

# Exam Practise 7: Heat

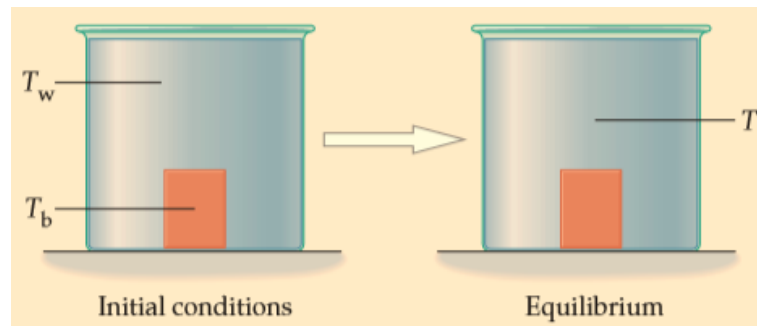
Q

# Q1

Sam pours 550 g of water at 32 °C into a 210-g aluminum can with an initial temperature of 15 °C. Find the final temperature of the system, assuming no heat is exchanged with the surroundings. (You fill in the missing values)

# Q2

- A 0.50-kg block of metal with an initial temperature of  $54.5\text{ }^{\circ}\text{C}$  is dropped into a container holding 1.1 kg of water at  $20.0\text{ }^{\circ}\text{C}$ . If the final temperature of the block–water system is  $21.4\text{ }^{\circ}\text{C}$ , what is the specific heat of the metal? Assume the container can be ignored, and that no heat is exchanged with the surroundings.



# Q3

- A hot water tank contains 135 L of water. Initially the water is at 20°C. Calculate the amount of energy that must be transferred to the water to raise the temperature to 70°C.
- 1 L of water = 1 kg

# Q4

- How much energy must be removed from 2.5 L of water at 0°C to produce a block of ice at 0°C? Express your answer in kJ.
- 1 L of water = 1 kg,

# Q5

- 50 mL of water is heated from a room temperature of  $20^{\circ}\text{C}$  to its boiling point at  $100^{\circ}\text{C}$ . It is boiled at this temperature until it is completely evaporated. How much energy in total was required to raise the temperature and boil the water?

# Q6

(a) Lead has a specific heat capacity of  $130 \text{ J kg}^{-1} \text{ K}^{-1}$ . Explain what is meant by this statement.

(b) Lead of mass  $0.75 \text{ kg}$  is heated from  $21 \text{ }^\circ\text{C}$  to its melting point and continues to be heated until it has all melted.

Calculate how much energy is supplied to the lead.

*melting point of lead =  $327.5 \text{ }^\circ\text{C}$*

*specific latent heat of fusion of lead =  $23\,000 \text{ J kg}^{-1}$*

# Q7

- A bicycle and its rider have a total mass of 95 kg. The bicycle is travelling along a horizontal road at a constant speed of  $8.0\text{ms}^{-1}$ .
- (a) Calculate the kinetic energy of the bicycle and rider.
- (b) The brakes are applied until the bicycle and rider come to rest. During braking, 60% of the kinetic energy of the bicycle and rider is converted to thermal energy in the brake blocks. The brake blocks have a total mass of 0.12 kg and the material from which they are made has a specific heat capacity of  $1200\text{ J kg}^{-1}\text{ K}^{-1}$ .
- (i) Calculate the maximum rise in temperature of the brake blocks.
- (ii) State an assumption you have made in part (b)(i).

# Q8

Calculate the quantity of heat energy required to raise the temperature of a mass of 810g of aluminium from 20°C to 75°C. The specific heat capacity of aluminium is 910 J kg<sup>-1</sup> K<sup>-1</sup>.

## Q9

A mass of 0.30 kg of water at 95°C is mixed with 0.50 kg of water at 20°C. Calculate the final temperature of the water, given that the specific heat capacity of water is 4200 J kg<sup>-1</sup> K<sup>-1</sup>.

# Q10

A mass of 12 g of ice at  $0^{\circ}\text{C}$  is placed in a drink of mass 210 g at  $25^{\circ}\text{C}$ . Calculate the final temperature of the drink, given that the specific latent heat of fusion of ice is  $334\text{ kJ kg}^{-1}$  and that the specific heat capacity of water and the drink is  $4.2\text{ kJ kg}^{-1}\text{ K}^{-1}$ .

# Q11

A hot water tank contains 135 litres of water. The water is initially at  $20^{\circ}\text{C}$ .

- a** Calculate the amount of energy that must be transferred to the water to raise the temperature to  $70^{\circ}\text{C}$ .
- b** Calculate the time this will take when a 5 kW electric water heater is used.

# Q12

The hot water tap of a bath delivers water at  $80^{\circ}\text{C}$ . Ten litres of hot water is added to a bath containing 30 litres of water at  $20^{\circ}\text{C}$ . Ignoring energy losses to the surrounding environment, what will be the final temperature of the bath water?

# Q13

50 grams of iron is heated over a flame for several minutes. It is then plunged into a closed container containing 1.0 litre of cool water, originally at  $15^{\circ}\text{C}$ . After the temperatures equalise, the water is now found to be at  $17^{\circ}\text{C}$ . If no water changed state to become steam and there were no losses to the surrounding environment, what was the temperature of the iron just prior to being immersed in the water?

# Q14

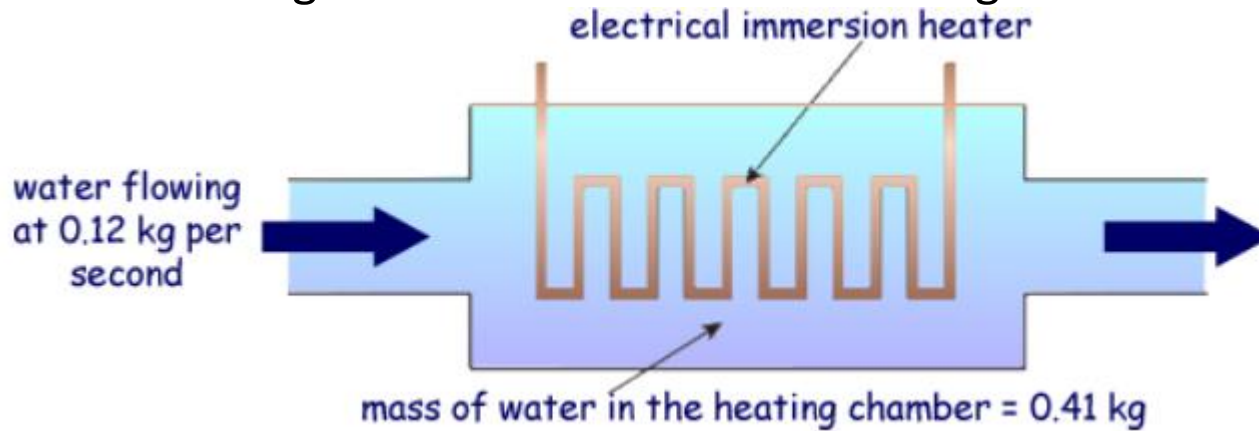
How much energy has to be removed from 2.5 kg of water at  $10^{\circ}\text{C}$  to produce a block of ice at  $0^{\circ}\text{C}$ ? Express your answer in kilojoules.

# Q15

Calculate the heat required to convert 5 kg of ice at  $-20^{\circ}\text{C}$  into steam at  $100^{\circ}\text{C}$ .

# Q16

- An electrical immersion heater supplies 8.5 kJ of energy every second. Water flows through the heater at a rate of  $0.12 \text{ kg s}^{-1}$  as shown in the diag



- (a) Assuming all the energy is transferred to the water, calculate the rise in temperature of the water (in kelvin) as it flows through the heater, given that the specific heat capacity of water =  $4200 \text{ J kg}^{-1}\text{K}^{-1}$

# Q16 continued

- (b) The water suddenly stops flowing at the instant when its average temperature is  $26^{\circ}\text{C}$ . The mass of water trapped in the heater is  $0.41\text{ kg}$ . Calculate the number of seconds it takes for the water to reach  $100^{\circ}\text{C}$  if the immersion heater continues supplying energy at the same rate.

# Q17

- The specific latent heat of vaporisation of water is  $2.26 \text{ MJ kg}^{-1}$ . Calculate the energy needed to change  $2.0 \text{ g}$  of water into steam at  $100 \text{ }^\circ\text{C}$ .

# Q18

- A tray containing 0.20 kg of water at 20 °C is placed in a freezer.
- (a) The temperature of the water drops to 0 °C in 10 minutes.
- (*specific heat capacity of water = 4200 J kg<sup>-1</sup> K<sup>-1</sup>*)
- Calculate:
- (i) the energy lost by the water as it cools to 0 °C,
- (ii) the average rate at which the water is losing energy, in J s<sup>-1</sup>.

# Q18 continued

- (b)
- (i) Estimate the time taken for the water at 0 °C to turn completely into ice.
- (*specific latent heat of fusion of water =  $3.3 \times 10^5 \text{ J kg}^{-1}$* )
- (ii) State any assumptions you make.

# Q19

- (a) A 2.0kW heater is used to heat a room from 5 °C to 20 °C. The mass of air in the room is 30 kg. Under these conditions the specific heat capacity of air = 1000 J kg<sup>-1</sup>K<sup>-1</sup>.
- Calculate
  - (i) the gain in thermal energy of the air,
  - (ii) the minimum time required to heat the room.
- (b) State and explain one reason why the actual time taken to heat the room is longer than the value calculated in part (a)(ii).

# Q20

- (a) Calculate the energy released when 1.5 kg of water at 18 °C cools to 0 °C and then freezes to form ice, also at 0 °C.
- *specific heat capacity of water =  $4200 \text{ J kg}^{-1} \text{ K}^{-1}$*
- *specific latent heat of fusion of ice =  $3.4 \times 10^5 \text{ J kg}^{-1}$*

# Q20 continued

- (b) Explain why it is more effective to cool cans of drinks by placing them in a bucket full of melting ice rather than in a bucket of water at an initial temperature of 0 °C.

# Q21

- 4.00 kg of water initially at 85.0°C is mixed with 3.00 kg of water initially at 25.0°C. What is the final temperature of the water once thermal equilibrium is reached?

# Q22

- A 75.0 g piece of copper is heated over a flame for several minutes. The copper is then plunged into an insulated, closed container containing 0.500 L of cool water, originally at 20.0°C. When thermal equilibrium is reached, the temperature of the water is found to be 22.0°C. If no water changes state to become steam and there are no other energy losses, then what was the temperature of the copper just before it was immersed in the water?

-

# Q23

- Calculate the heat energy that must be lost, in J, to convert 5.00 kg of water vapour at 140.0°C into solid ice at 0.00°C.