Unit 12 · Heat

HARDER PRACTICE QUESTIONS

Full marks 45

Write your answers on separate paper. Show your working. Unless told otherwise, use s of water = 4,200 J/(kg °C), s of ice = 2,100 J/(kg °C), L of fusion of ice = 336,000 J/kg, L of vaporization of water = 2,260,000 J/kg. No heat is lost unless the question says so.

1 Too much steam [4]

50 g of steam at 100 °C is passed into 200 g of water at 20 °C in a flask. Predict the final temperature by first finding how much heat the water can take. How much steam stays uncondensed?

2 Spot the error [4]

Prasanna dropped 100 g of ice at 0 °C into 200 g of water at 10 °C. He wrote:
"Heat lost = heat gained: $0.2 \times 4{,}200 \times (10 - T) = 0.1 \times 336{,}000 + 0.1 \times 4{,}200 \times T$. So $8{,}400 - 840T = 33{,}600 + 420T$, and $T = \mathbf{-20}$ **°C**."
His algebra is right. What is wrong? Find the true final state.

3 Read the curve [5]

A 500 W heater warms 1 kg of an unknown metal in a closed, insulated box. All its heat goes into the metal.

Time (s)	0	3	7	20	40	53	58
Temperature (°C)	300	312	327	327	327	327	345

i. Find its melting point.
ii. Find its specific latent heat of fusion. Which metal in the table below is it?
iii. Find the specific heat capacity of the solid.
iv. Does the solid or the liquid warm faster? What does that say about their specific heat capacities?

Metal	iron	aluminium	lead
Latent heat of fusion (J/kg)	247,000	397,000	23,000

4 Snow for tea [4]

At a high camp, Pemba melts 2 kg of snow at −10 °C on a stove and brings it to the boil at 85 °C (the boiling point up there; take this value as given). The stove gives the pot 1,200 J every second.

i. How long does the whole job take?
ii. Which stage takes the longest? Is melting close behind?

5 Two days, two readings [3]

A wet-and-dry-bulb hygrometer gives these readings at noon.

	Dry bulb (°C)	Wet bulb (°C)
Day A	30	22
Day B	30	29

Which day is more humid? On which day would clothes dry faster and a *matka* work better? Explain.

6 Fair test [4]

Apekshya thinks that an unglazed clay *matka* keeps water cooler than a steel vessel of the same size. Plan a fair test.

i. What will she change, and what will she measure?
ii. Name three things she must keep the same.
iii. How can she make her results more reliable?
iv. What result would support her idea, and why would it happen?

7 Plan for it [4]

A bridge is 250 m long. Between a cold night and a hot afternoon its temperature changes from 5 °C to 45 °C. Take the unit's figure: a 1 km bridge grows by 12 mm for each 1 °C.

i. How much does this bridge's length change?
ii. It rests on rollers at one end and has one expansion joint. It was finished on a day at 45 °C. Should the joint's gap be wide or nearly closed that day? Explain.
iii. A square steel plate on the bridge grows by 0.1% each way. By about what percentage does its area grow?

8 Find the unknown [3]

A piece of metal of mass 200 g, heated in boiling water at 100 °C, is dropped into a copper calorimeter of mass 100 g holding 300 g of water at 20 °C. The temperature rises to 25 °C. Find the specific heat capacity of the metal. (s of copper = 385 J/(kg °C))

9 Predict, then explain [3]

Write your prediction first, then explain it.

A straight brass and iron strip, with the brass on top and one end clamped, is (a) heated and (b) put in a freezer. Predict which way the free end moves each time. (c) What happens if both metals are brass?

10 How much sweat? [3]

A porter's body must lose 400 J every second by sweating. Take L at the skin as 2,400,000 J/kg.

i. How much sweat must evaporate in an hour?
ii. On a humid day half of his sweat drips off without evaporating. How much must he sweat in an hour now?

11 Correct the misconceptions [3]

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

Prabin wrote: "Water in a pan gets hotter and hotter as long as the flame is on, even while it boils. Blowing on hot tea cools it because your breath produces cold. A wide dish and a narrow glass holding the same water evaporate at the same rate."

12 Think [3]

Suppose the latent heat of fusion of ice were ten times smaller than it is. What would change (a) in a Himalayan river in spring, (b) in a glass of juice cooled with ice, and (c) in how long a lake's surface takes to freeze? Explain each.

13 Make your own [2]

Invent a problem in which ice at 0 °C and warm water end up exactly as water at 0 °C, with all the ice just melted. Give the masses and the water's temperature, and show that your numbers work.