 4200 J/kg °C)

Find the temperature change. $\Delta\theta = 70 - 20 = 50$ °C

Use the equation. $\Delta E = m \times c \times \Delta\theta$

Put the numbers in. $2 \times 4200 \times 50$

Answer: 420 000 J

Your notes

A 0.5 kg metal block is given 9000 J of energy and warms by 20 °C. Find its specific heat capacity.

Rearrange ΔE = m c Δθ to make c the subject. **c = ΔE ÷ (m × Δθ)**

Put the numbers in. **9000 ÷ (0.5 × 20) = 9000 ÷ 10**

Answer: 900 J/kg °C

Your notes

Key terms

Specific heat capacity	The energy needed to raise the temperature of 1 kg of a substance by 1 °C.
Thermal energy	Energy in the thermal store of an object, linked to its temperature.
Temperature change	The final temperature minus the starting temperature.
Joulemeter	A meter that measures the energy transferred by an electric circuit.
Thermal conductivity	How well a material conducts thermal energy.
Insulator	A material with low thermal conductivity that reduces energy transfer.

Quick questions

Cover the answers and test yourself: remembering is what makes it stick.

1. What is specific heat capacity?
2. How much energy is needed to heat 2 kg of water by 10 °C? (c = 4200 J/kg °C)
3. How much energy is needed to heat 0.5 kg of aluminium from 20 °C to 40 °C? (c = 900 J/kg °C)
4. 36 000 J raises the temperature of a 2 kg block by 20 °C. What is its specific heat capacity?
5. Why is water used in central heating systems?
6. Why is the metal block wrapped in insulation in the practical?
7. Why is the measured specific heat capacity usually too high?
8. 21 000 J is transferred to 0.5 kg of water. By how much does its temperature rise? (c = 4200 J/kg °C)

Answers

1. The energy needed to raise the temperature of 1 kg of a substance by 1 °C
2. 84 000 J
3. 9000 J
4. 900 J/kg °C
5. It has a high specific heat capacity, so it stores a lot of energy
6. To reduce energy lost to the surroundings
7. Some energy heats the surroundings, not the block
8. 10 °C

What to do next

Practise 10 questions on this topic

Try 6 exam questions, with mark schemes

Read the lesson, one step at a time

Free revision for GCSE and KS3 at lycolearn.co.uk. Some notes are for one exam board only, and say so in brackets.

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