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

The numerical value of latent heat of fusion is the quantity of heat energy required to convert 1kg of a substance from 1kg to another [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.

$q = mc\Delta t$
$= 0.024 \times 2.1\times10^3 \times 15$
$= 756$

$q = mL$
$= 0.024 \times 3.3\times10^5$
$= 7920$

energy = 8676 J [3]

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

or 24-x

$8676 + m_{iw}c_{iw}\Delta t = m_w c_w \Delta t$
$8676 + 0.024 \times 4.2\times10^3 \times x = 0.2 \times 4.2\times10^3 \times (28-x)$
$8676 + 100.8x = 84(x-28)$
$8676 + 100.8x = 84x - 2352$
$16.8x =$

22.
2.

temperature = ... °C [3]

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

As the supplied energy is being used to overcome the intermolecular forces and break the bonds between molecules and ~~as~~ KE is unchanged ∴ PE increases so energy is required [3]

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

....

....

.... [2]

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

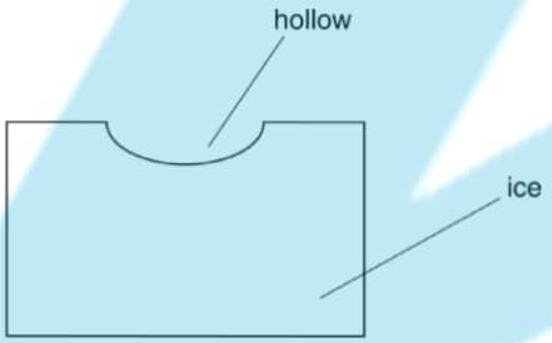

Fig. 2.1

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.

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

Energy lost of 160g water = Energy gained by 205 g ice ~~+~~

" " " ~~205g melted at~~

$m_w c_w \Delta t = m_i L_i$ ~~$+ m_i c_w \Delta t$~~

$0.16 \times 4.2 \times 100 = 0.205L$ ~~$+ 0.205 \times 4.2 \times$~~

H* $67.2 = 0.205L$

$L = 327.8$ 60

specific latent heat = ...330...... kJ kg^{-1} [3]

For Examiner's Use

(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.

Smaller, as ice would gain energy from surroundings and so the actual value ~~as~~ would be lower [2]

[2]

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

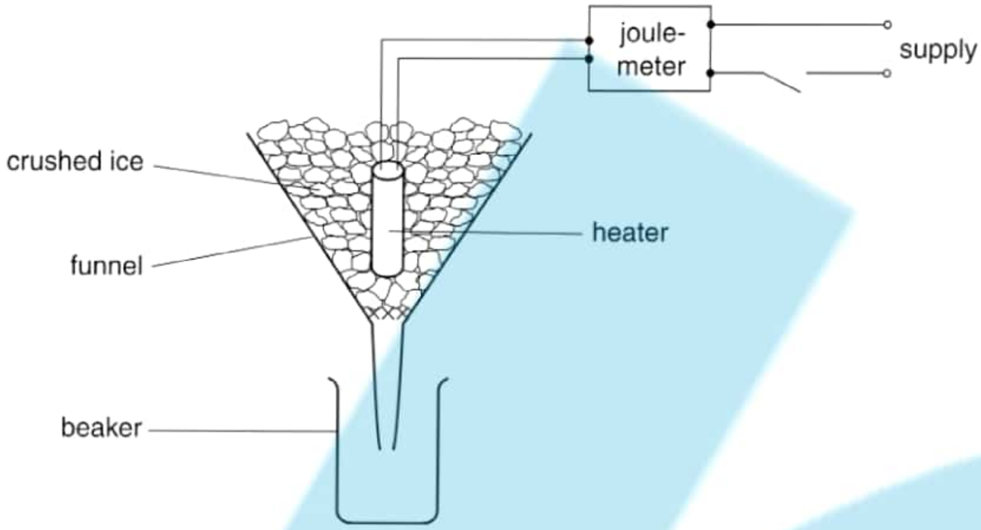

Fig. 2.1

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

why time ?

Fig. 2.2

?

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

To allow the water to gain heat from the surroundings

[1]

7

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

Constant Rate of increase in mass of beaker

[1]

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

$q = \Delta m L$

$18000 = (64.7 - \frac{16.6}{2})L$

$18000 = \frac{48.1}{1000} L$

$L = 374220.3740 \; J\,kg^{-1}$

$= 374.22$

latent heat = 374 kJ kg^{-1} [3]

2

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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 intermolecular bonds
increase PE of molecules.

2. Energy is required for doing the work during expansion.

[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.

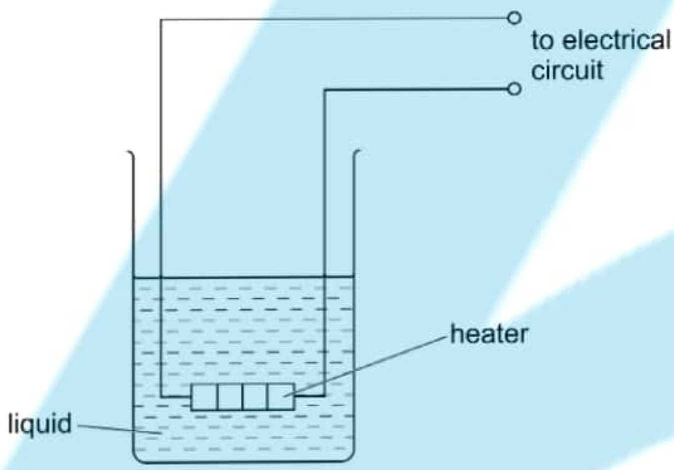


Fig. 3.1

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	6.5
70.0	13.6

Fig. 3.2

(i) Suggest

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

Rate of decrease of mass of beaker should be constant.

[1]

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

To eliminate Heat lost to surroundings

[1]

.... [1]

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

?? H + 50 × 5 × 60 = 6.5 L + H ??

① 15000 = 6.5L + H

70 × 5 × 60 = 13.6L + H

② 21000 = 13.6L + H

② − ①

6000 = 7.1L

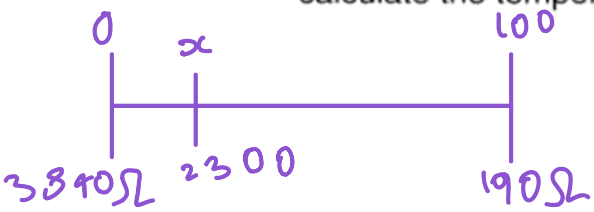
L = 845.07

845

specific latent heat of vaporisation = ... Jg^{-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.



$$\frac{x-0}{2300-3840} = \frac{100-0}{190-3840}$$

$$\therefore\ x = \frac{-1640 \times 100}{-3650}$$

$$= \cancel{41.095^\circ}\ 42$$

temperature = ~~41.1~~ 42 °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)**.

!!

286K = 13°C, this proves that the thermodynamic scale does not depend on the property of a substance, so the change in resistance with temp is non 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 $3.3 \times 10^5\ \text{J kg}^{-1}$.

q of ice to melt + q of melted ice to reach final temp = q lost by 95 g water

$$(0.012 \times 3.3 \times 10^5) + (0.012 \times 4.2 \times 10^3 \times (x-0)) = 0.095 \times 4.2 \times 10^3 \times (28-x)$$

$$3960 + 50.4x = 11172 - 399x$$

$$449.4x = 7212$$

$$x = 16.048$$

temperature = 16 °C [4]

Fc Exami Us

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

There is no net transfer of energy between the spheres, this means that the temp of sphere is same, which is 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.

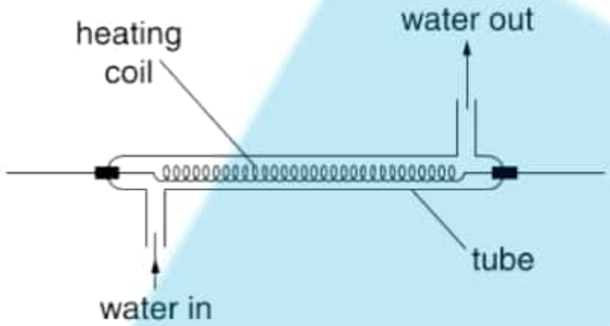


Fig. 3.1

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 $4.2\,\mathrm{J\,g^{-1}\,K^{-1}}$.

#

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

$3800 \times t = m \times 4.2\mathrm{J} \times 24$

$\frac{t}{m} = \frac{4.2 \times 24}{3800}$

$\frac{m}{t} = 38$

flow rate = ... 38 .... $\mathrm{g\,s^{-1}}$ [3]

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

2.

over estimate as energy would be lost to surroundings, so actual value of energy would be lower .... [2]

(a) Define *specific latent heat*.

11/2

....

....

....

.... [2]

(b) An electrical heater is immersed in some melting ice that is contained in a funnel, as shown in Fig. 3.1.

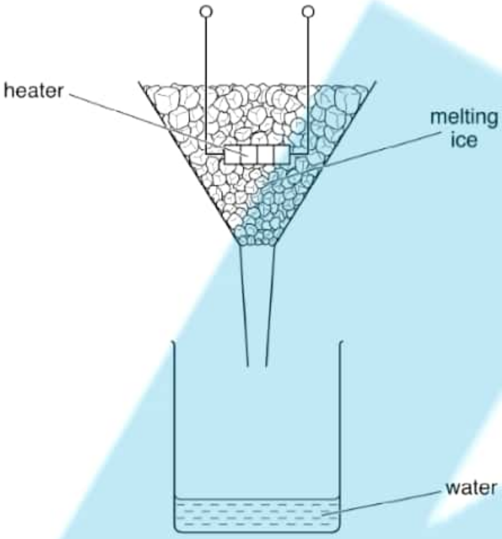


Fig. 3.1

The heater is switched on and, when the ice is melting at a constant rate, the mass m of ice melted in 5.0 minutes is noted, together with the power P of the heater. The power P of the heater is then increased. A new reading for the mass m of ice melted in 5.0 minutes is recorded when the ice is melting at a constant rate.

Data for the power P and the mass m are shown in Fig. 3.2.

power of heater P/W	mass m melted in 5.0 minutes/g	mass m melted per second/g s^{-1}
70	78	0.26
110	114	0.38

Fig. 3.2

(i) Complete Fig. 3.2 to determine the mass melted per second for each power of the heater. [2]

(ii) Use the data in the completed Fig. 3.2 to determine

1. a value for the specific latent heat of fusion L of ice,

$q = mL + H$

$70 = 0.26L + H$

$110 = 0.38L + H$

$\therefore 40 = 0.12L$

$L = 333.\dot{3}$

L = ...330........ J g^{-1} [3]

2. the rate h of thermal energy gained by the ice from the surroundings.

$q - mL = H$

$70 - 0.26(333.333) = H$

$-16.66 = H$

h = ...17........ W [2]

2/2

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(a) State

(i) what may be deduced from the difference in the temperatures of two objects,

?? their molecules have different P.E and K.E

[1]

(ii) the basic principle by which temperature is measured.

?? change in physical property of an object/ substance with temp

[1]

(b) By reference to your answer in **(a)(ii)**, explain why two thermometers may not give the same temperature reading for an object.

!! The temp scale assumes linear change of temp with property of substance and physical properties do not linearly vary with temp

[2]

(c) A block of aluminium of mass 670 g is heated at a constant rate of 95 W for 6.0 minutes. The specific heat capacity of aluminium is 910 J kg^{-1} K^{-1}. The initial temperature of the block is 24 °C.

(i) Assuming that no thermal energy is lost to the surroundings, show that the final temperature of the block is 80 °C.

$95 \times 6 \times 60 = 0.67 \times 910 \times (x - 24)$

$34200 = -14632.8 + 609x$

$609x = 48832.8$

$x = 80.185\,°C$

≈ 80

[3]

(ii) In practice, there are energy losses to the surroundings.
The actual variation with time t of the temperature θ of the block is shown in Fig. 1.1.

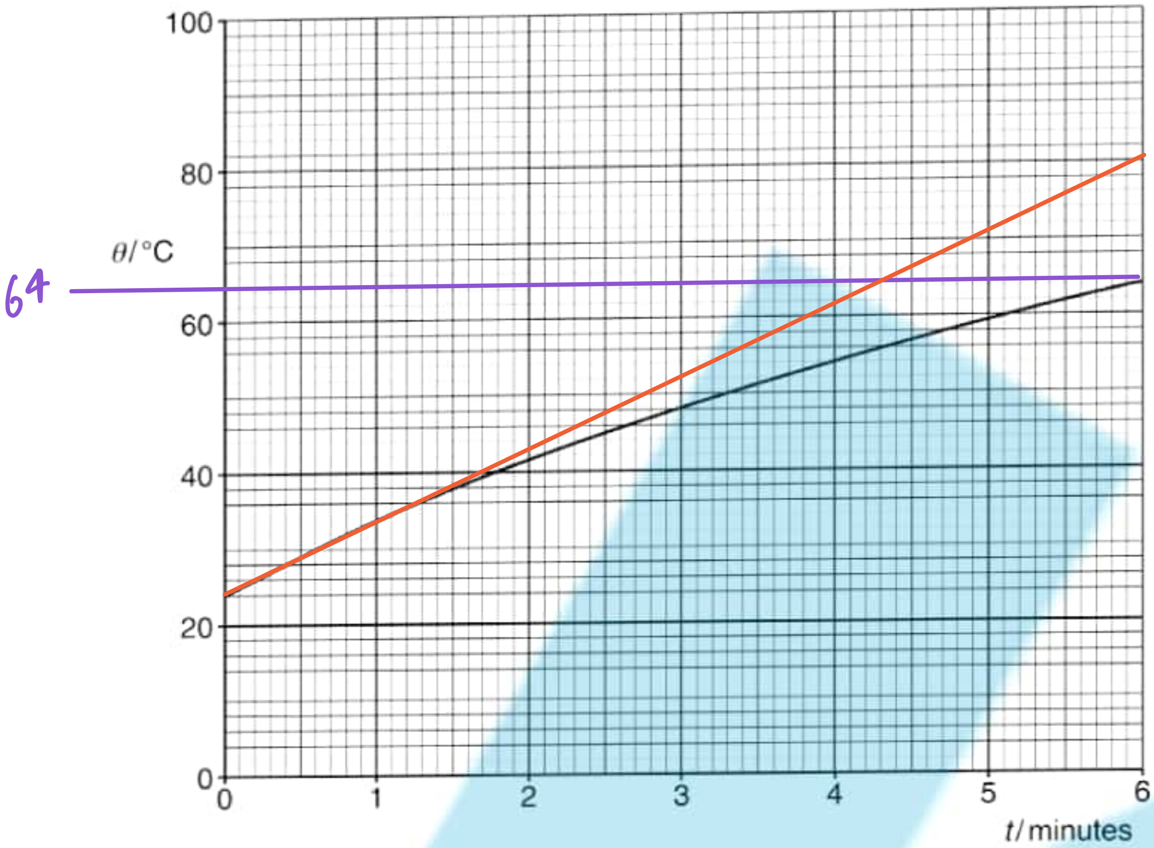

Fig. 1.1

1. Use the information in **(i)** to draw, on Fig. 1.1, a line to represent the temperature of the block, assuming no energy losses to the surroundings. [1]

2. Using Fig. 1.1, calculate the total energy loss to the surroundings during the heating process.

??

$95 \times 6 \times 60 = 0.67 \times 910 \times (40) + H$

$34200 = 24388 + H$

energy loss = 9812 J [2]

[Total: 10]

$f(x) = 4 - \sqrt{2}\sin\left(\frac{a}{2}\right) - a$

when $x = 2$ $\quad a = 3$

$f(x) = 0.7$ $\quad f(x) = -0.41$

#

(a) During melting, a solid becomes liquid with little or no change in volume.

Use kinetic theory to explain why, during the melting process, thermal energy is required although there is no change in temperature.

....

....

....

....

....[3]

(b) An aluminium can of mass 160 g contains a mass of 330 g of warm water at a temperature of 38 °C, as illustrated in Fig. 3.1.

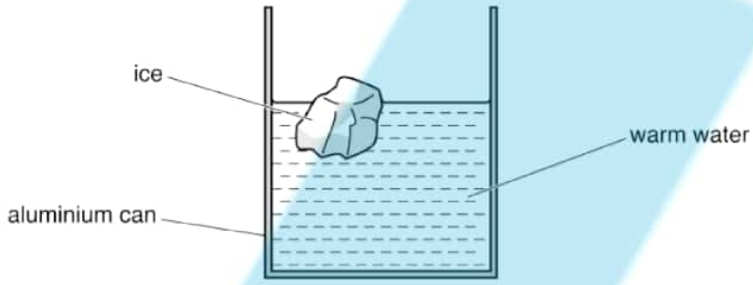

Fig. 3.1

A mass of 48 g of ice at −18 °C is taken from a freezer and put in to the water. The ice melts and the final temperature of the can and its contents is 23 °C.

Data for the specific heat capacity *c* of aluminium, ice and water are given in Fig. 3.2.

	c / J g^{-1} K^{-1}
aluminium	0.910
ice	2.10
water	4.18

Fig. 3.2

??

Assuming no exchange of thermal energy with the surroundings,

(i) show that the loss in thermal energy of the can and the warm water is 2.3×10^4 J,

(48×2.1×(0−25.5))+(48×L) + (48×4.18×−29.6) = (330×4.18×28.8) ((60×0.91×28.8)

+H

[2]

(ii) use the information in **(i)** to calculate a value *L* for the specific latent heat of fusion of ice.

L = ... J g^{-1} [2]

[Total: 7]