Unit 11 · Quantity of Heat

HARDER PRACTICE QUESTIONS

Full marks 28

Write your answers on separate paper. Show your working. Specific heat capacity of water 4200 J/(kg K); latent heat of fusion of ice 3.36×10^5 J/kg; latent heat of vaporization of water 2.26×10^6 J/kg.

1 Spot the error [3]

Find the mistake and correct it.

Sabin mixes 0.10 kg of ice at 0 °C with 0.40 kg of water at 50 °C. He writes:
"Heat lost = heat gained: $0.40 \times 4200 \times (50 - \theta) = 0.10 \times 4200 \times \theta$, so $\theta =$ **40** °C."

2 Predict, then explain [3]

Write your prediction first, then explain it.

1 kg of ice at 0 °C is mixed with 1 kg of water at 80 °C in an insulated vessel.

i. Predict the final temperature: 40 °C, above 0 °C, or 0 °C?
ii. Show that your prediction is right.

3 Read the data [5]

Answer from the table.

Ishwor records a cup of tea cooling in a room at 20 °C:

Time (min)	0	5	10	15
Temperature (°C)	80.0	60.0	46.7	37.8

i. Find the excess temperature over the room at each time.
ii. Show that the excess falls by the same fraction in every 5 minutes.
iii. Predict the temperature at 20 minutes.
iv. Ishwor says: "It cooled by 20 °C in the first 5 minutes, so it will be at room temperature after 15 minutes." Correct him.

4 Show that [3]

Equal masses of two liquids, of specific heat capacities s_1 and s_2, at temperatures θ_1 and θ_2, are mixed. Show that the final temperature is $\theta = \dfrac{s_1\theta_1 + s_2\theta_2}{s_1 + s_2}$. What is θ when the two liquids are the same?

5 Read the phase diagram [3]

Freeze-dried food is made by freezing it and then lowering the air pressure round it below 0.006 atm. Using the phase diagram of water, explain what happens to the ice in the food, and why the food dries without its ice melting.

6 Estimate it [3]

The numbers are rounded.

A runner loses about 1 kg of sweat in an hour, and suppose all of it evaporates from the skin. Using the latent heat of vaporization, estimate the rate at which the evaporation takes heat from the body, in watts.

7 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Rohini wrote: “If you turn the gas up under a pot of boiling water, the water gets hotter than 100 °C. Water only evaporates when it reaches 100 °C. A big pot and a small cup of water have different specific heat capacities.”

8 Think [3]

Pressing two ice cubes together for a moment joins them into one. Kamal tries it with two cubes straight from a freezer at −20 °C, pressing as hard as he can with his hands, and they don’t melt where they touch. Explain both results.

9 Make your own [2]

Mix hot water at 70 °C with cold water at 15 °C to make a 20-litre bath at 40 °C. How many litres of each do you need? Show that it works. (Ignore heat lost.)