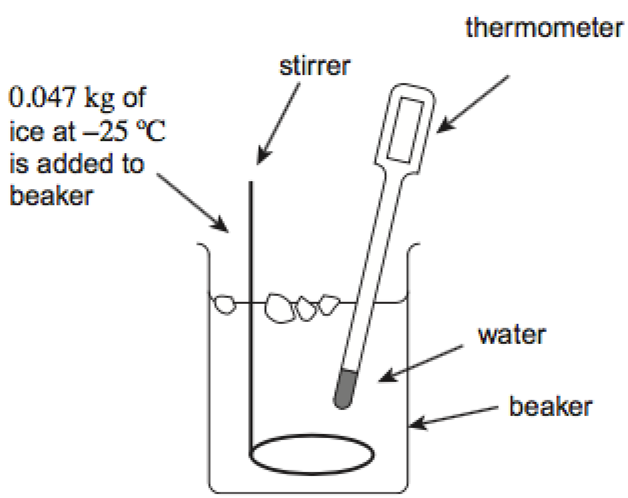
1 (a) Which statement explains why energy is needed to melt ice at 0°C to water at 0°C?

Place a tick (✓) in the right-hand column to show the correct answer.

	✓ 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.	

(1)

(b) The diagram shows an experiment to measure the specific heat capacity of ice.



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.

(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}.

energy = ____________________ J

(1)

(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.

energy = ______________________ J

(1)

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

specific heat capacity = ______________________ unit = ___________

(2)

(Total 5 marks)

2 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)

(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)

(Total 5 marks)

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

___

___

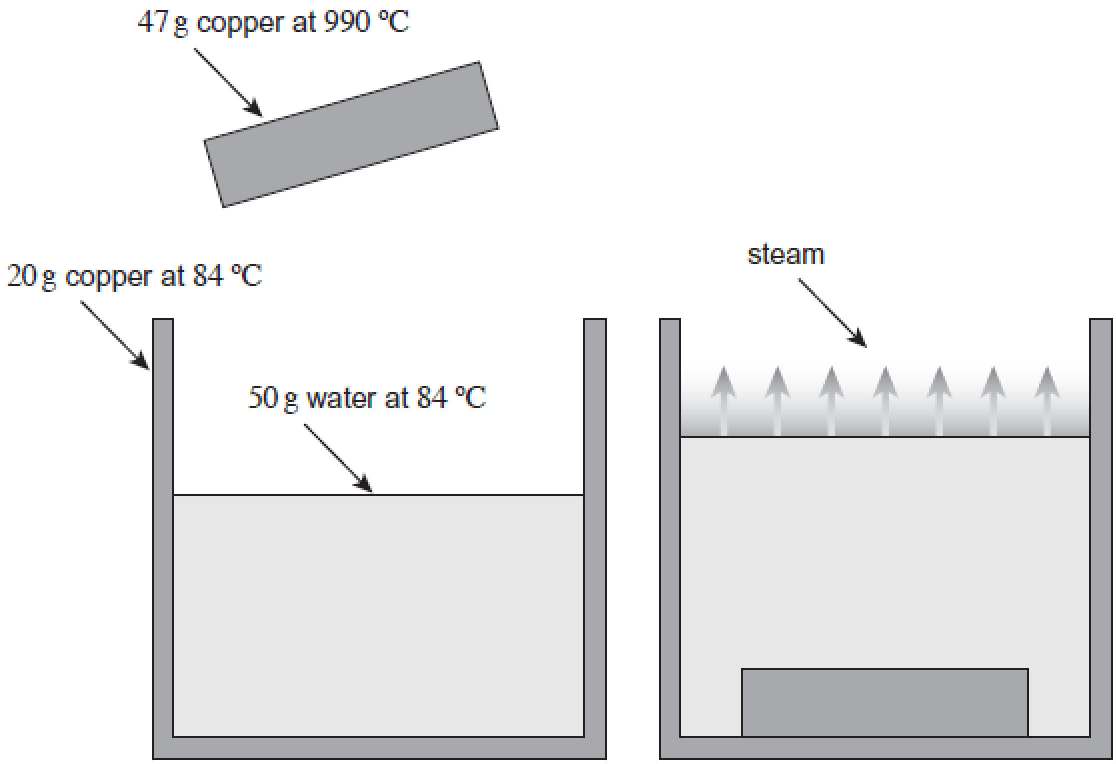
___

___

(2)

(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 the figure below. 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 = 2.3×10^{6} $J\ kg^{-1}$



Before placement After placement

(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.

thermal energy transferred ____________________ J

(2)

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

available thermal energy ____________________ J

(2)

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

mass ____________________ kg

(1)

(Total 7 marks)

4 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)

(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 = $3.3 \times 10^5\ J\ kg^{-1}$

(3)

(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).

____

____

____

____

(2)

(Total 7 marks)

5 A female runner of mass 60 kg generates thermal energy at a rate of 800 W.

(a) Assuming that she loses no energy to the surroundings and that the average specific heat capacity of her body is 3900 J $kg^{-1}K^{-1}$, calculate

(i) the thermal energy generated in one minute,

____

____

(ii) the temperature rise of her body in one minute.

____

____

____

____

(3)

(b) In practice it is desirable for a runner to maintain a constant temperature. This may be achieved partly by the evaporation of sweat. The runner in part (a) loses energy at a rate of 500 Wby this process.

Calculate the mass of sweat evaporated in one minute.

specific latent heat of vaporisation of water = 2.3×10^6 J kg^{-1}

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(3)

(c) Explain why, when she stops running, her temperature is likely to fall.

(2)
(Total 8 marks)

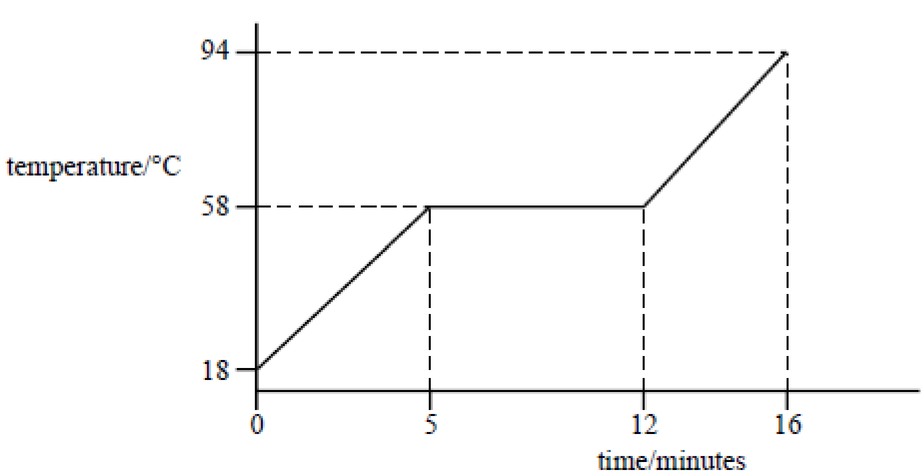
6 (a) Explain what is meant by

(i) the specific heat capacity of water,

(ii) the specific latent heat of fusion of ice.

(4)

(b) A sample of solid material, which has a mass of 0.15 kg, is supplied with energy at a constant rate. The specific heat capacity of the material is 1200 J kg^{-1} K^{-1} when in the solid state. During heating, its temperature is recorded at various times and the following graph is plotted.



Assume there is no heat exchange with the surroundings.

(i) Show that energy is supplied to the material at a rate of 24 W.

(ii) Calculate the specific latent heat of fusion of the material.

(iii) Calculate the specific heat capacity of the material when in the liquid state.

(6)

(Total 10 marks)

7 (a) (i) Explain what is meant by the *specific latent heat of vaporisation* of a liquid.

(ii) Suggest why the specific latent heat of vaporisation of water is much greater than the specific latent heat of fusion of water.

(3)

(b) A cup contains 0.25 kg of water at a temperature of 15 °C. The water is heated by passing steam at 100 °C into it.

specific heat capacity of water	$= 4200\ J\ kg^{-1}\ K^{-1}$
specific latent heat of vaporisation of water	$= 2.3 \times 10^{6}\ J\ kg^{-1}$
boiling point of water	= 100 °C

(i) Use the above data to calculate the minimum mass of water that is in the cup when the temperature of the water reaches its boiling point.

(ii) Explain why there is likely to be a greater mass of water in the cup than you have calculated in part (b)(i).

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____

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(4)

(Total 7 marks)