

Heating, melting and boiling: energy calculations

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These twenty problems train you to choose between $\Delta E = m c \Delta\theta$ and $E = m L$, convert units, and read heating curves. They start with recall and one-step calculations and finish with multi-stage energy budgets.

They suit GCSE, IGCSE, O Level and Class 9-10 students. Use $c(\text{water}) = 4200 \text{ J/(kg } ^\circ\text{C)}$, $L_f = 3.34 \times 10^5 \text{ J/kg}$ and $L_v = 2.26 \times 10^6 \text{ J/kg}$ unless told otherwise.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE P3, IGCSE 2.2

Problem 1 Meaning of c (easy)

1. State what *specific heat capacity* means.
2. Give its unit and say what the symbol $\Delta\theta$ stands for.

Problem 2 Warming a pan of water (easy)

Wanjiru in Nairobi heats 250 g of water by 12°C ($c = 4200 \text{ J/(kg } ^\circ\text{C)}$).

1. Convert the mass to kilograms.
2. Calculate the energy needed in joules and in kilojoules.

Problem 3 An aluminium pan (easy)

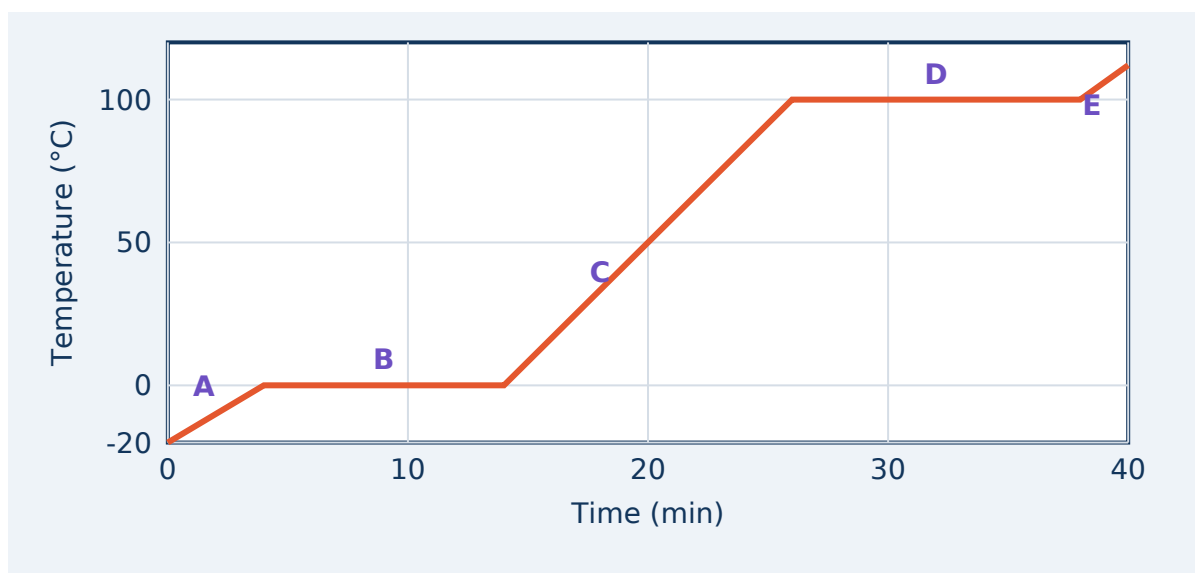
An aluminium pan of mass 2.0 kg has $c = 900 \text{ J/(kg } ^\circ\text{C)}$. Calculate the energy needed to raise its temperature by 30°C .

Problem 4 Melting ice (easy)

Use $L_f = 3.34 \times 10^5 \text{ J/kg}$. Calculate the energy needed to melt 0.60 kg of ice already at 0°C .

Problem 5 Reading a heating curve (easy)

The graph shows water heated steadily from -20°C .



Temperature of a sample of water heated steadily.

1. State what is happening in sections B and D.
2. Explain why D is much longer than B.
3. In which sections is the water entirely liquid?

Problem 6 A cooling copper block (medium)

A copper block of mass 0.80 kg ($c = 390 \text{ J/(kg } ^\circ\text{C)}$) cools from 95°C to 25°C . Calculate the energy it releases.

Problem 7 Finding the rise (medium)

A solar water heater delivers 63 000 J to 3.0 kg of water. Calculate the temperature rise.

Problem 8 Finding the mass (medium)

Kofi in Accra supplies 8400 J and the water warms by 4.0°C . Calculate the mass of water.

Problem 9 Boiling dry (medium)

A pot holds 0.25 kg of water at 100°C . Use $L_v = 2.26 \times 10^6 \text{ J/kg}$ to find the energy needed to turn all of it into steam.

Problem 10 Heater and time (medium)

A 500 W immersion heater warms 0.40 kg of water from 20°C to 50°C . Ignore energy losses.

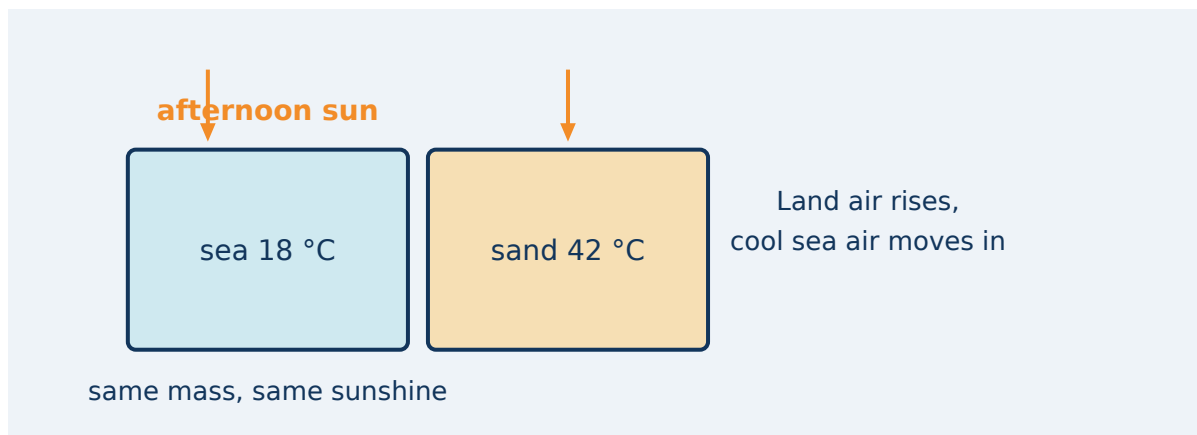
1. Calculate the energy transferred to the water.
2. Calculate the time taken.

Problem 11 Unknown metal (medium)

A 0.50 kg metal block warms from 18 °C to 50 °C when 14 400 J are supplied. Calculate its specific heat capacity and say which metal in the lesson table it is.

Problem 12 Why the sand is hotter (medium)

On a beach in Durban the afternoon sand reaches 42 °C while the sea is 18 °C.



Same sunshine, very different temperatures.

Explain this using specific heat capacity, and say what it does to the breeze.

Problem 13 Iron or copper? (medium)

Each of two 1.0 kg blocks, iron (450 J/(kg °C)) and copper (390 J/(kg °C)), receives 9000 J.

1. Calculate each temperature rise.
2. State which block ends up hotter.

Problem 14 Kettle efficiency (medium)

A 2.4 kW kettle takes 170 s to heat 1.0 kg of water from 15 °C to 100 °C.

1. Calculate the electrical energy supplied.
2. Calculate the energy gained by the water.
3. Calculate the efficiency of the kettle.

Problem 15 Spot the error (medium)

A student heats 400 g of water from 15 °C to 40 °C and writes: $Q = 0.4 \times 4200 \times 40 = 67\,200\text{ J}$. Identify the mistake and give the correct energy.

Problem 16 Ice to steam (hard)

Calculate the total energy needed to turn 0.20 kg of ice at -10 °C into steam at 100 °C . Use $c(\text{ice}) = 2100$, $c(\text{water}) = 4200\text{ J/(kg °C)}$, $L_f = 3.34 \times 10^5\text{ J/kg}$ and $L_v = 2.26 \times 10^6\text{ J/kg}$.

Problem 17 Mixing hot and cool water (hard)

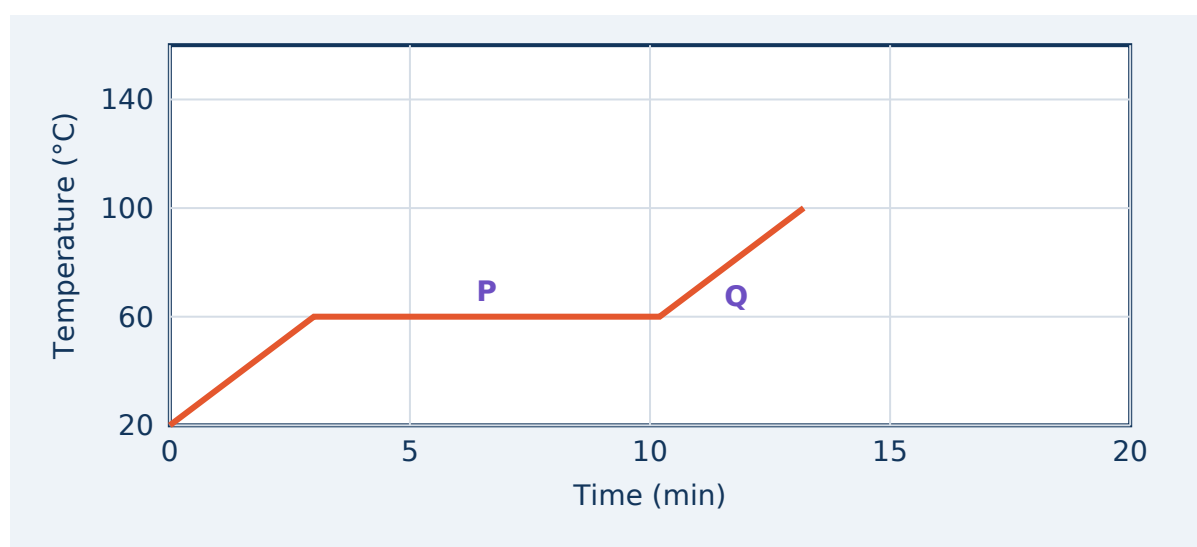
Bilal in Lahore pours 0.30 kg of water at 80 °C into 0.50 kg of water at 20 °C. Assume no energy is lost. Calculate the final temperature.

Problem 18 Ice in a drink (hard)

Emma in Leeds drops 30 g of ice at 0 °C into 0.25 kg of juice (treat as water) at 24 °C. Assuming no losses, calculate the final temperature.

Problem 19 Wax from a heater trace (hard)

A 250 W heater warms 0.60 kg of wax. The graph shows the temperature against time. Assume all the energy goes into the wax.



Heating a 0.60 kg sample of wax.

- Find the energy transferred during section P and calculate the specific latent heat of fusion of the wax.
- Calculate the specific heat capacity of the liquid wax from section Q.

Problem 20 A steam burn (hard)

A drop of 10 g of steam at 100 °C lands on skin and ends as water at 40 °C. A drop of 10 g of boiling water ends at 40 °C too.

- Calculate the energy each drop gives to the skin.
- Calculate how many times greater the steam value is and explain why steam burns are worse.