1. When a gas in a container of fixed volume is heated, the pressure of the gas increases.

   Which statement explains this?
   A The molecules expand and get heavier, so they hit each other harder.
   B The molecules have less room to move, so they collide with each other more frequently.
   C The molecules hit the walls harder and less frequently.
   D The molecules move faster, so they collide with the walls more frequently.

2. What would be the resulting rise in temperature, in °C, when 2 kg of water are supplied with 220 000 J of heat energy, given that the specific heat capacity of water is 4200 J/kg °C ?

3. A metal toy car of mass 320 g was placed in a measuring cylinder of water. The water level rose to 260 cm^3 from 130 cm^3. What is the density of the metal?

4. Which one of the statements about changes of state is incorrect?
   a) A change of state requires energy to be transferred to or from a substance without changing its temperature
   b) A change of state involves changing the physical arrangement of the particles of the substance
   c) Conservation of mass applies to a change of state
   d) During the change from a liquid to a gas, the molecules experience a change in their chemical structure

5. How much energy is needed to raise the temperature of a 10kg block of iron from room temperature (20 °C) to its melting point (1535 °C) and then melt the block? The specific heat capacity of iron is 450 J/kg °C and the specific latent heat of fusion of iron is 272 000 J/kg.

6. Match the change of state with the name of the process.
   Choose the answers from: Condensing, Sublimating, Boiling, Melting.

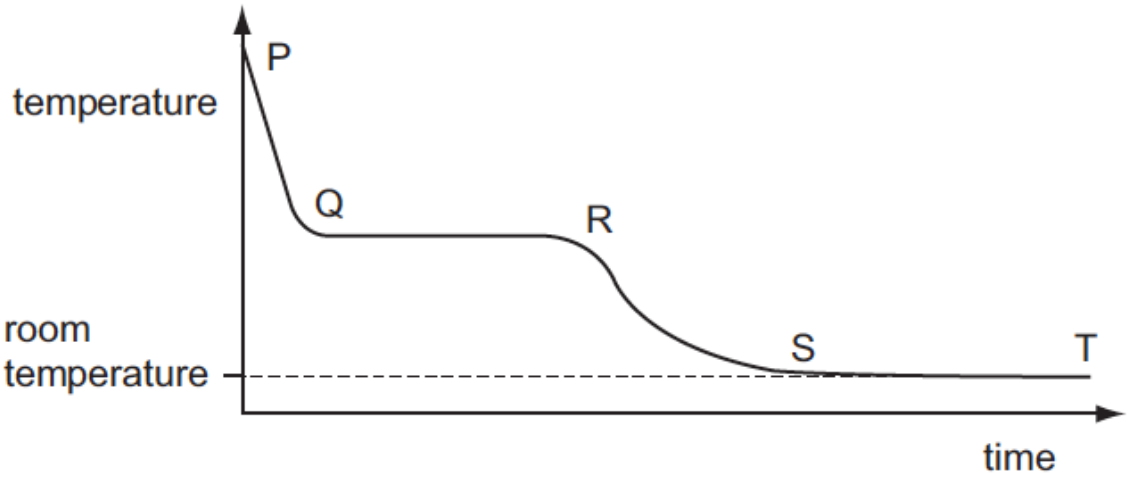
Change from solid to liquid	
Change from liquid to gas	
Change from gas to liquid	
Change from solid to gas	

7. An ice-cube has a mass of 7.50 g. The ice-cube is at 0°C.
Heat from the surroundings reaches the ice-cube at an average rate of 1.25 J / s.
How long does it take for all the ice to melt?
(specific latent heat of fusion of ice = 333 J / g)

8. An ice pack is used to cool 0.25 kg of water. The specific heat capacity of water is 4200 J/kg °C. How much thermal energy must the ice pack extract from the water to reduce the water temperature by 15 °C?

9. A gas is enclosed in a container of fixed volume. It gains heat energy from an external source. What happens to the molecules of the gas?
   A They expand.
   B They move faster inside the container.
   C They move further apart.
   D They vibrate with greater frequency.

10. A hot liquid is allowed to cool. The graph shows the cooling curve.



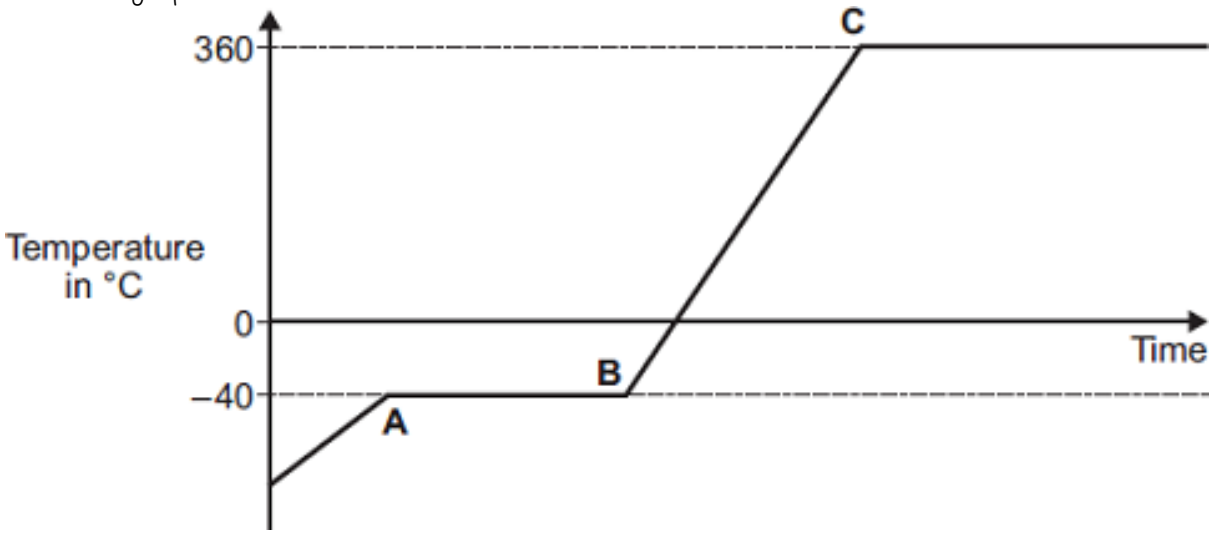
In which part of the curve is latent heat released?

A: PQ **B:** QR **C:** RS **D:** ST

11. What is meant by the specific latent heat of vaporisation?

12. Water can exist as either a liquid or a gas at 100 ^{O}C.
Explain why a mass of gaseous water at 100 ^{O}C contains more energy than an equal mass of liquid water at 100 ^{O}C.

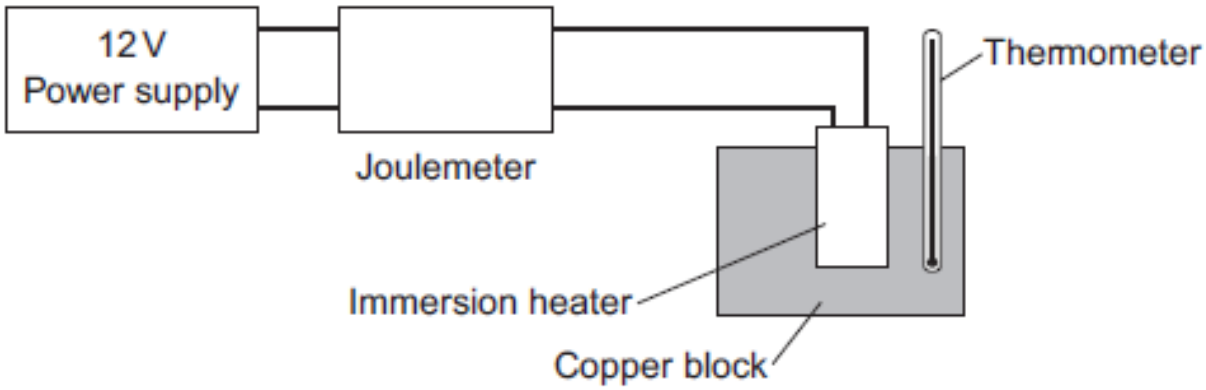
13. The graph shows how temperature varies with time for a substance as it is heated.
The graph is not drawn to scale.



Explain what is happening to the substance in sections AB and BC of the graph.
Section AB

Section BC

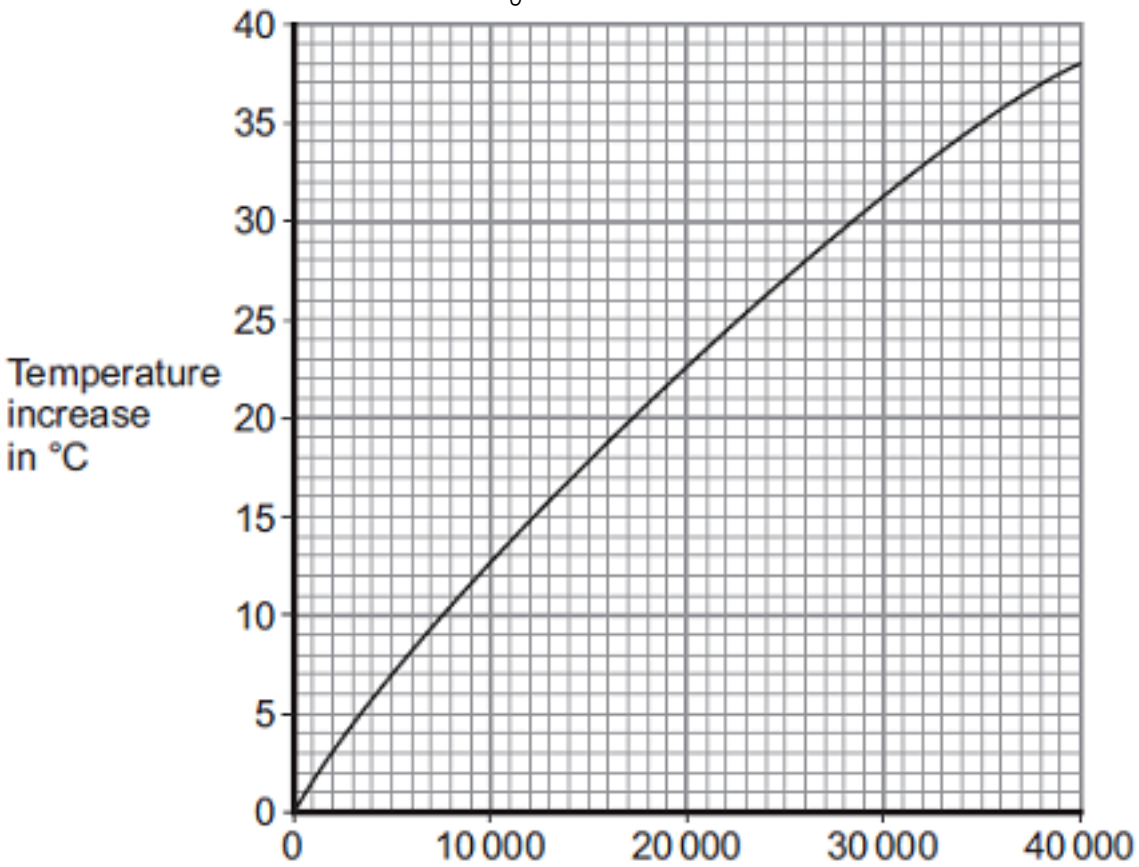
14. A student used the apparatus in Figure 1 to obtain the data needed to calculate the specific heat capacity of copper.



The initial temperature of the copper block was measured.
The power supply was switched on.
The energy transferred by the heater to the block was measured using the joulemeter.
The temperature of the block was recorded every minute.
The temperature increase was calculated.

Figure 2 shows the student's results.

Figure 2



(a) Energy is transferred through the copper block.
What is the name of the process by which the energy is transferred?

(b) Use Figure 2 to determine how much energy was needed to increase the temperature of the copper block by 35 °C.

(c) The copper block has a mass of 2 kg.

Use your answer to part (b) to calculate the value given by this experiment for the specific heat capacity of copper. Give the unit.

(d) This experiment does not give the correct value for the specific heat of copper.
Suggest one reason why.

Annotated answers

1. When a gas in a container of fixed volume is heated, the pressure of the gas increases.

   Which statement explains this?
   A The molecules expand and get heavier, so they hit each other harder.
   B The molecules have less room to move, so they collide with each other more frequently.
   C The molecules hit the walls harder and less frequently.
   D The molecules move faster, so they collide with the walls more frequently.
   The particles have increased their kinetic energy so they will move faster.

2. What would be the resulting rise in temperature, in °C, when 2 kg of water are supplied with 220 000 J of heat energy, given that the specific heat capacity of water is 4200 J/kg °C ?

Energy transferred = mass x specific heat capacity x change in temperature $\Delta E = m \times c \times \Delta\theta$

$220\,000 = 2 \times 4200 \times \Delta\theta$

$220\,000 = 8400 \times \Delta\theta$

$\Delta\theta = 220\,000 / 8400 = 26.2\ ^\circ C$

3. A metal toy car of mass 320 g was placed in a measuring cylinder of water. The water level rose to 260 cm^3 from 130 cm^3. What is the density of the metal?

Density = mass / volume
First calculate volume of car: 260 – 130 = 130 cm^3
Density = 320 / 130 = 2.46 g / cm^3

4. Which one of the statements about changes of state is incorrect?
   a) A change of state requires energy to be transferred to or from a substance without changing its temperature
   b) A change of state involves changing the physical arrangement of the particles of the substance
   c) Conservation of mass applies to a change of state
   d) During the change from a liquid to a gas, the molecules experience a change in their chemical structure

5. How much energy is needed to raise the temperature of a 10kg block of iron from room temperature (20 °C) to its melting point (1535 °C) and then melt the block? The specific heat capacity of iron is 450 J/kg °C and the specific latent heat of fusion of iron is 272 000 J/kg.

Energy transferred = mass x specific heat capacity x change in temperature $\Delta E = m \times c \times \Delta\theta$
Energy transferred = mass x specific latent heat $\Delta E = m \times L$

For this question, we need to split it into two sections. First, we use this formula, $\Delta E = m \times c \times \Delta\theta$, to calculate the energy required to raise the temperature of iron from 20^0C to 1535^0C. We then need to use the formula $\Delta E = m \times L$, to calculate the energy required to change the state of iron (solid to liquid).

For the change in temperature we use this equation: $\Delta E = m \times c \times \Delta\theta$

First calculate the change in temperature.
Change in temperature = final temperature – initial temperature = 1535 – 20 = 1515
Substitute the values from the question into the equation: $\Delta E = 5 \times 450 \times 1515$
$\Delta E = 3\,408\,750\,J$

For the change in state we use this equation $\Delta E = m \times L$
Substitute the values from the question into the equation: $\Delta E = 5 \times 272\,000$
$\Delta E = 1\,360\,000\,J$

To calculate the total amount of energy used we add to two figures together
Total energy transferred = 3 408 750J + 1 360 000J = 4 768 750J

6. Match the change of state with the name of the process.
Choose the answers from: Condensing, Sublimating, Boiling, Melting.

Change from solid to liquid	Melting
Change from liquid to gas	Boiling
Change from gas to liquid	Condensing
Change from solid to gas	Sublimating

7. An ice-cube has a mass of 7.50 g. The ice-cube is at 0°C.
Heat from the surroundings reaches the ice-cube at an average rate of 1.25 J / s.
How long does it take for all the ice to melt?
(specific latent heat of fusion of ice = 333 J / g)

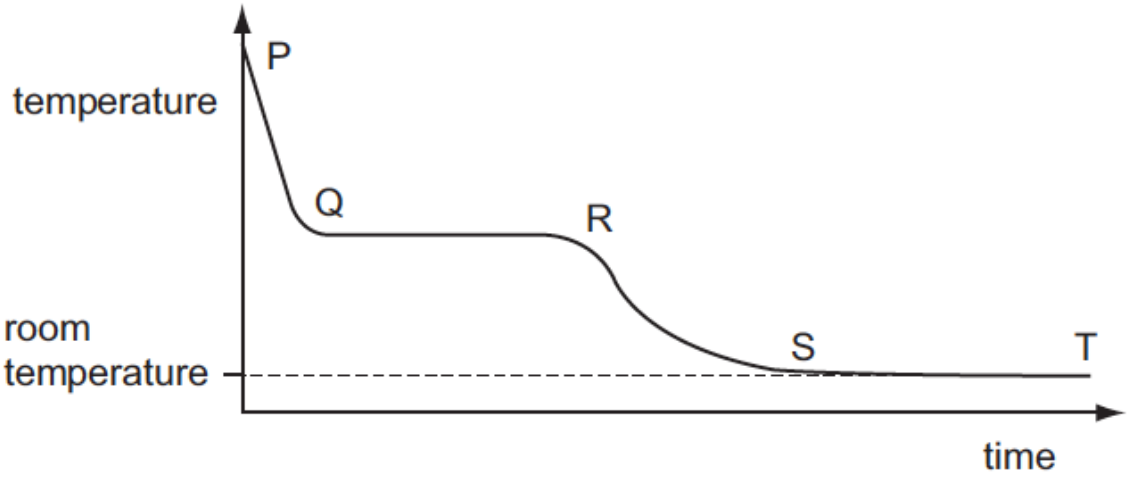
First we need to calculate the energy required to melt the ice. Once that is done you can divide the total energy by the energy reaching the ice cube per second to calculate the time.
Energy transferred = mass x specific latent heat $\Delta E = m \times L$
$E = 7.5 \times 333 = 2497.5\ J$
Total time to melt = total energy / energy per second
Total time to melt = 2497.5 / 1.25 = 1998 seconds

8. An ice pack is used to cool 0.25 kg of water. The specific heat capacity of water is 4200 J/kg °C. How much thermal energy must the ice pack extract from the water to reduce the water temperature by 15 °C? (16kJ)

Energy transferred = mass x specific heat capacity x change in temperature $\Delta E = m \times c \times \Delta\theta$
$E = 0.25 \times 4200 \times 15 = 15\,750J$

9. A gas is enclosed in a container of fixed volume. It gains heat energy from an external source.
What happens to the molecules of the gas?
A They expand.
B They move faster inside the container.
C They move further apart.
D They vibrate with greater frequency.

10. A hot liquid is allowed to cool. The graph shows the cooling curve.



In which part of the curve is latent heat released?
A: PQ B: QR C: RS D: ST

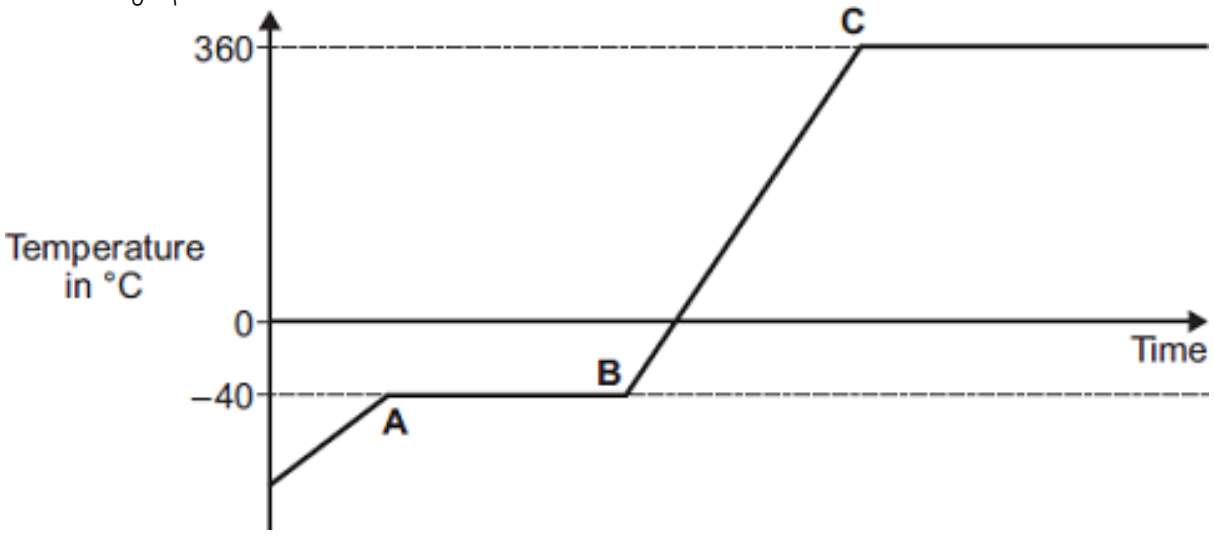
11. What is meant by the specific latent heat of vaporisation?

The energy required to change the state of 1kg liquid to a gas or 1kg of gas to a liquid

12. Water can exist as either a liquid or a gas at 100 ^{O}C.
Explain why a mass of gaseous water at 100 ^{O}C contains more energy than an equal mass of liquid water at 100 ^{O}C.

The internal energy of a system is the sum of the kinetic energy and potential energy of the particles.
Both liquid and gaseous water at 100 ^{O}C have the same kinetic energy.
Gaseous water contains more energy because it has a higher potential energy than liquid water.

13. The graph shows how temperature varies with time for a substance as it is heated.
The graph is not drawn to scale.



Explain what is happening to the substance in sections AB and BC of the graph.

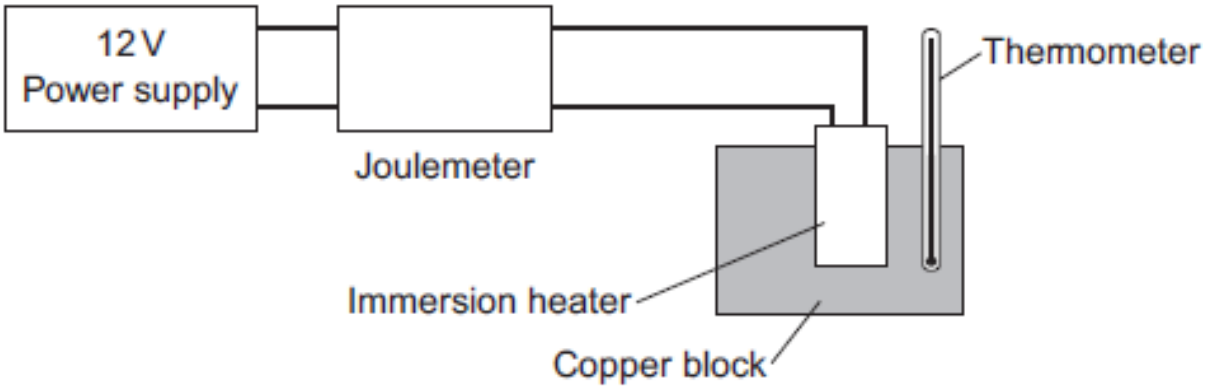
Section AB

The substance is changing state. We can assume it is melting because there is another change of state (boiling) at C. The potential energy of the particles has increased

Section BC

The liquid is increasing in temperature. The kinetic energy of the particles has increased. At C the liquid has reached its boiling point.

14. A student used the apparatus in Figure 1 to obtain the data needed to calculate the specific heat capacity of copper.



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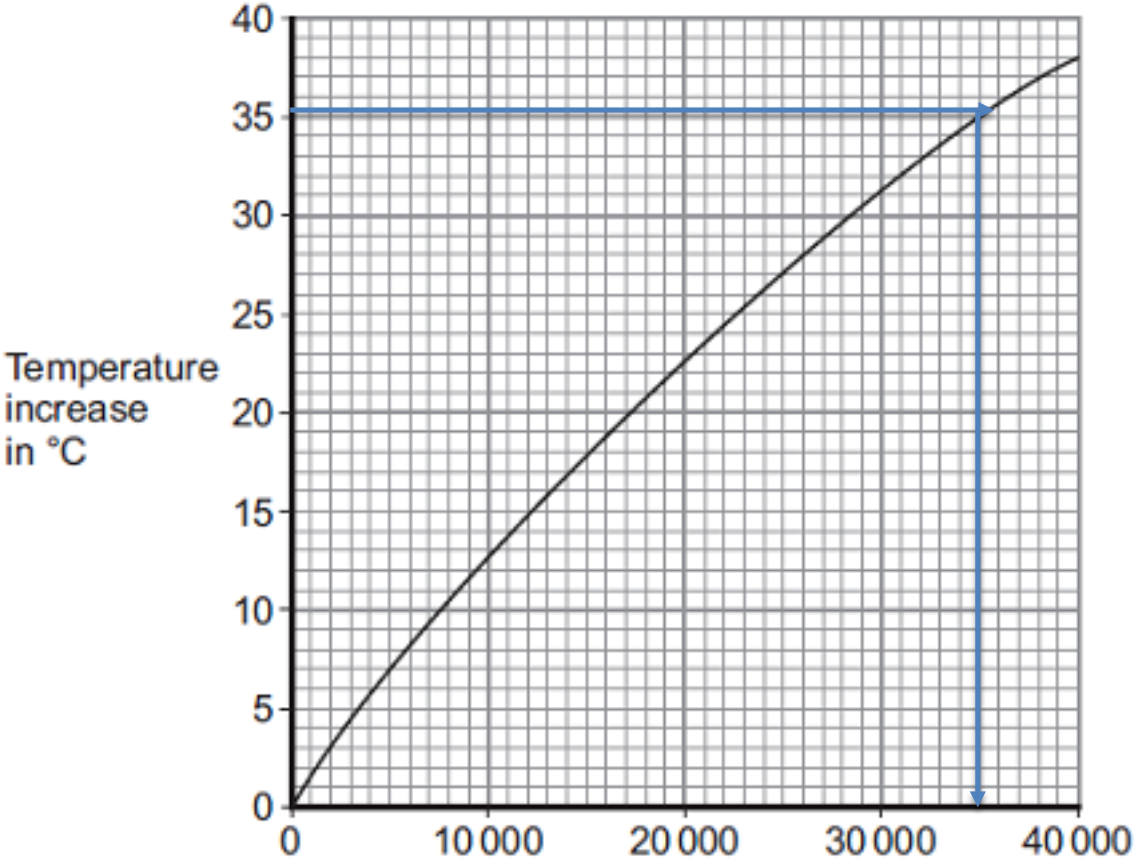

(a) Energy is transferred through the copper block.
What is the name of the process by which the energy is transferred?
CONDUCTION

(b) Use Figure 2 to determine how much energy was needed to increase the temperature of the copper block by 35 ^{O}C.

35000 J (see graph)

(c) The copper block has a mass of 2 kg.

Use your answer to part (b) to calculate the value given by this experiment for the specific heat capacity of copper. Give the unit.

Energy transferred = mass x specific heat capacity x change in temperature $\Delta E = m \times c \times \Delta\theta$

$35000 = 2 \times c \times 35$

$35000 = 70 \times c$

$c = 500$ J/Kg ^{O}C

(d) This experiment does not give the correct value for the specific heat of copper. Suggest one reason why.

Energy lost from the block to the atmosphere. This could be reduced by insulating the block.