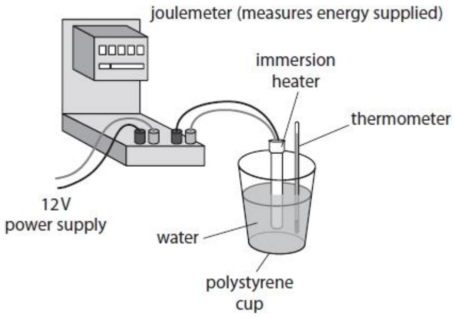
Q1.
A student uses the apparatus in Figure 3 to determine the specific heat capacity of water.



(i) State the measurements needed to calculate the specific heat capacity of water. (4)

(ii) State **two** ways that the apparatus could be adapted to improve the procedure.
(2)

Q2.
A student wants to determine the specific heat capacity of copper.
Figure 2 shows a piece of copper, with a thread tied around it, in a glass beaker of boiling water.

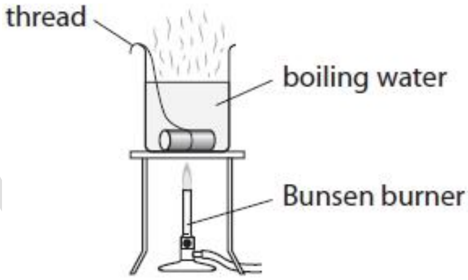


Figure 2

The student leaves the piece of copper in the boiling water so that the copper reaches a temperature of 100 °C. The student uses the thread to take the piece of copper out of the boiling water. The student puts the hot piece of copper into a different beaker of cold water at 20 °C.
The apparatus is shown in Figure 3.

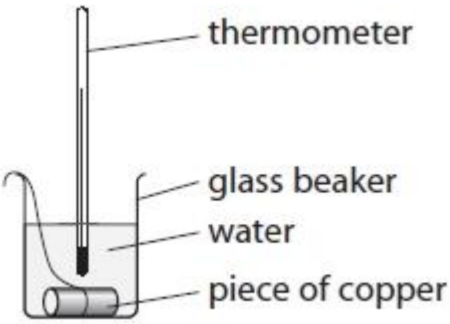


Figure 3

The student assumes that the thermal energy gained by the water equals the thermal energy lost by the piece of copper.
The water and copper both reach a temperature of 22 °C.
The cold water gains 1050 J of energy. The mass of the piece of copper is 0.058 kg.
(i) Calculate a value for the specific heat capacity of copper, using these results. Use the equation $\Delta Q = m \times c \times \Delta\theta$ (2)
(ii) The value for the specific heat capacity of copper obtained from the student's results is lower than the correct value.
State **two** ways that the experiment could be improved to give a value that is closer to the correct value. (2)

Q3.
A steel ball has a volume of 3.6 cm^3 and a mass of 28 g.
(i) Calculate the density of steel in kg/m^3. (3)

(ii) The steel ball is at a room temperature of 20 °C. It is then put in a pan of boiling water maintained at 100 °C. Calculate how much thermal energy the ball gains as its temperature increases from 20 °C to 100 °C. Specific heat capacity of steel = 510 J/kg °C. Use an equation selected from the list of equations at the end of this paper. (2)

(iii) The steel ball is put into a furnace where it melts. Compare the motion of particles in the steel when they are in the solid state with their motion when in the molten (liquid) state. (3)

Q4.
A beaker contains 0.25 kg of water at room temperature.
The beaker of water is heated until the water reaches boiling point (100 °C).
The specific heat capacity of water is 4200 J/kg °C.
The total amount of thermal energy supplied to the water is 84 000 J.
(i) Calculate the temperature of the water before it was heated.
Use an equation selected from the list of equations from the relevant equation sheet. (3)

(ii) The heating continues until 0.15 kg of the water has turned into steam.
The thermal energy needed to turn the boiling water into steam is 0.34 MJ.
Calculate the specific latent heat of vapourisation of water.
Use an equation selected from the list of equations from the relevant equation sheet.
(2)

(iii) The graph in Figure 6 shows how the **volume** of 1 kg of water changes with temperature.

Describe how the **density** of water changes with temperature over the range of temperature shown in Figure 6.
Calculations are not required. **(2)**

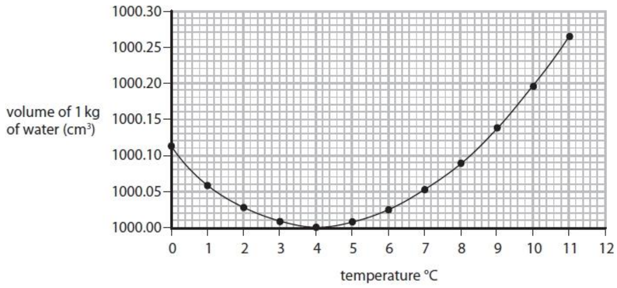


Figure 6

Q5.
Figure 1 shows a small piece of copper about 3 cm high.

A student wants to determine the density of copper.
The student uses a balance to measure the mass of the piece of copper.
(i) Explain how the student could measure the volume of the piece of copper. **(3)**


© David J. Green/Alamy Stock Photo
Figure 1

(ii) The mass of the piece of copper is 0.058 kg.
The volume of the piece of copper is 6.5×10^{-6} m^3.
Calculate the density of copper. **(2)**

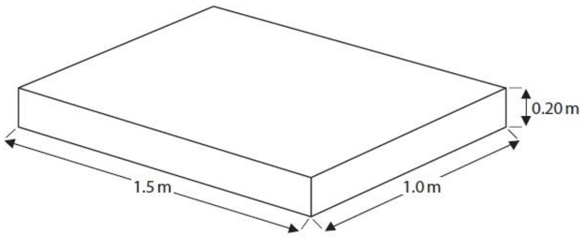


Figure 3

Q6.
Figure 3 shows the dimensions of a solid block of concrete.
Density of concrete, ρ, = 2100 kg / m^3.
Calculate the mass of the concrete block.
Use the equation $m = \rho \times V$ **(3)**

Q7.
Figure 3 shows some water in a measuring cylinder and a lump of iron.

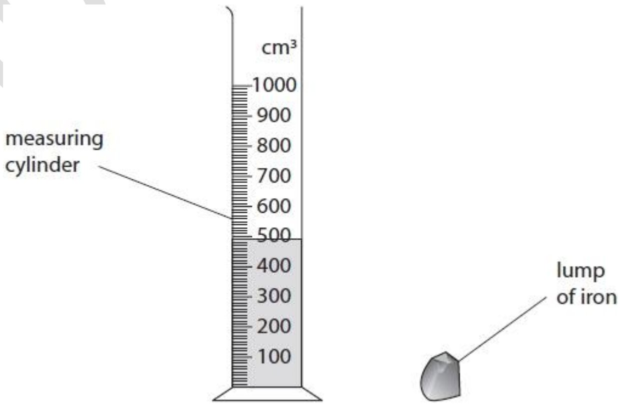


Figure 3

The lump of iron is lowered fully into the water.
The water level in the measuring cylinder rises to 530 cm^3.
The density of iron is 7.9 g / cm^3.
Calculate the mass of the lump of iron.
Use the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Give your answer to 2 significant figures. **(4)**

Q8.
On a very cold day, the temperature of the air is −4 °C.
Calculate the value of this temperature on the kelvin scale. **(1)**

Q9.
An electric kettle contains 1.41 kg of water at 25 °C.
The kettle is switched on.
After a while, the water reaches boiling point at 100 °C.
The specific heat capacity of water is 4200 J / kg °C.
(i) Calculate the amount of thermal energy supplied to the water by the kettle.
Give your answer to the appropriate number of significant figures.
Use an equation selected from the list of equations at the end of the paper.
(3)

(ii) The kettle is kept switched on and the water continues to boil.
After a while, the mass of the water in the kettle has decreased to 1.21 kg.
The thermal energy supplied to the water during this time was 450 000 J.
Calculate the specific latent heat of vaporisation of water.
Use an equation selected from the list of equations at the end of the paper. **(3)**

Q10.
Another student decides to melt some ice.
The student melts 380 g of ice at 0 °C.
The specific latent heat of fusion of ice is 3.34 × 105 J/kg.
Calculate the thermal energy needed to melt the ice.
Select an equation from the list of equations at the end of this paper. **(2)**

Q11.
The espresso machine shown in Figure 27 is an electrical appliance.


(Source: © tanawaty/123RF)

The espresso machine has an electrical heater connected to a 440 V mains supply.
The power of the electrical heater is 3.5 kW.
(i) The rating of a fuse is the current above which it melts.
Which of these is the most suitable fuse for the espresso machine circuit? **(1)**

☐ **A** 1 A
☐ **B** 5 A
☐ **C** 10 A
☐ **D** 13 A

(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.
The specific heat capacity of water is 4200 J/kg K.
Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18°C to 95°C.

Q12.
The espresso machine shown in Figure 27 is an electrical appliance.
The espresso machine has a steam pipe that can be used to heat milk in a jug.
Steam from the pipe enters the milk, where steam condenses to water.
The steam and hot water heat the milk.
(i) Describe, in terms of energy, how the arrangement and movement of particles in the steam changes as the steam enters the milk, condenses and cools.
(2)

(ii) The specific heat capacity of milk is 3840 J/kg K.
The specific heat capacity of water is 4200 J/kg K.
The specific latent heat of condensation of steam is 2260 kJ/kg.
The temperature of the steam is 100°C
The mass of steam that condenses is 25 g.
The temperature of the milk rises from 5°C to 65°C.
By considering the transfer of energy from the steam to the milk, calculate the mass of milk that is heated by the steam and hot water.
Use equations from the formula sheet.
(4)

(iii) Give **two** reasons why the actual mass of steam needed to heat the milk from 5°C to 65°C is greater than 25 g.
(2)

Q13.
* This question is about determining the specific heat capacity of aluminium.
An aluminium block is placed in boiling water as shown in Figure 10.

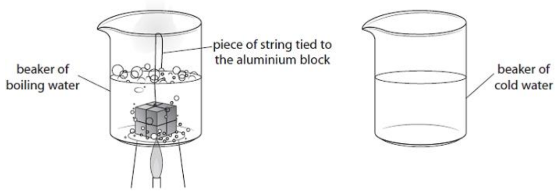


Figure 10

The piece of string is tied to the aluminium block so the block can be transferred from the boiling water to the cold water.
Describe how a student could use this apparatus, and any additional items needed, to determine the specific heat capacity of aluminium.
Your answer should include how the student would

- obtain the necessary measurements
- use the measurements to calculate the specific heat capacity of aluminium.

(6)

Q14.
A student measures the density of glass.
The student has
− a bag of marbles, all made from the same type of glass
− a weighing balance
− a plastic measuring cylinder containing water
Describe how the student could find, as accurately as possible, the density of the glass used for the marbles.

(4)

Q15.
Describe, in terms of particles, **two** differences between a solid and a liquid of the same substance.

(2)

Q16.
Describe what happens when a substance experiences sublimation.

(2)

Q17.
Figure 10 shows some apparatus that may be used to determine the specific heat capacity of water.

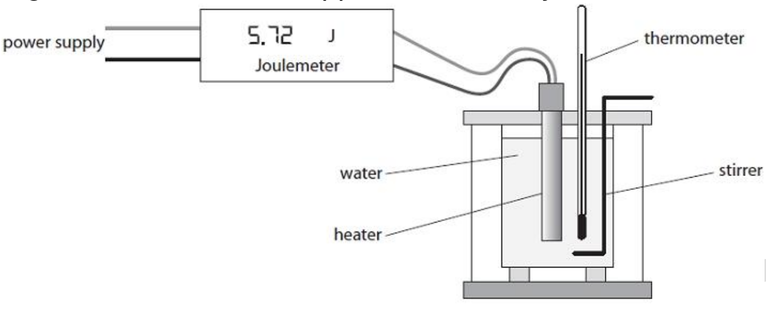


Figure 10

A student measures the initial temperature of the water.
The power supply is switched on for 10 minutes and then switched off.
Explain how the student should then obtain an accurate reading for the final temperature of the water, to be used in the calculation of the specific heat capacity. **(3)**

Q18.
* A container of gas is at room temperature.
The gas is then heated. The volume of the container remains the same.
By considering changes in velocities of the gas particles, explain how the temperature increase affects
- the average kinetic energy of the particles
- the pressure the particles exert on the walls of the container.

(6)

Q19.
Explain the difference between the term 'specific heat capacity' and the term 'specific latent heat' when applied to heating substances.

(2)

Q20.

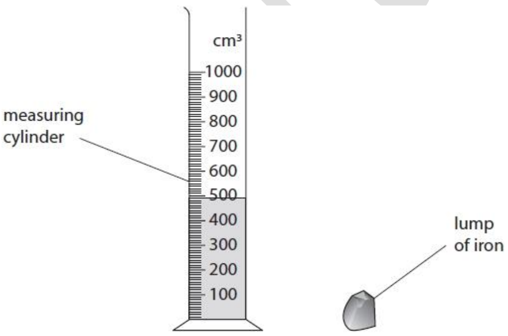


Figure 3

Figure 3 shows some water in a measuring cylinder and a lump of iron.

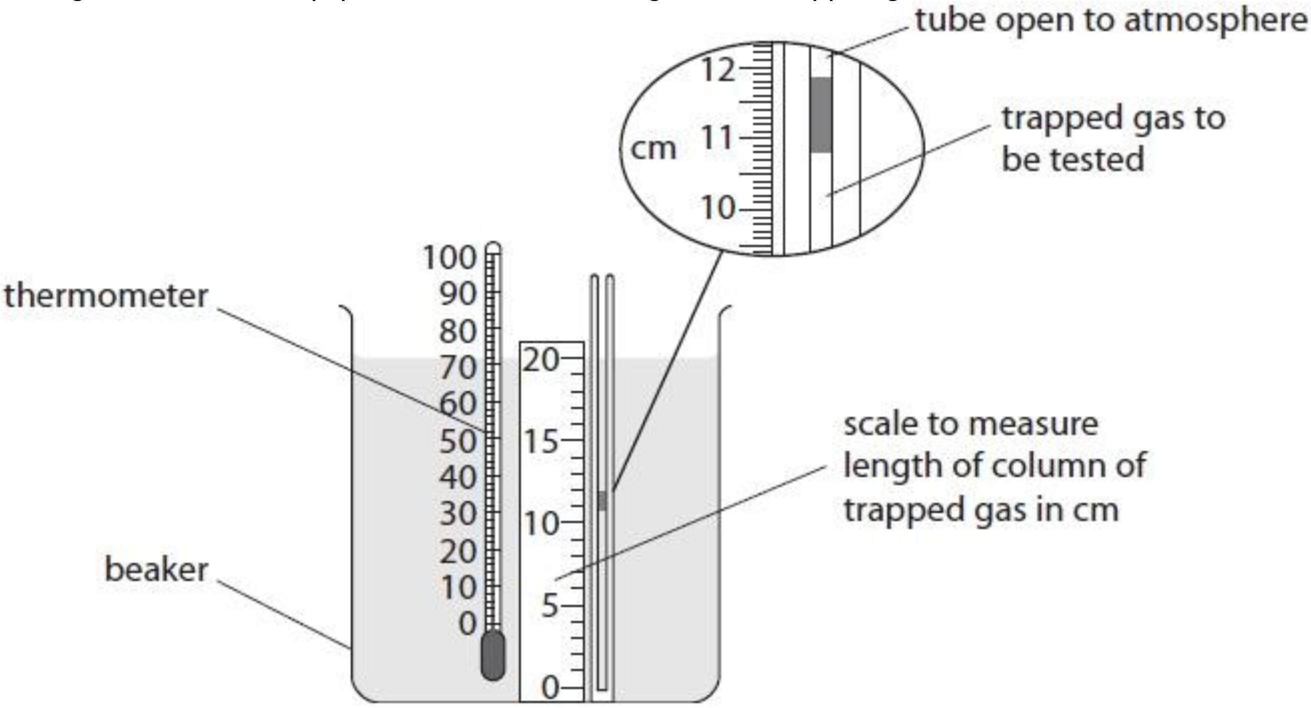
The lump of iron is lowered fully into the water.
The water level in the measuring cylinder rises to 530 cm^3.
The density of iron is 7.9 g / cm^3.
To find the mass of the lump of iron you would use the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

A piece of wood has a similar shape and volume to the lump of iron.
The density of the wood is 0.82 g / cm^3.
The density of water is 1.00 g / cm^3
Explain why the method used for the lump of iron cannot be used to determine the mass of the piece of wood.

(2)

Q21.
A student investigates how the volume of a gas changes when its temperature increases.
The diagram shows the equipment used and the length of the trapped gas at 25°C.



(a) (i) Use the scale to estimate the length of the column of trapped gas.
(1)

length of column of trapped gas = ... cm

(ii) The cross-sectional area of the capillary tube is 1.94×10^{-3} cm^2. The volume of the column of trapped gas at 25°C is about **(1)**

- ☒ **A** $5.6 \times 10^{+3}$ cm^3
- ☒ **B** 2.1×10^{-2} cm^3
- ☒ **C** 2.1×10^{-3} cm^3
- ☒ **D** 5.6×10^{-4} cm^3

(iii) The gas is heated to 50°C.
The volume of the trapped gas at 50°C is 2.31×10^{-2} cm^3.
Calculate the volume of the trapped gas at 100°C.
(3)

(b) Describe how the average kinetic energy of the particles of the gas changes as the temperature of the gas changes.
(3)

Q22.

Kinetic theory describes the behaviour of gas particles.
(a) (i) At −273 °C the particles in a gas are **(1)**

- ☒ **A** moving rapidly
- ☒ **B** moving slowly
- ☒ **C** stationary
- ☒ **D** vibrating

(ii) The temperature of a gas changes from 300 K to 150 K.
State how the average kinetic energy of the gas particles changes.
(1)

(b) The photograph shows a weather balloon filled with helium.
When released the balloon rises rapidly to a height of 30 000 m above the Earth.

Explain how the helium gas exerts a pressure on the balloon.

(3)

(c) On the surface of the Earth the weather balloon has a volume of 9.1 m^3, when the temperature is 0 °C and the pressure inside the balloon is 101 kPa. At 30 000 m above the Earth, the temperature is −46 °C and the pressure inside the balloon is 1.12 kPa.

(i) Show that −46 °C is 227 K.

(1)

(ii) Calculate the volume of the weather balloon when it is at a height of 30 000 m.

(3)

(iii) Suggest what will happen to the balloon as it carries on rising above 30 000 m.

(1)

Q23.

As part of the testing of different types of steel, a steelworker needs to obtain a temperature-time graph for **solidifying** molten steel.
Figure 6 shows an arrangement the steelworker could use.

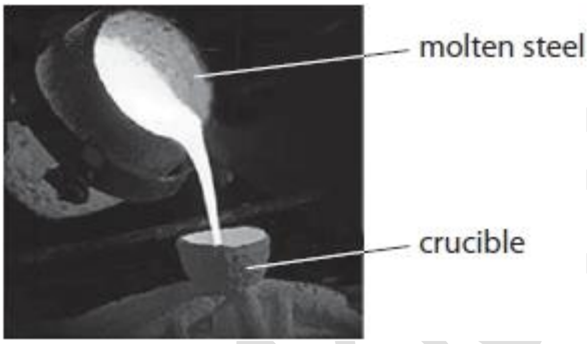


Figure 6

The following devices are available to the steel worker.
The melting point of these steels is between 1425 and 1540 °C

device	range of temperatures	other notes
Thermocouple thermometer	−50 to 1800 °C	Fast response time Probe inserted into melt
Infrared thermometer (pyrometer)	1200 to 2000 °C	Remotely read, using infrared radiation, measures the temperature of the surface it is aimed at
Platinum resistance thermometer	−200 to 850 °C	The most accurate of thermometers based on how resistance changes with temperature

Describe how the steelworker could obtain a temperature-time graph for steel as it goes from the liquid to the solid state.

(4)

Q24.

A student uses the apparatus in Figure 3 to determine the specific heat capacity of water.

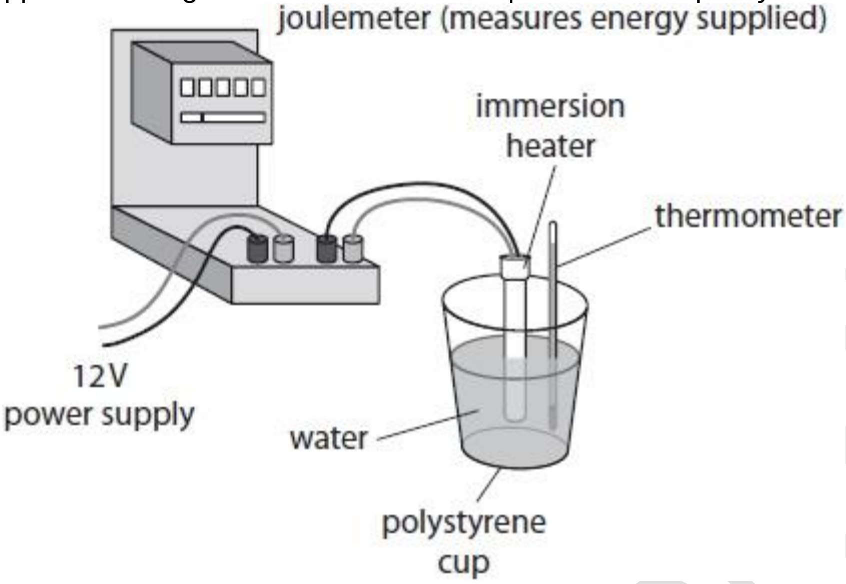


Figure 3

The student decides to measure the temperature of the water every minute while it is being heated.
Figure 4 shows a graph of the student's results.

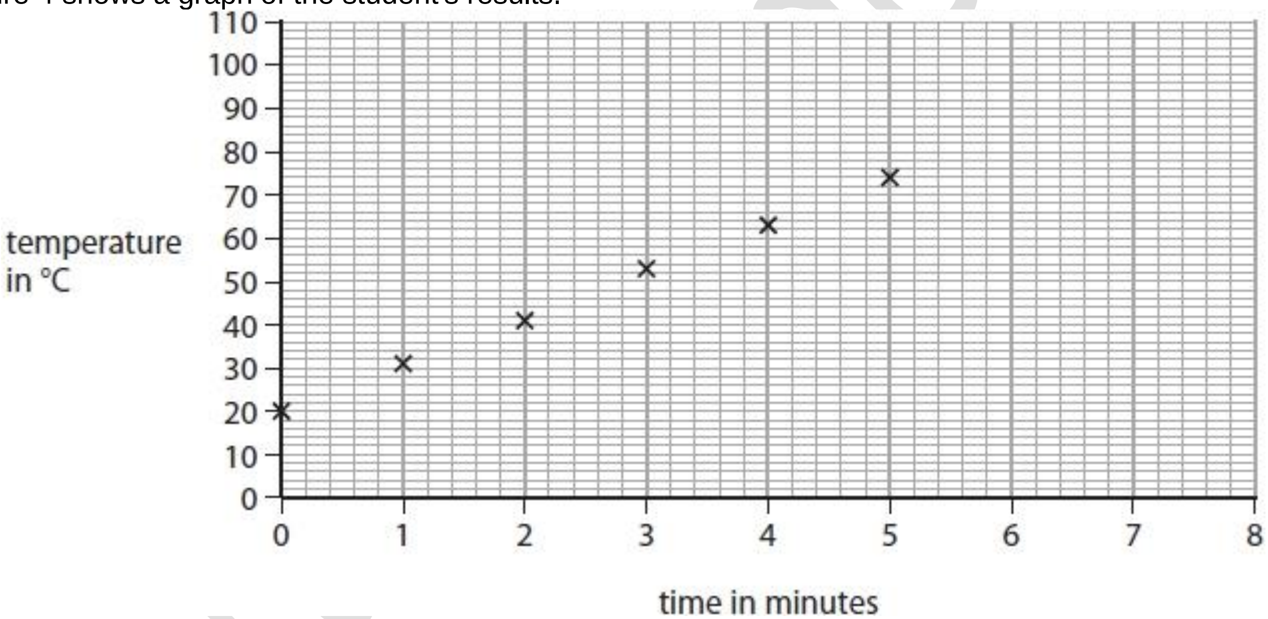


Figure 4

Predict the temperature of the water if the heating continues up to 8 minutes.

(1)

Q25.

Figure 4 shows a shed made mostly of concrete blocks.

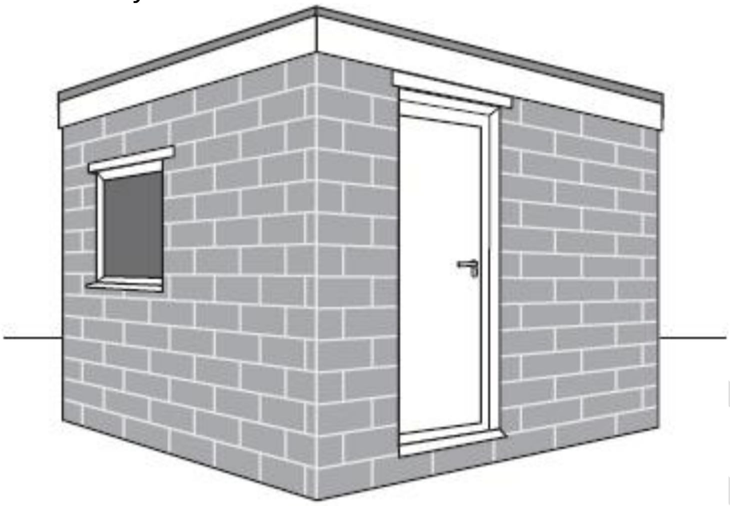


Figure 4

State **two** practical ways to reduce heat loss from this shed.

(2)

1 ....

....

2 ....

....

Q26.

When water boils and turns into steam, there are changes in the arrangement of particles and the density.

Which of these shows the changes?

(1)

		space between particles in steam	density of steam
☒	**A**	bigger than in water	greater than water
☒	**B**	bigger than in water	less than water
☒	**C**	smaller than in water	greater than water
☒	**D**	smaller than in water	less than water