1)

An electrical heater is placed in an insulated container holding 100 g of ice at a temperature of –14 °C. The heater supplies energy at a rate of 98 joules per second.

(a) After an interval of 30 s, all the ice has reached a temperature of 0 °C.
Calculate the specific heat capacity of ice.

answer = ...$J\,kg^{-1}\,K^{-1}$
(2 marks)

(b) Show that the final temperature of the water formed when the heater is left on for a further 500 s is about 40 °C.

specific heat capacity of water = 4200 $J\,kg^{-1}\,K^{-1}$
specific latent heat of fusion of water = 3.3×10^5 $J\,kg^{-1}$

(3 marks)

(c) The whole procedure is repeated in an uninsulated container in a room at a temperature of 25 °C.
State and explain whether the final temperature of the water formed would be higher or lower than that calculated in part (b).

....

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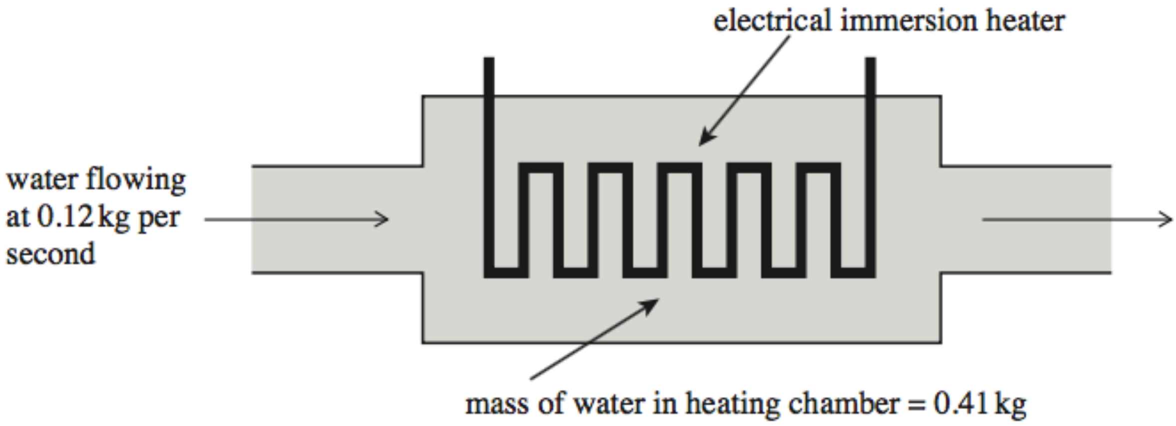
....

....
(2 marks)

2)

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

Figure 1



(a) Assuming all the energy is transferred to the water, calculate the rise in temperature of the water as it flows through the heater.

specific heat capacity of water = $4200\,J\,kg^{-1}\,K^{-1}$

answer = ... K

(2 marks)

(b) The water suddenly stops flowing at the instant when its average temperature is 26 °C. The mass of water trapped in the heater is 0.41 kg.
Calculate the time taken for the water to reach 100 °C if the immersion heater continues supplying energy at the same rate.

answer = ... s

(2 marks)

3)

A cola drink of mass 0.200 kg at a temperature of 3.0 °C is poured into a glass beaker. The beaker has a mass of 0.250 kg and is initially at a temperature of 30.0 °C.

specific heat capacity of glass = 840 $J\,kg^{-1}\,K^{-1}$
specific heat capacity of cola = 4190 $J\,kg^{-1}\,K^{-1}$

(i) Show that the final temperature, T_f, of the cola drink is about 8 °C when it reaches thermal equilibrium with the beaker.
Assume no heat is gained from or lost to the surroundings.

(2 marks)

(ii) The cola drink and beaker are cooled from T_f to a temperature of 3.0 °C by adding ice at a temperature of 0 °C.
Calculate the mass of ice added.
Assume no heat is gained from or lost to the surroundings.

specific heat capacity of water = 4190 $J\,kg^{-1}\,K^{-1}$
specific latent heat of fusion of ice = 3.34×10^5 $J\,kg^{-1}$

mass .... kg
(3 marks)

4)

(a) Define the specific latent heat of vaporisation of water.

[2 marks]

....

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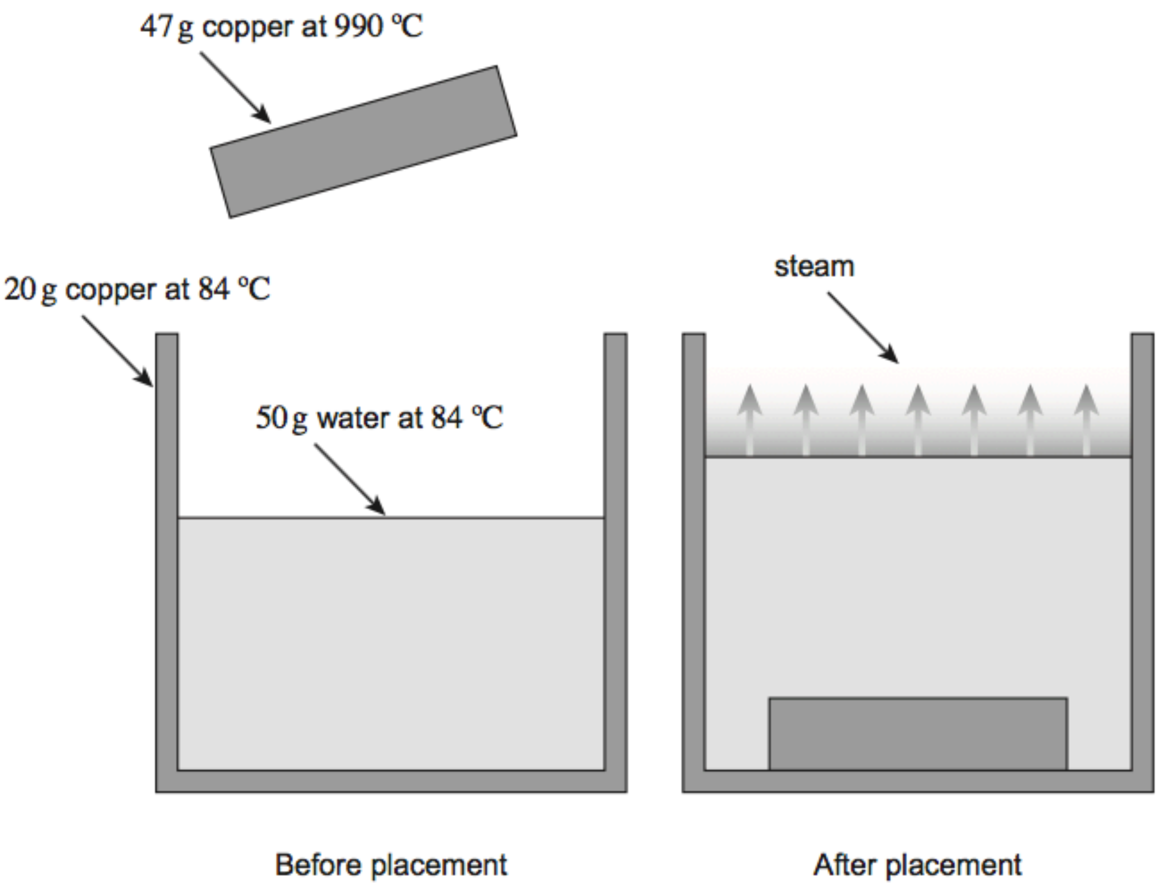
....

....

(b) An insulated copper can of mass 20 g contains 50 g of water both at a temperature of 84 °C. A block of copper of mass 47 g at a temperature of 990 °C is lowered into the water as shown in **Figure 2**. As a result, the temperature of the can and its contents reaches 100 °C and some of the water turns to steam.

specific heat capacity of copper = 390 $J\,kg^{-1}\,K^{-1}$
specific heat capacity of water = 4200 $J\,kg^{-1}\,K^{-1}$
specific latent heat of vaporisation of water = $2.3 \times 10^6\,J\,kg^{-1}$

Figure 2



(b) (i) Calculate how much thermal energy is transferred from the copper block as it cools to 100 °C.
Give your answer to an appropriate number of significant figures.

[2 marks]

thermal energy transferred .... J

(b) (ii) Calculate how much of this thermal energy is available to make steam.
Assume no heat is lost to the surroundings.

[2 marks]

available thermal energy .... J

(b) (iii) Calculate the maximum mass of steam that may be produced.

[1 mark]

mass .... kg

5)

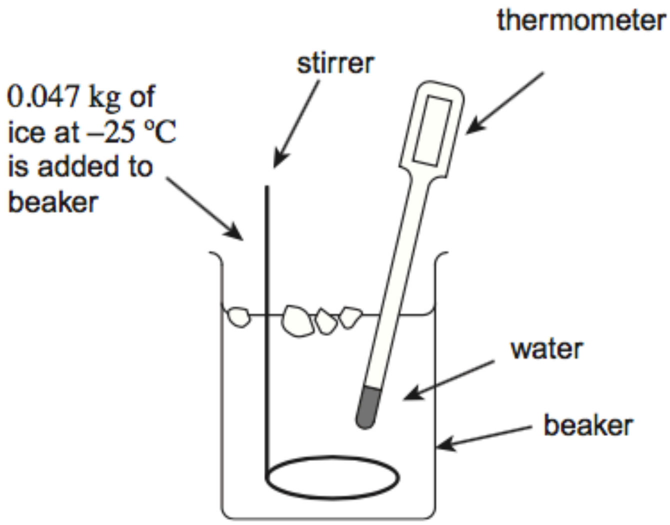
(a) Which statement explains why energy is needed to melt ice at 0 °C to water at 0 °C?
Place a tick (✓) in the right-hand column to show the correct answer.

[1 mark]

	✓ if correct
It provides the water with energy for its molecules to move faster.	
It breaks all the intermolecular bonds.	
It allows the molecules to vibrate with more kinetic energy.	
It breaks some intermolecular bonds.	

(b) **Figure 5** shows an experiment to measure the specific heat capacity of ice.

Figure 5



A student adds ice at a temperature of –25 °C to water. The water is stirred continuously. Ice is added slowly until all the ice has melted and the temperature of the water decreases to 0 °C. The mass of ice added during the experiment is 0.047 kg.

(b) (i) Calculate the energy required to melt the ice at a temperature of 0 °C.
The specific latent heat of fusion of water is 3.3×10^5 J kg^{-1}.

[1 mark]

energy = ______________________________ J

(b) (ii) The water loses 1.8×10^4 J of energy to the ice during the experiment.
Calculate the energy given to the ice to raise its temperature to 0 °C. Assume that no energy is transferred to or from the surroundings and beaker.

[1 mark]

energy = ____________________________ J

(b) (iii) Calculate the specific heat capacity of the ice.
State an appropriate unit for your answer.

[2 marks]

specific heat capacity = ______________________ unit = __________

6)

(a) Lead has a specific heat capacity of $130\ \text{J kg}^{-1}\ \text{K}^{-1}$.

Explain what is meant by this statement.

[1 mark]

....

....

....

....

(b) Lead of mass 0.75 kg is heated from 21 °C to its melting point and continues to be heated until it has all melted.

Calculate how much energy is supplied to the lead.
Give your answer to an appropriate number of significant figures.

melting point of lead = 327.5 °C
specific latent heat of fusion of lead = $23\ 000\ \text{J kg}^{-1}$

[3 marks]

energy supplied .... J

7)

Molten lead at its melting temperature of 327°C is poured into an iron mould where it solidifies. The temperature of the iron mould rises from 27°C to 84°C, at which the mould is in thermal equilibrium with the now solid lead.

mass of lead = 1.20 kg
specific latent heat of fusion of lead = 2.5×10^4 J kg^{-1}
mass of iron mould = 3.00 kg
specific heat capacity of iron = 440 J kg^{-1} K^{-1}

(a) Calculate the heat energy absorbed by the iron mould.

answer = ... J
(2 marks)

(b) Calculate the heat energy given out by the lead while it is changing state.

answer = ... J
(1 mark)

(c) Calculate the specific heat capacity of lead.

answer = ... $J\,kg^{-1}\,K^{-1}$

(3 marks)

(d) State **one** reason why the answer to part 1 **(c)** is only an approximation.

....

....

....

(1 mark)