



Specific Heat Capacity and Latent heat questions

Name: _____

Class: _____

Date: _____

Time: **31 minutes**

Marks: **23 marks**

Comments:



Q1. A liquid flows continuously through a chamber that contains an electric heater. When the steady state is reached, the liquid leaving the chamber is at a higher temperature than the liquid entering the chamber. The difference in temperature is Δt .

Which of the following will increase Δt with no other change?

- | | |
|---|-----------------------|
| A Increasing the volume flow rate of the liquid | ☐ |
| B Changing the liquid to one with a lower specific heat capacity | ☐ |
| C Using a heating element with a higher resistance | ☐ |
| D Changing the liquid to one that has a higher density | ☐ |

(Total 1 mark)

Q2. A raindrop of mass m falls to the ground at its terminal speed v . The specific heat capacity of water is c and the acceleration of free fall is g . Given that 25% of the energy is retained in the raindrop when it strikes the ground, what is the rise in temperature of the raindrop?

- A** $\frac{mv^2}{8c}$
- B** $\frac{v^2}{4mc}$
- C** $\frac{mg}{4c}$
- D** $\frac{v^2}{8c}$

(Total 1 mark)

Q3. A thermometer has a thermal capacity of 1.3 J K^{-1} . The initial temperature of the thermometer is 20°C . When used to measure the temperature of 40 g of water, it measures 37°C .



- (a) Determine the energy absorbed by the thermometer when it is placed in the water.

(2)

- (b) Calculate the temperature change of the water as a result of introducing the thermometer.

specific heat capacity of water = $4.2 \times 10^3 \text{ J kg}^{-1} \text{ K}^{-1}$

(2)

(Total 4 marks)

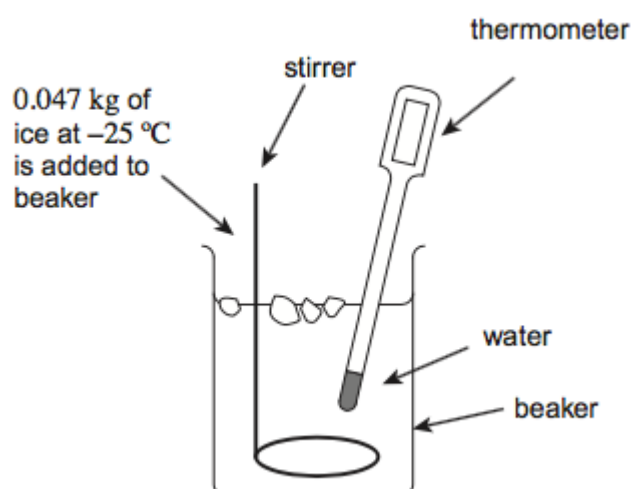
- Q4.(a)** Which statement explains why energy is needed to melt ice at 0°C to water at 0°C ?

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 $3.3 \times 10^5\text{ J kg}^{-1}$.

energy = J (1)

- (ii) The water loses $1.8 \times 10^4\text{ J}$ 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)

Q5.(a) Define the specific latent heat of vaporisation of water.

.....
.....



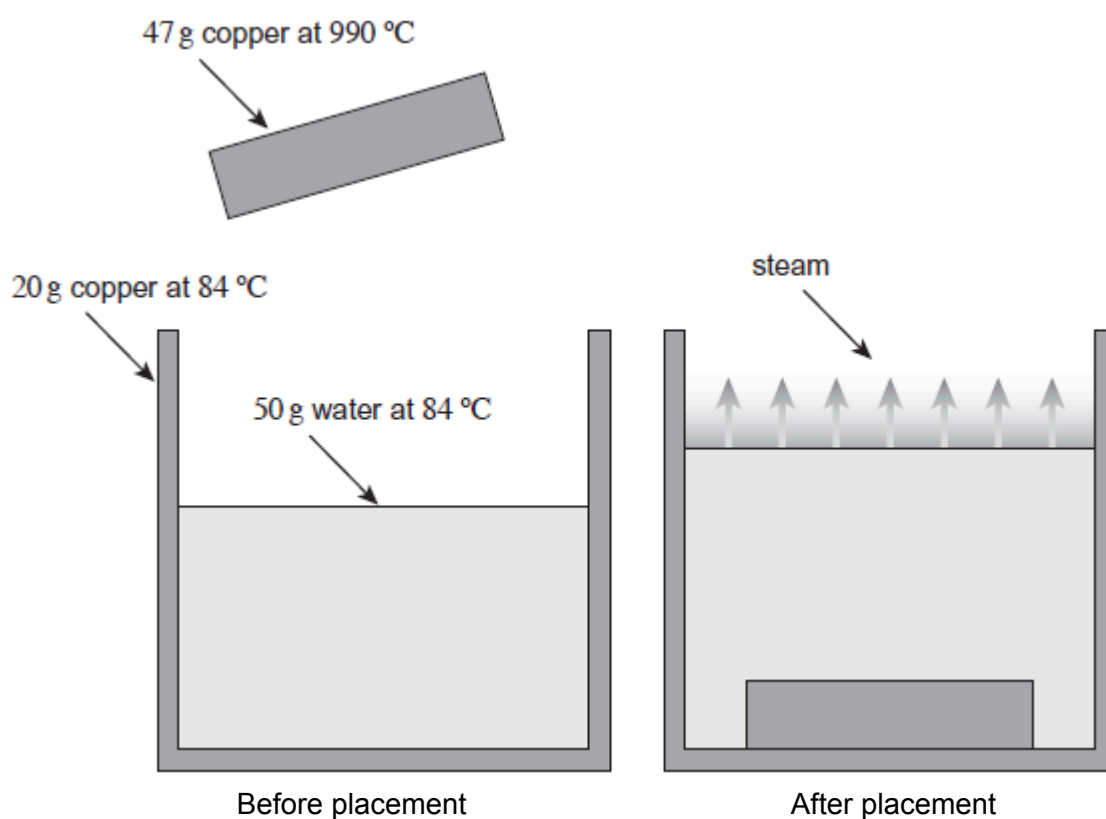
(2)

- (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⁻¹K⁻¹

specific heat capacity of water = 4200 J kg⁻¹K⁻¹

specific latent heat of vaporisation of water = 2.3×10^6 J kg⁻¹



- (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)

Q6. 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⁻¹K⁻¹

specific heat capacity of cola = 4190 J kg⁻¹K⁻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_i to a temperature of $3.0\text{ }^{\circ}\text{C}$ by adding ice at a temperature of $0\text{ }^{\circ}\text{C}$.
Calculate the mass of ice added.
Assume no heat is gained from or lost to the surroundings.

specific heat capacity of water = $4190\text{ J kg}^{-1}\text{ K}^{-1}$

specific latent heat of fusion of ice = $3.34 \times 10^5\text{ J kg}^{-1}$

mass kg

(3)

(Total 5 marks)



M1.B

[1]

M2.D

[1]

M3.(a) energy = heat capacity × temperature change

C1

22 J

A1

(2)

(b) $E = mc\theta$

C1

0.13 K condone °C / $\frac{\text{their(i)}}{168}$ (allow e.c.f. from (i))

A1

(2)

[4]

M4.(a) Tick in 4th box

1

(b) (i) (using heat energy = ml)
 energy = $0.047 \times 3.3 \times 10^5 = 1.6 \times 10^4$ (J) ✓ (1.55×10^4 J)
answer alone gains mark

1

(ii) (heat in from water = heat supplied to melt and raise ice temperature)



$1.8 \times 10^4 = 1.6 \times 10^4 + (\text{energy to raise temp of ice})$
 energy to raise temp of ice = 2×10^3 (J) ✓
answer alone gains mark allow 2, 2.5 or 3×10^3 J
allow CE if substitution is shown
 $1.8 \times 10^4 - (b)(i)$

1

(iii) (using heat energy = $mc\Delta T$)
 $c = 2 \times 10^3 / 0.047 \times 25$
 $= 2 \times 10^3$ ✓ (1.7×10^3) (note there is a large range of correct answers)
 $\text{J kg}^{-1} \text{K}^{-1}$ or $\text{J kg}^{-1} \text{°C}^{-1}$ ✓ (allow use of dividing line but don't allow °K and °C^{-1} is not the same as C^{-1})
only allow CE if substitutions are seen
 $c = (b)(ii) / 0.047 \times 25$
 $= b(ii) \times 0.851$
allow 1 sig fig.
common answers:
for 2.5×10^3 J gives 2.1×10^3 or 2×10^3
for 3×10^3 J gives 2.6×10^3 or 3×10^3

2

[5]

M5.(a) the energy required to change the state of a unit mass of water to steam / gas ✓
 when at its boiling point temperature / 100°C / without a change in temperature) ✓
allow 1 kg in place of unit
allow liquid to vapour / gas without reference to water
don't allow 'evaporation' in first mark

2

(b) (i) thermal energy given by copper block (= $mc\Delta T$)
 $= 0.047 \times 390 \times (990 - 100)$
 $= 1.6 \times 10^4$ (J) ✓
 2 sig figs ✓
can gain full marks without showing working
a negative answer is not given credit
sig fig mark stands alone

2

(ii) thermal energy gained by water and copper container
 (= $mc\Delta T_{\text{water}} + mc\Delta T_{\text{copper}}$)
 $= 0.050 \times 4200 \times (100 - 84) + 0.020 \times 390 \times (100 - 84)$



or
 $= 3500 \text{ (J)} \checkmark (3485 \text{ J})$
 available heat energy ($= 1.6 \times 10^4 - 3500$) $= 1.3 \times 10^4 \text{ (J)} \checkmark$

allow both 12000 J and 13000 J

allow CE from (i)

working must be shown for a CE

*take care in awarding full marks for the final answer –
 missing out the copper container may result in the correct
 answer but not be worth any marks because of a physics
 error*

(3485 is a mark in itself)

ignore sign of final answer in CE

(many CE's should result in a negative answer)

2

(iii) (using $Q = ml$)

$$m = 1.3 \times 10^4 / 2.3 \times 10^6$$

$$= 0.0057 \text{ (kg)} \checkmark$$

Allow 0.006 but not 0.0060 (kg)

allow CE from (ii)

*answers between 0.0052 $\rightarrow$ 0.0057 kg resulting from use of
 12000 and 13000 J*

1

[7]

M6.(i) (heat supplied by glass = heat gained by cola)

(use of $m_g c_g \Delta T_g = m_c c_c \Delta T_c$)

1st mark for RHS or LHS of substituted equation

$$0.250 \times 840 \times (30.0 - T_f) = 0.200 \times 4190 \times (T_f - 3.0) \checkmark$$

2nd mark for 8.4°C

$$(210 \times 30 - 210 T_f = 838 T_f - 838 \times 3)$$

$$T_f = 8.4(1) \text{ (°C)} \checkmark$$

Alternatives:

*8°C is substituted into equation (on either side shown will get
 mark) ✓*

resulting in 4620J~4190J ✓

or

*8°C substituted into LHS ✓ (produces $\Delta T = 5.5^\circ\text{C}$ and
 hence)*

$$= 8.5^\circ\text{C} \sim 8^\circ\text{C} \checkmark$$



8°C substituted into RHS ✓
(produces $\Delta T = 20^{\circ}\text{C}$ and hence)
 $= 10^{\circ}\text{C} \sim 8^{\circ}\text{C}$ ✓

2

- (ii) (heat gained by ice = heat lost by glass + heat lost by cola)
NB correct answer does not necessarily get full marks

(heat gained by ice = $mc\Delta T + ml$)
heat gained by ice = $m \times 4190 \times 3.0 + m \times 3.34 \times 10^5$ ✓
(heat gained by ice = $m \times 346600$)
3rd mark is only given if the previous 2 marks are awarded

heat lost by glass + heat lost by cola
 $= 0.250 \times 840 \times (8.41 - 3.0) + 0.200 \times 4190 \times (8.41 - 3.0)$ ✓
(= 5670 J)
(especially look for $m \times 4190 \times 3.0$)
the first two marks are given for the formation of the substituted equation not the calculated values

$m (=5670 / 346600) = 0.016 \text{ (kg)}$ ✓
if 8°C is used the final answer is 0.015 kg

or (using cola returning to its original temperature)
(heat supplied by glass = heat gained by ice)
(heat gained by glass = $0.250 \times 840 \times (30.0 - 3.0)$)
heat gained by glass = 5670 (J) ✓
(heat used by ice = $mc\Delta T + ml$)
heat used by ice = $m(4190 \times 3.0 + 3.34 \times 10^5)$ ✓ (= $m(346600)$)
 $m (=5670 / 346600) = 0.016 \text{ (kg)}$ ✓

3

[5]