(a) Use the kinetic theory of matter to explain why melting requires energy but there is no change in temperature.

On melting bond between molecules are weakened KE is constant so no change in temp, but potential energy is increased, so energy is required

.... [3]

(b) Define *specific latent heat of fusion.*

Thermal energy required to convert unit mass of solid to liquid, without any change in temp

.... [2]

(c) A block of ice at 0 °C has a hollow in its top surface, as illustrated in Fig. 2.1.

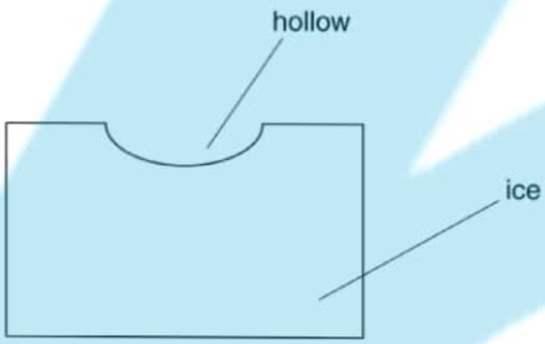

Fig. 2.1

A mass of 160 g of water at 100 °C is poured into the hollow. The water has specific heat capacity 4.20 kJ kg^{-1} K^{-1}. Some of the ice melts and the final mass of water in the hollow is 365 g. 205

(i) Assuming no heat gain from the atmosphere, calculate a value, in kJ kg^{-1}, for the specific latent heat of fusion of ice.

thermal energy lost by water

$q = mC\Delta T$

$= 160 \times 4.20 \times 100$

$67200 J = 67.2 KJ$

$67.2 = \left(\frac{365-160}{1000}\right) L$

$L = 327.8$

specific latent heat = ...328............ kJ kg^{-1} [3]

(ii) In practice, heat is gained from the atmosphere during the experiment. This means that your answer to **(i)** is not the correct value for the specific latent heat. State and explain whether your value in **(i)** is greater or smaller than the correct value.

The heat energy from surrounding will melt ice, ∴ $\Delta m \uparrow$ thus L decreses

.... [2]

(a) Define *specific latent heat of fusion.*

....

....

.... [2]

(b) Some crushed ice at 0 °C is placed in a funnel together with an electric heater, as shown in Fig. 2.1.

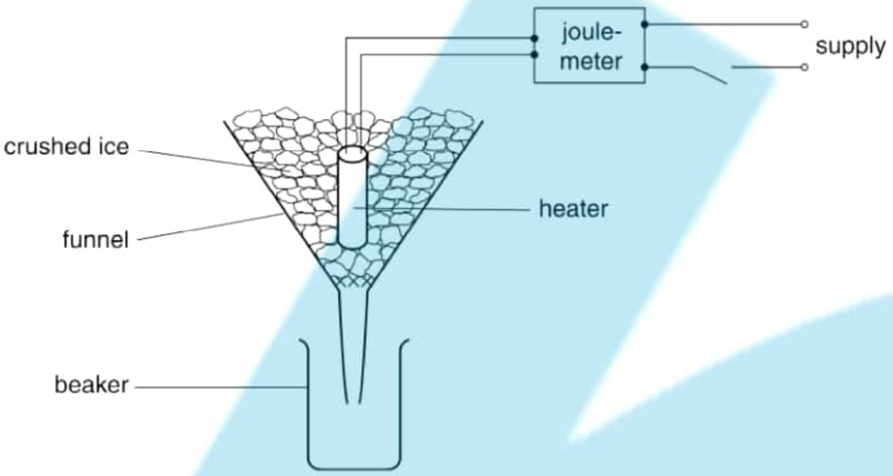

Fig. 2.1

The mass of water collected in the beaker in a measured interval of time is determined with the heater switched off. The mass is then found with the heater switched on. The energy supplied to the heater is also measured.
For both measurements of the mass, water is not collected until melting occurs at a constant rate.
The data shown in Fig. 2.2 are obtained.

	mass of water / g	energy supplied to heater / J	time interval / min
heater switched off	16.6	0	10.0
heater switched on	64.7	18000	5.0

Fig. 2.2

(i) State why the mass of water is determined with the heater switched off.

To make allowance for heat gains from atmosphere .... [1]

(ii) Suggest how it can be determined that the ice is melting at a constant rate.

constant mass of water collected per min

.... [1]

(iii) Calculate a value for the specific latent heat of fusion of ice.

mass change after heater

$64.7 - \frac{16.6}{2} = 56.4\,g$

$Q = \Delta m L$

$18000 = \frac{56.4}{1000} \times L$

$L = 3.1914 \times 10^5\ J = 3.1914 \times 10^2\ kJ$

latent heat = ...319...... $kJ\,kg^{-1}$ [3]

When a liquid is boiling, thermal energy must be supplied in order to maintain a constant temperature.

(a) State two processes for which thermal energy is required during boiling.

1. Breaking bonds between molecules

2. Doing work againt the atmosphere when expanding

[2]

(b) A student carries out an experiment to determine the specific latent heat of vaporisation of a liquid.
Some liquid in a beaker is heated electrically as shown in Fig. 3.1.

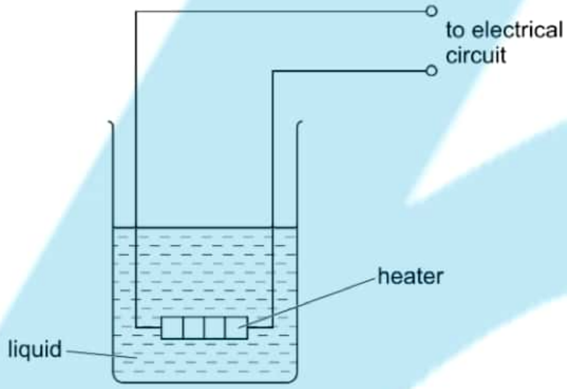

Fig. 3.1

Energy is supplied at a constant rate to the heater. When the liquid is boiling at a constant rate, the mass of liquid evaporated in 5.0 minutes is measured.
The power of the heater is then changed and the procedure is repeated.
Data for the two power ratings are given in Fig. 3.2.

power of heater /W	mass evaporated in 5.0 minutes /g
50.0 70.0	6.5 13.6

Fig. 3.2

(i) Suggest

1. how it may be checked that the liquid is boiling at a constant rate,

mass loss per min should be constant

[1]

2. why the rate of evaporation is determined for two different power ratings.

To eliminate heat losses to atmosphere

[1]

(ii) Calculate the specific latent heat of vaporisation of the liquid.

$50 \times 5 \times 60 = 6.5 \times L + H$

$- \quad 70 \times 5 \times 60 = 13.6 \times L + H$

$-6000 = -7.1 L + 0 =$

specific latent heat of vaporisation = 845 $J g^{-1}$ [3]

(a) The resistance of a thermistor at 0 °C is 3840 Ω. At 100 °C the resistance is 190 Ω. When the thermistor is placed in water at a particular constant temperature, its resistance is 2300 Ω.

(i) Assuming that the resistance of the thermistor varies linearly with temperature, calculate the temperature of the water.

$$\frac{3840-190}{100} = 36.5\,\Omega$$

$$3840-2300 = 1540$$

$$\frac{1540}{36.5} = 42.192$$

temperature = 42.2 °C [2]

(ii) The temperature of the water, as measured on the thermodynamic scale of temperature, is 286 K.

By reference to what is meant by the thermodynamic scale of temperature, comment on your answer in **(i)**.

42.2°C = 315K, thermodynamic scale does not depend on property of the substance, so change in resistance is not linear [3]

(b) A polystyrene cup contains a mass of 95 g of water at 28 °C.

A cube of ice of mass 12 g is put into the water. Initially, the ice is at 0 °C. The water, of specific heat capacity $4.2 \times 10^3\,\text{J kg}^{-1}\,\text{K}^{-1}$, is stirred until all the ice melts.

Assuming that the cup has negligible mass and that there is no heat exchange with the atmosphere, calculate the final temperature of the water.

The specific latent heat of fusion of ice is $3.3 \times 10^5\,\text{J kg}^{-1}$.

$$m_i L + m_i c \Delta t = m_w c \Delta t$$

$$(0.012 \times 3.3\times10^5) + 0.012 \times 4.2\times10^3 \times T = \frac{95}{1000} \times 4.2\times10^3 \times (28-T)$$

$$3960 + 50.4T = 399(28-T)$$

$$3960 = 399(28-T) - 50.4T$$

$$9.924 = 28 - T - 50.4T$$

$$-18.075 = -51.4T$$

temperature = ... °C [4]

(a) Two metal spheres are in thermal equilibrium.
State and explain what is meant by *thermal equilibrium*.

....

....

....[2]

(b) An electric water heater contains a tube through which water flows at a constant rate. The water in the tube passes over a heating coil, as shown in Fig. 3.1.

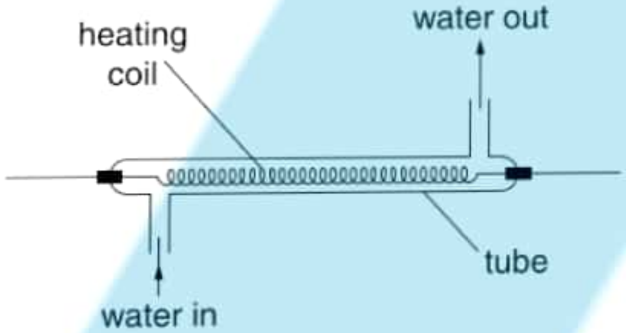

Fig. 3.1

The water flows into the tube at a temperature of 18 °C. When the power of the heater is 3.8 kW, the temperature of the water at the outlet is 42 °C.
The specific heat capacity of water is $4.2\,J\,g^{-1}\,K^{-1}$.

(i) Use the data to calculate the flow rate, in $g\,s^{-1}$, of water through the tube.

flow rate = ... $g\,s^{-1}$ [3]

(ii) State and explain whether your answer in **(i)** is likely to be an overestimate or an underestimate of the flow rate.

....

....

....[2]

Fc Exami Us

(a) Define *specific latent heat of fusion*.

....

....

....[2]

(b) A mass of 24 g of ice at –15 °C is taken from a freezer and placed in a beaker containing 200 g of water at 28 °C. Data for ice and for water are given in Fig. 3.1.

	specific heat capacity / $J\,kg^{-1}\,K^{-1}$	specific latent heat of fusion / $J\,kg^{-1}$
ice	2.1×10^3	3.3×10^5
water	4.2×10^3	–

Fig. 3.1

(i) Calculate the quantity of thermal energy required to convert the ice at –15 °C to water at 0 °C.

energy = ... J [3]

(ii) Assuming that the beaker has negligible mass, calculate the final temperature of the water in the beaker.

temperature = ... °C [3]