

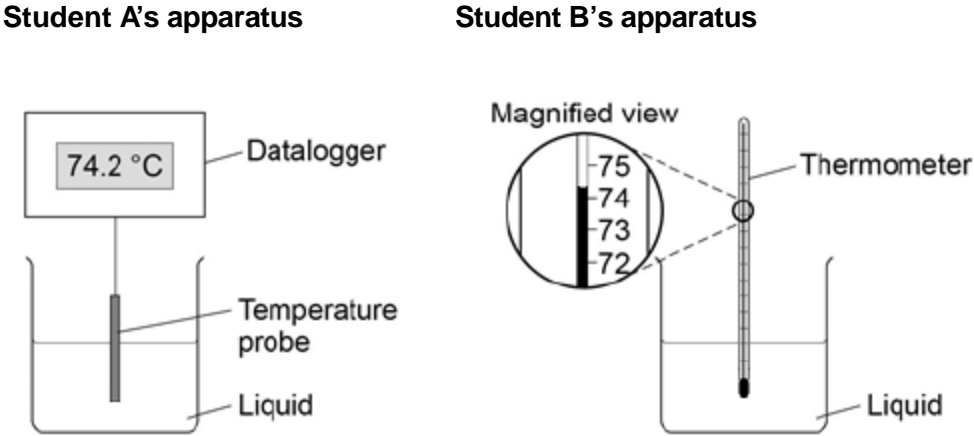
1

Two students investigated the change of state of stearic acid from liquid to solid.

They measured how the temperature of stearic acid changed over 5 minutes as it changed from liquid to solid.

Figure 1 shows the different apparatus the two students used.

Figure 1



(a) Choose **two** advantages of using student **A's** apparatus.

Tick **two** boxes.

Student **A's** apparatus made sure the test was fair.

Student **B's** apparatus only measured categoric variables.

Student **A's** measurements had a higher resolution.

Student **B** was more likely to misread the temperature.

(2)

- (b) Student **B** removed the thermometer from the liquid each time he took a temperature reading.

What type of error would this cause?

Tick **one** box.

A systematic error

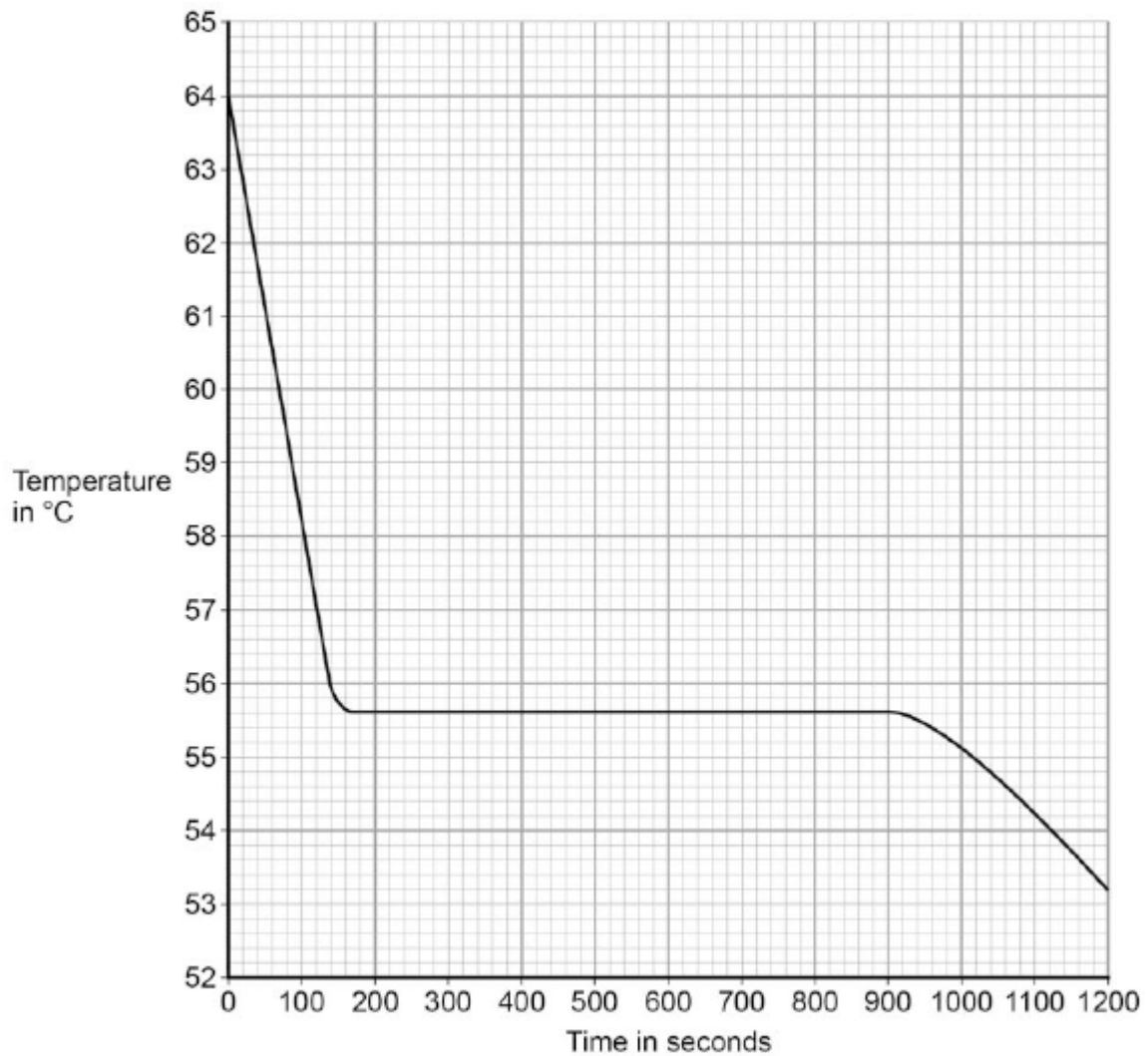
A random error

A zero error

(1)

- (c) Student **A**'s results are shown in **Figure 2**.

Figure 2



What was the decrease in temperature between 0 and 160 seconds?

Tick **one** box.

8.2 °C

8.4 °C

53.2 °C

55.6 °C

(1)

- (d) Use **Figure 2** to determine the time taken for the stearic acid to change from a liquid to a solid.

Time = seconds

(1)

- (e) Calculate the energy transferred to the surroundings as 0.40 kg of stearic acid changed state from liquid to solid.

The specific latent heat of fusion of stearic acid is 199 000 J / kg.

Use the correct equation from the Physics Equations Sheet.

.....
.....
.....

Energy = J

(2)

- (f) After 1200 seconds the temperature of the stearic acid continued to decrease.

Explain why.

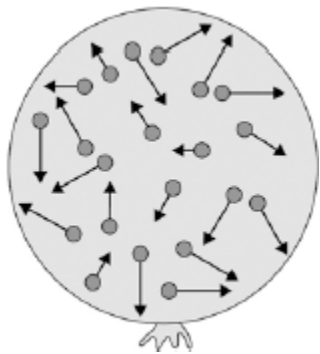
.....
.....
.....
.....

(2)

(Total 9 marks)

2

The figure below shows a balloon filled with helium gas.



(a) Describe the movement of the particles of helium gas inside the balloon.

.....
.....
.....
.....

(2)

(b) What name is given to the total kinetic energy and potential energy of all the particles of helium gas in the balloon?

Tick **one** box.

External energy

Internal energy

Movement energy

(1)

(c) Write down the equation which links density, mass and volume.

.....

(1)

(d) The helium in the balloon has a mass of 0.00254 kg.

The balloon has a volume of 0.0141 m³.

Calculate the density of helium. Choose the correct unit from the box.

m³ / kg	kg / m³	kg m³
---------------------------	---------------------------	-------------------------

.....

.....

.....

.....

Density = Unit

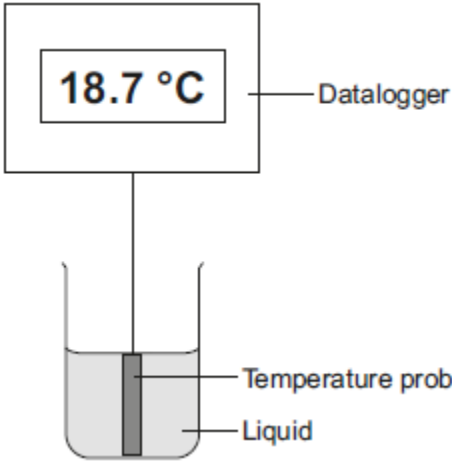
(3)
(Total 7 marks)

3

A student investigated the cooling effect of evaporation.

She used the equipment (datalogger and probe) shown in **Figure 1** to measure how the temperature of a liquid changed as the liquid evaporated.

Figure 1



(a) Which type of variable was the temperature in this investigation?

Tick (✓) **one** box.

	Tick (✓)
control	
dependent	
independent	

(1)

(b) Before the investigation started, the student checked the accuracy of three different temperature probes. The student put the probes in a beaker of boiling water that had a temperature of 100.0 °C.

The readings from the three temperature probes are shown in **Figure 2**.

Figure 2

Probe A	Probe B	Probe C
99.8	100.1	103.2

Which **one** of the temperature probes, **A**, **B** or **C**, was **least** accurate?

Write the correct answer in the box.

Give a reason for your answer.

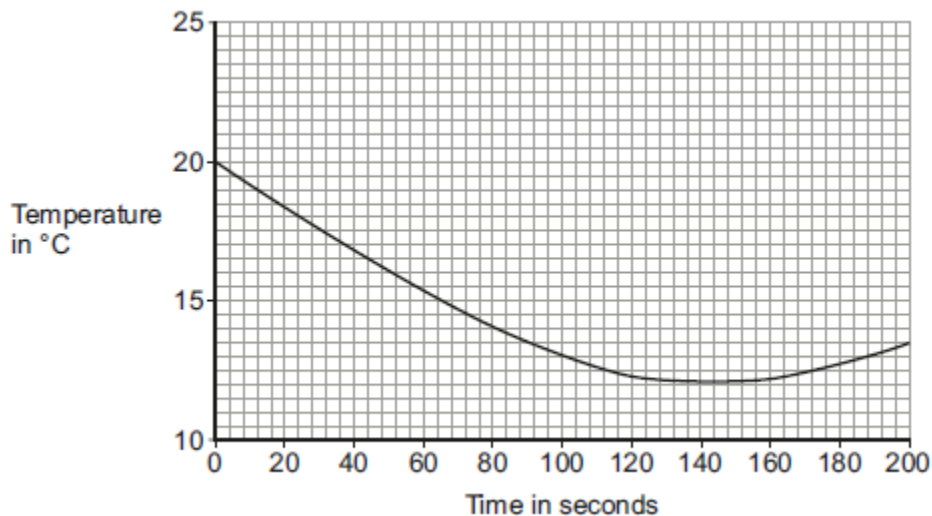
.....

.....

(2)

(c) **Figure 3** shows how the temperature recorded changed during the investigation.

Figure 3



(i) Use **Figure 3** to determine the lowest temperature recorded as the liquid evaporated.

Temperature = °C

(1)

(ii) Use **Figure 3** to determine how long it took for all the liquid to evaporate. Give a reason for your answer.

Time = seconds

Reason:

.....

(2)

(iii) How would increasing the starting temperature of the liquid above 20 °C affect the rate of evaporation of the liquid?

.....

.....

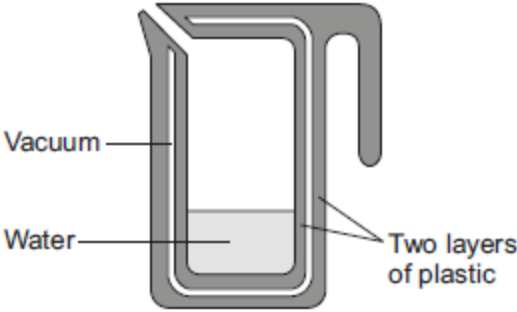
(1)

(Total 7 marks)

4

A new design for a kettle is made from two layers of plastic separated by a vacuum. After the water in the kettle has boiled, the water stays hot for at least 2 hours.

The new kettle is shown below.



- (a) The energy transferred from the water in the kettle to the surroundings in 2 hours is 46 200 J.

The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

The initial temperature of the water is 100 °C.

Calculate the temperature of the water in the kettle after 2 hours.

.....
.....
.....
.....

Temperature after 2 hours = °C

(3)

- (b) Calculate the average power output from the water in the kettle to the surroundings in 2 hours.

.....
.....
.....
.....

Average power output = W

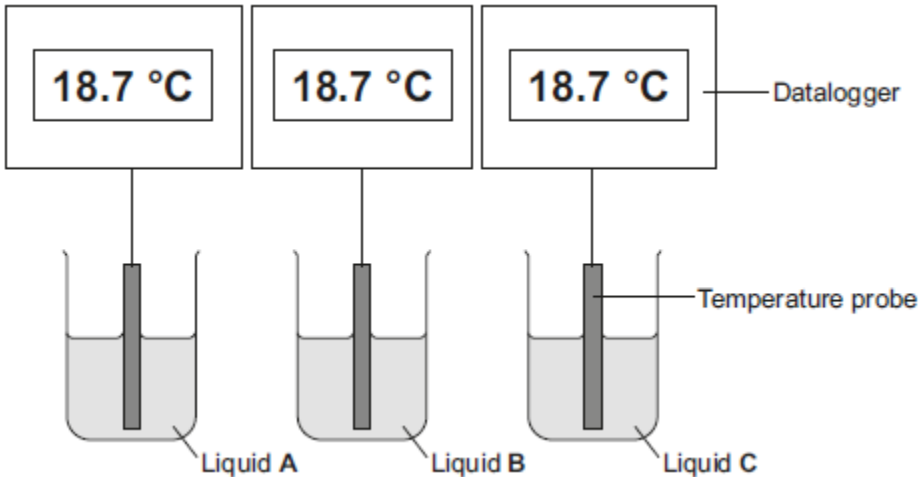
(2)

(Total 5 marks)

5

A student investigated the cooling effect of evaporation. She used the equipment in **Figure 1** to measure how the temperature of three different liquids changed as the liquids evaporated.

Figure 1



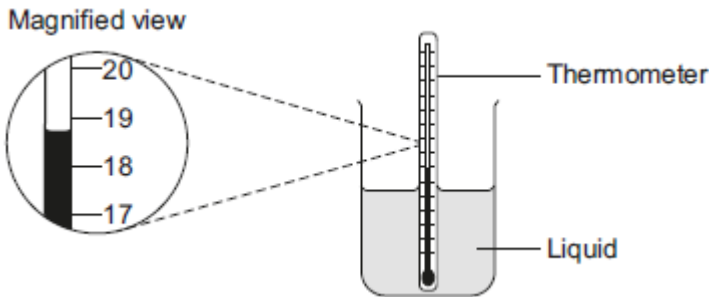
- (a) The temperature and volume of each liquid was the same at the start of the investigation. State **one** further control variable in this investigation.

.....
.....

(1)

- (b) Give **two** advantages of using dataloggers and temperature probes compared to using the thermometer shown in **Figure 2**.

Figure 2

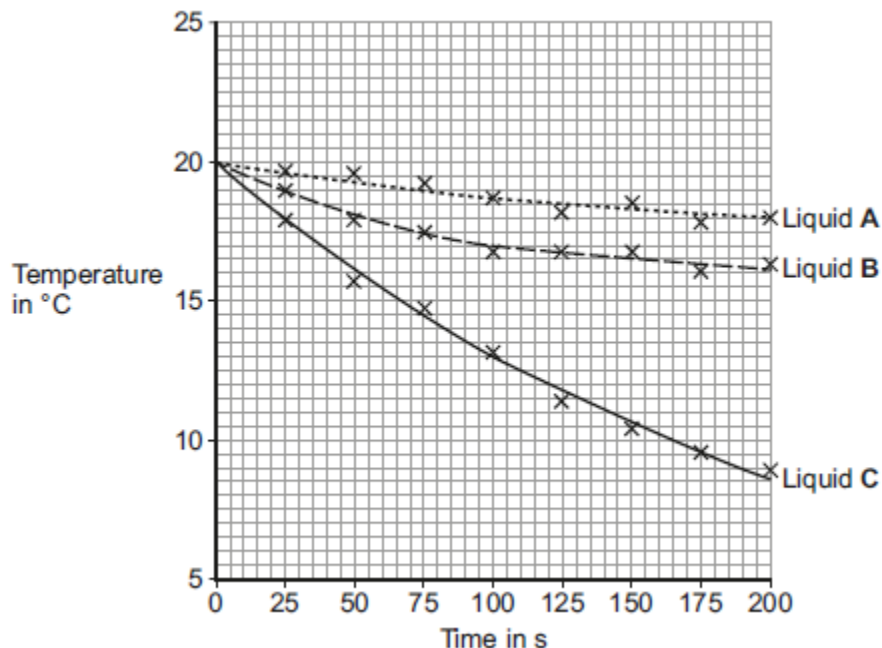


1.
.....
2.
.....

(2)

(c) The student's results are shown in **Figure 3**.

Figure 3



(i) Calculate the average rate of temperature decrease of liquid **C** between 0 and 100 seconds.

.....

Average rate of temperature decrease = °C / s

(2)

(ii) Give **one** conclusion that can be made about the rate of temperature decrease of **all three** liquids from the results in **Figure 3**.

.....

(1)

(iii) Which liquid had the lowest rate of evaporation? Give a reason for your answer.

Liquid

Reason

.....

(1)

- (iv) A second student did the same investigation but using a smaller volume of liquid than the first student.

All other variables were kept the same.

What effect would this have on the results of the second student's investigation?

.....
.....

(1)

- (d) Explain how the evaporation of a liquid causes the temperature of the remaining liquid to decrease.

.....
.....
.....
.....
.....
.....
.....
.....
.....

(3)
(Total 11 marks)

6

Solid, liquid and gas are three different states of matter.

(a) Describe the difference between the solid and gas states, in terms of the arrangement and movement of their particles.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

(4)

(b) What is meant by 'specific latent heat of vaporisation'?

.....
.....
.....
.....

(2)

(c) While a kettle boils, 0.018 kg of water changes to steam.

Calculate the amount of energy required for this change.

Specific latent heat of vaporisation of water = 2.3×10^6 J / kg.

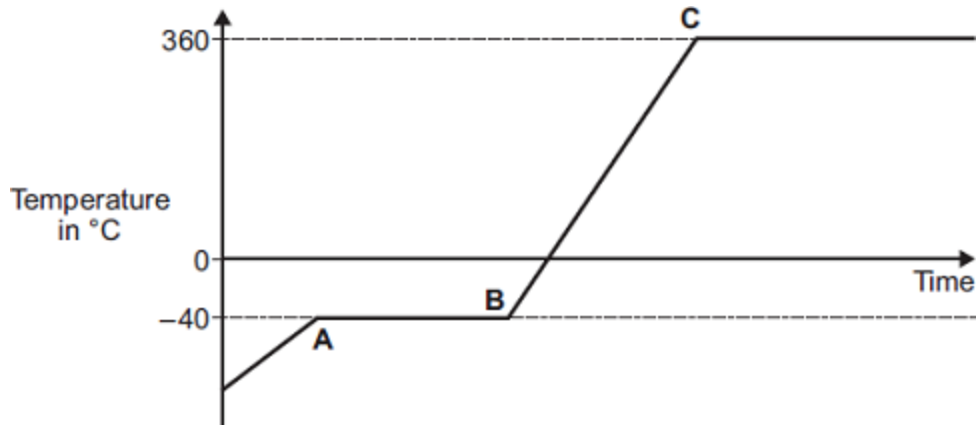
.....
.....
.....

Energy required = J

(2)

(d) 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**

.....
.....
.....
.....
.....

(4)
(Total 12 marks)

7

Energy can be transferred through some materials by convection.

(a) Use the correct answer from the box to complete the sentence.

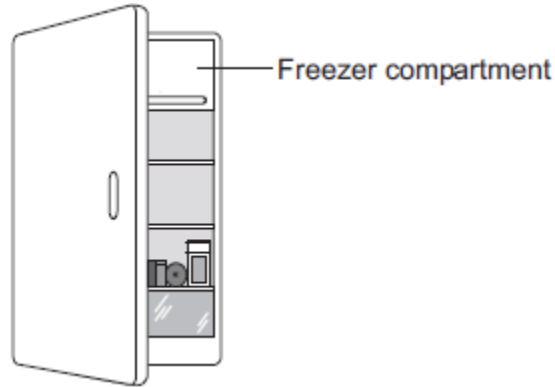
gas	liquid	solid
-----	--------	-------

Energy **cannot** be transferred by convection through a

(1)

(b) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is $-5\text{ }^{\circ}\text{C}$.



Use the correct answer from the box to complete each sentence.

Each answer may be used once, more than once or not at all.

decreased unchanged increased

When the air near the freezer compartment is cooled, the energy of the air particles is

The spaces between the air particles are

The density of the air is

(3)

(c) The table below shows some information about three fridges, **A**, **B** and **C**.

The efficiency of each fridge is the same.

Fridge	Volume in litres	Energy used in one year in kWh
A	232	292
B	382	409
C	622	524

(i) Which fridge, **A**, **B** or **C**, would cost the least to use for 1 year?

Give **one** reason for your answer.

.....

.....

(2)

(ii) A householder looks at the data in the table above.

What should she conclude about the pattern linking the volume of the fridge and the energy it uses in one year?

.....
.....

(1)

(iii) The householder could not be certain that her conclusion is correct for all fridges.

Suggest **one** reason why not.

.....
.....

(1)

(Total 8 marks)

8

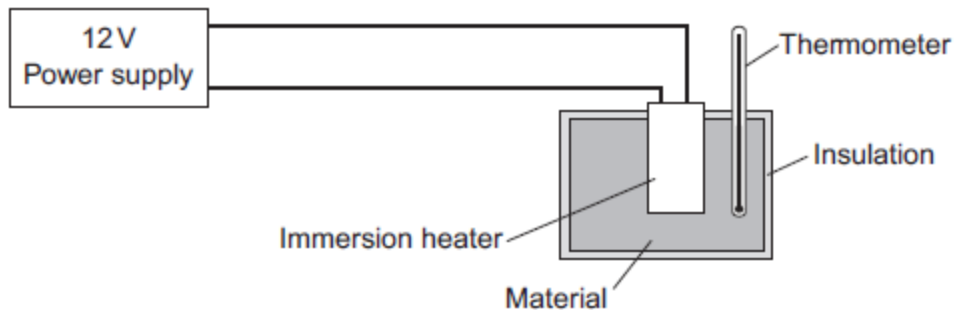
A student used the apparatus in **Figure 1** to compare the energy needed to heat blocks of different materials.

Each block had the same mass.

Each block had holes for the thermometer and the immersion heater.

Each block had a starting temperature of 20 °C.

Figure 1



The student measured the time taken to increase the temperature of each material by 5 °C.

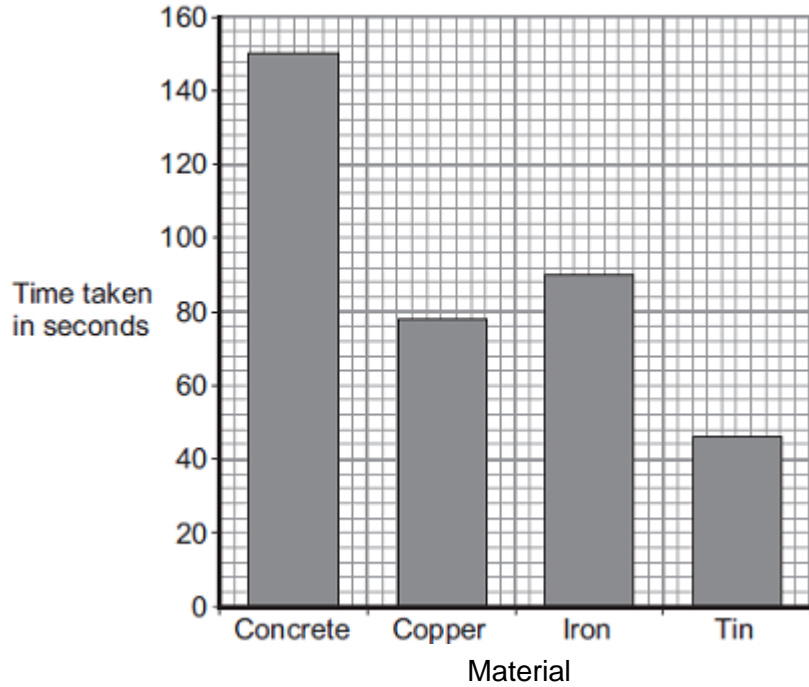
(a) (i) State **two** variables the student controlled.

1
2

(2)

Figure 2 shows the student's results.

Figure 2



(ii) Why was a bar chart drawn rather than a line graph?

.....
.....

(1)

(iii) Which material was supplied with the most energy?

.....

Give the reason for your answer.

.....
.....

(2)

(iv) The iron block had a mass of 2 kg.

Calculate the energy transferred by the heater to increase the temperature of the iron block by 5 °C.

The specific heat capacity of iron is 450 J / kg °C.

.....
.....
.....

Energy transferred = J

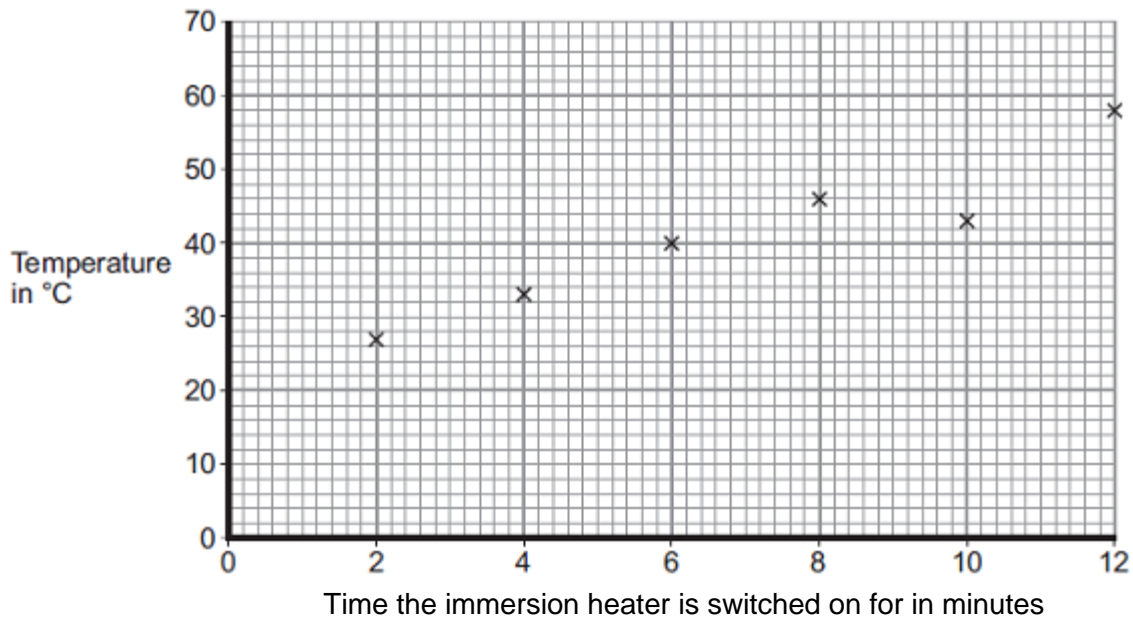
(2)

(b) The student used the same apparatus to heat a 1 kg block of aluminium.

He recorded the temperature of the block as it was heated from room temperature.

The results are shown in **Figure 3**.

Figure 3



(i) One of the student's results is anomalous.

Draw a ring around the anomalous result.

(1)

(ii) Draw the line of best fit for the points plotted in **Figure 3**.

(1)

(iii) What was the temperature of the room?

Temperature = °C

(1)

(iv) What was the interval of the time values used by the student?

Interval = minutes

(1)
(Total 11 marks)

9

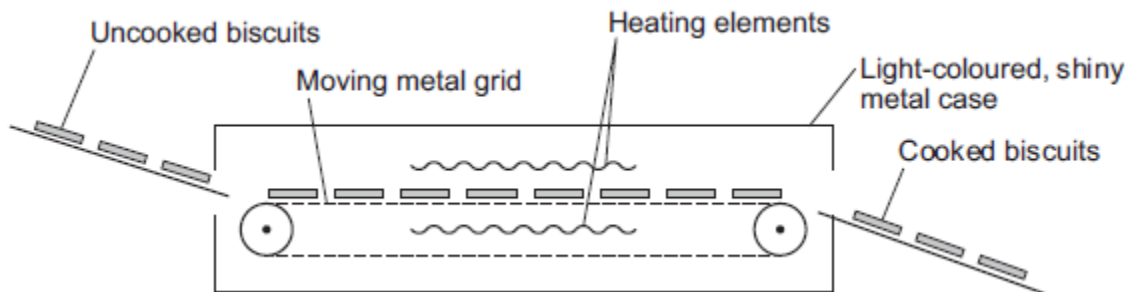
Figure 1 shows one way that biscuit manufacturers cook large quantities of biscuits.

The uncooked biscuits are placed on a moving metal grid.

The biscuits pass between two hot electrical heating elements inside an oven.

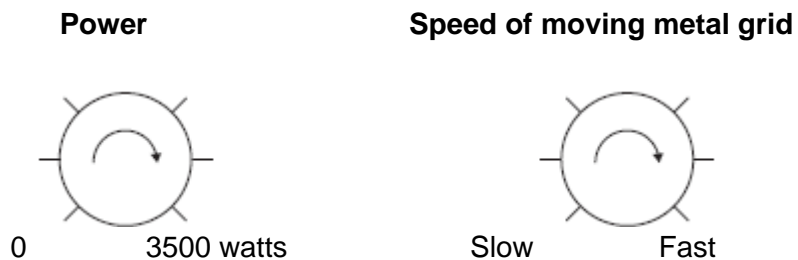
The biscuits turn brown as they cook.

Figure 1



The oven has two control knobs, as shown in **Figure 2**.

Figure 2



(a) Which type of electromagnetic radiation makes the biscuits turn brown?

.....

(1)

(b) Suggest **two** ways of cooking the biscuits in this oven, to make them turn browner.

1

.....

2

.....

(2)

(c) The inside and outside surfaces of the oven are light-coloured and shiny.

Explain why.

.....

.....

.....

.....

.....

.....

(3)
(Total 6 marks)

10

In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.

The information in the box is about the properties of solids and gases.

<p>Solids:</p> <ul style="list-style-type: none">• have a fixed shape• are difficult to compress (to squash). <p>Gases:</p> <ul style="list-style-type: none">• will spread and fill the entire container• are easy to compress (to squash).
--

Use your knowledge of kinetic theory to explain the information given in the box.

You should consider:

- the spacing between the particles
- the movement of individual particles
- the forces between the particles.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Extra space

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

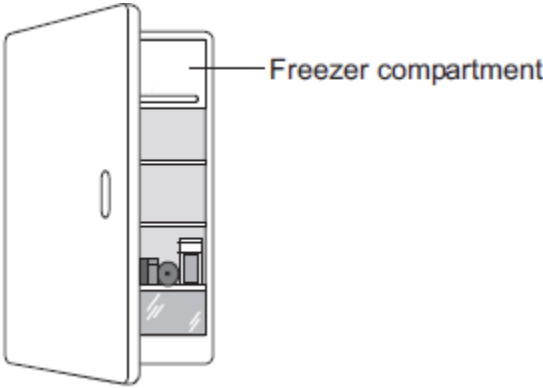
.....

.....

(Total 6 marks)

11

- (a) The figure below shows a fridge with a freezer compartment.
The temperature of the air inside the freezer compartment is $-5\text{ }^{\circ}\text{C}$.



The air inside the fridge forms a convection current when the fridge door is closed.
Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(b) The table below shows information about four fridges.

Fridge	Volume in litres	Energy used in one year in kWh
A	250	300
B	375	480
C	500	630
D	750	750

A householder concludes that the energy used in one year is directly proportional to the volume of the fridge.

Explain why her conclusion is **not** correct.

Use data from the table in your answer.

.....

.....

.....

.....

(2)

(c) New fridges are more efficient than fridges made twenty years ago.

Give **one** advantage and **one** disadvantage of replacing an old fridge with a new fridge.

Ignore the cost of buying a new fridge.

Advantage

.....

Disadvantage

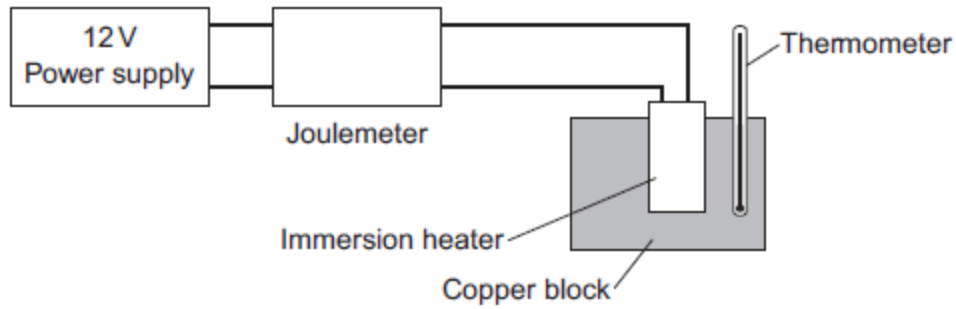
.....

(2)
(Total 8 marks)

12

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

Figure 1



The initial temperature of the copper block was measured.

The power supply was switched on.

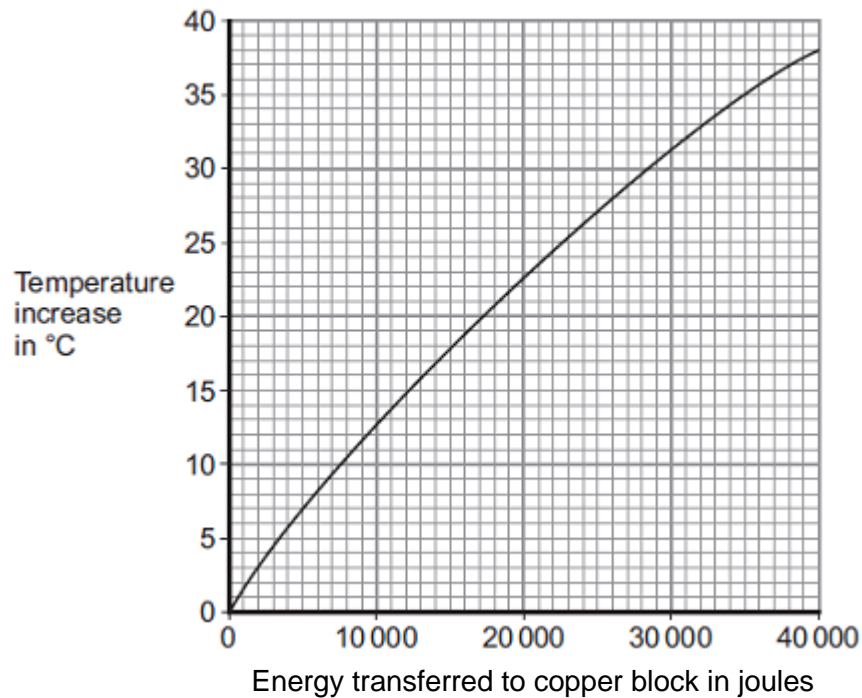
The energy transferred by the heater to the block was measured using the joulemeter.

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?

Tick (✓) **one** box.

Conduction

Convection

Radiation

(1)

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

..... joules

(1)

(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.

.....
.....
.....
.....

Specific heat capacity =

(3)

(d) This experiment does **not** give the correct value for the specific heat of copper.

Suggest **one** reason why.

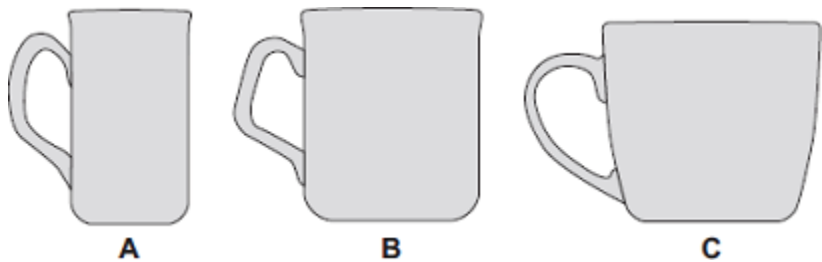
.....
.....

(1)

(Total 6 marks)

13

The diagram shows three cups **A**, **B** and **C**.



Energy is transferred from hot water in the cups to the surroundings.

(a) Use the correct answer from the box to complete each sentence.

condensation	conduction	convection
---------------------	-------------------	-------------------

Energy is transferred through the walls of the cup by

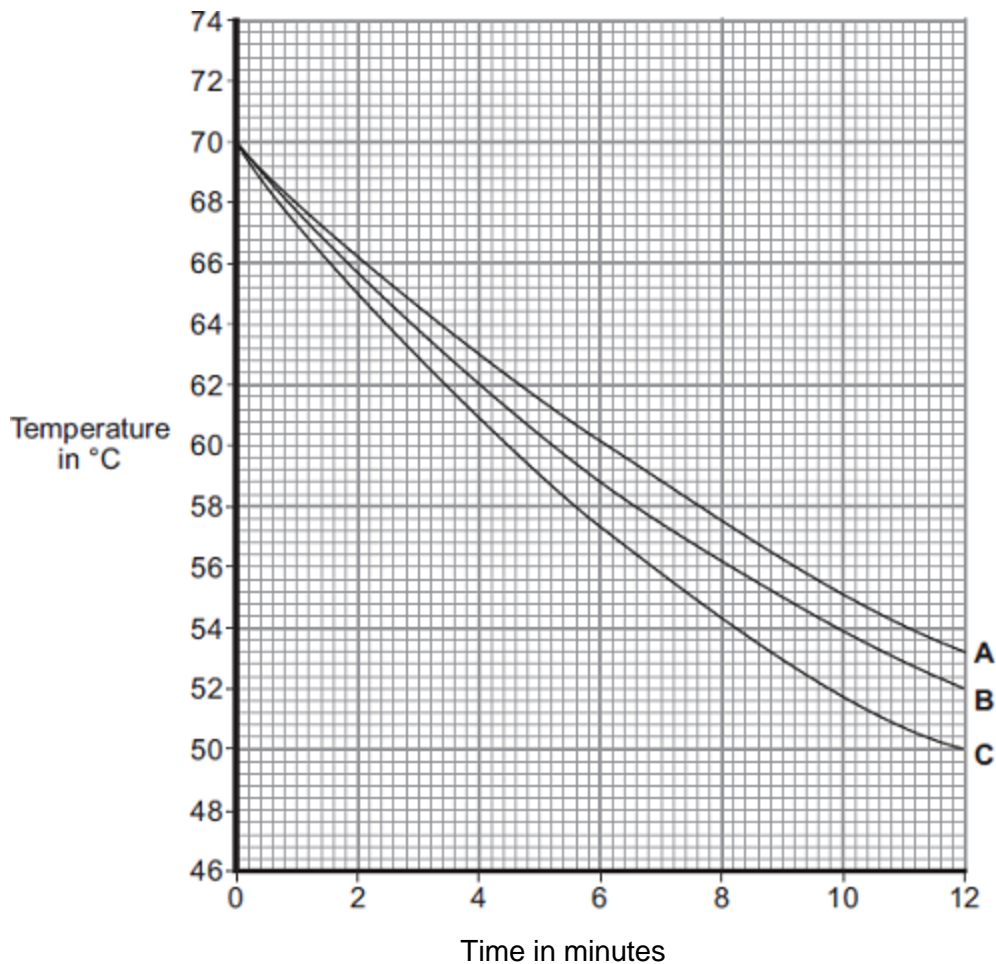
In the air around the cup, energy is transferred by

(2)

- (b) Some students investigated how the rate of cooling of water in a cup depends on the surface area of the water in contact with the air.

They used cups **A**, **B** and **C**. They poured the same volume of hot water into each cup and recorded the temperature of the water at regular time intervals.

The results are shown on the graph.



- (i) What was the starting temperature of the water for each cup?

Starting temperature = °C

(1)

- (ii) Calculate the temperature fall of the water in cup **B** in the first 9 minutes.

.....

Temperature fall = °C

(2)

- (iii) Which cup, **A**, **B** or **C**, has the greatest rate of cooling?

Using the graph, give a reason for your answer.

.....
.....

(2)

- (iv) The investigation was repeated using the bowl shown in the diagram.
The same starting temperature and volume of water were used.



Draw on the graph in part (b) another line to show the expected result.

(1)

- (v) After 4 hours, the temperature of the water in each of the cups and the bowl was 20°C.

Suggest why the temperature does **not** fall below 20°C.

.....

(1)

- (c) (i) The mass of water in each cup is 200 g.

Calculate the energy, in joules, transferred from the water in a cup when the temperature of the water falls by 8°C.

Specific heat capacity of water = 4200 J / kg°C.

.....
.....
.....

Energy transferred = J

(3)

(ii) Explain, in terms of particles, how evaporation causes the cooling of water.

.....

.....

.....

.....

.....

.....

.....

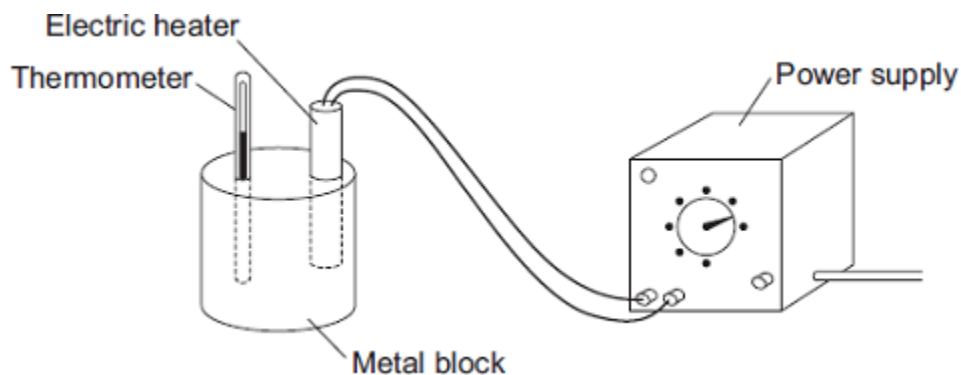
.....

.....

(4)
(Total 16 marks)

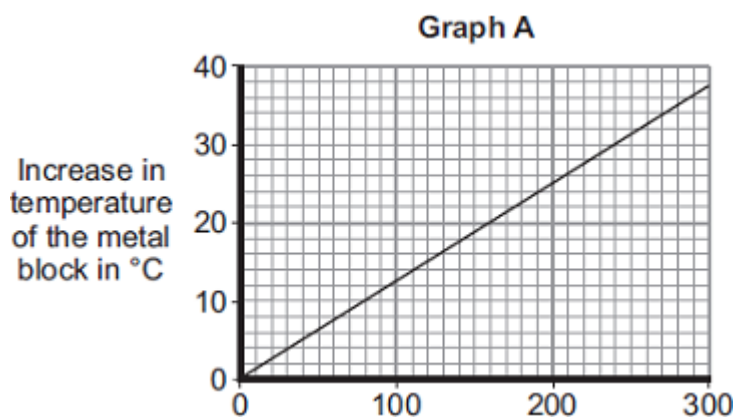
14

(a) A student used the apparatus drawn below to investigate the heating effect of an electric heater.



(i) Before starting the experiment, the student drew **Graph A**.

Graph A shows how the student expected the temperature of the metal block to change after the heater was switched on.



Describe the pattern shown in **Graph A**.

.....

.....

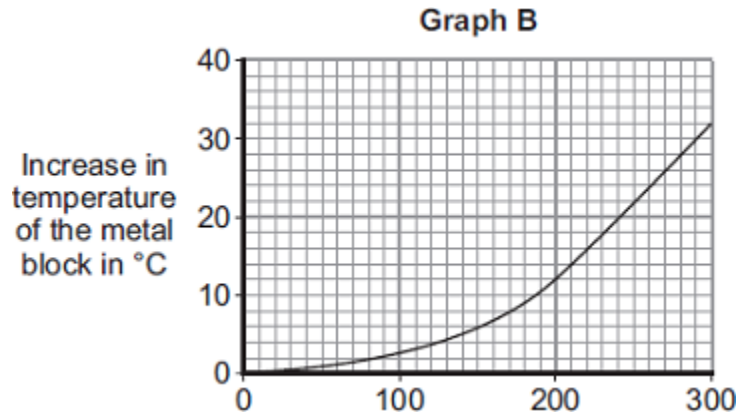
.....

.....

(2)

- (ii) The student measured the room temperature. He then switched the heater on and measured the temperature of the metal block every 50 seconds.

The student calculated the increase in temperature of the metal block and plotted **Graph B**.



After 300 seconds, **Graph B** shows the increase in temperature of the metal block is lower than the increase in temperature expected from **Graph A**.

Suggest **one** reason why.

.....
.....

(1)

- (iii) The power of the electric heater is 50 watts.

Calculate the energy transferred to the heater from the electricity supply in 300 seconds.

.....
.....
.....

Energy transferred = J

(2)

- (b) The student uses the same heater to heat blocks of different metals. Each time the heater is switched on for 300 seconds.

Each block of metal has the same mass but a different specific heat capacity.

Metal	Specific heat capacity in J/kg°C
Aluminium	900
Iron	450
Lead	130

Which **one** of the metals will heat up the most?

Draw a ring around the correct answer.

aluminium

iron

lead

Give, in terms of the amount of energy needed to heat the metal blocks, a reason for your answer.

.....

.....

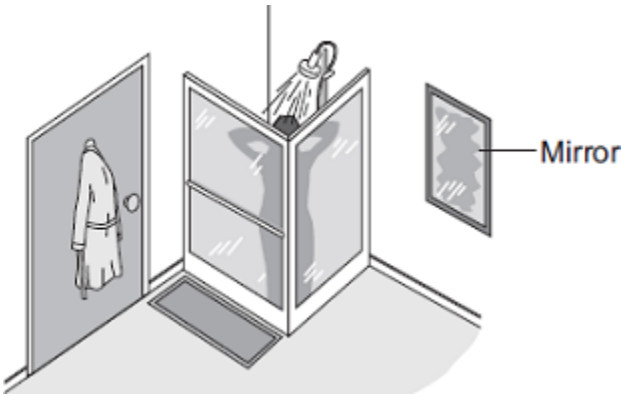
.....

.....

(2)
(Total 7 marks)

15

The picture shows a person taking a hot shower.



(a) When a person uses the shower the mirror gets misty.

Why?

.....

.....

.....

.....

.....

.....

.....

.....

.....

(3)

(b) The homeowner installs an electrically heated mirror into the shower room.

When a person has a shower, the heated mirror does **not** become misty but stays clear.

Why does the mirror stay clear?

.....

.....

.....

.....

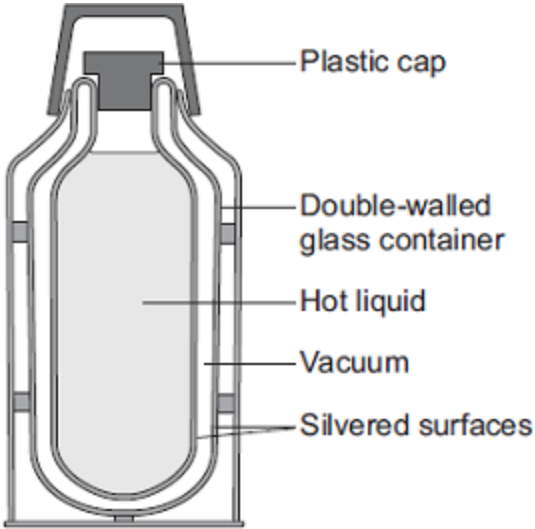
.....

(2)
(Total 5 marks)

16

(a) *In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.*

The diagram shows the structure of a vacuum flask.



A vacuum flask is designed to reduce the rate of energy transfer by heating processes.

Describe how the design of a vacuum flask keeps the liquid inside hot.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(6)

(b) Arctic foxes live in a very cold environment.



© Purestock/Thinkstock

Arctic foxes have small ears.

How does the size of the ears help to keep the fox warm in a cold environment?

.....

.....

.....

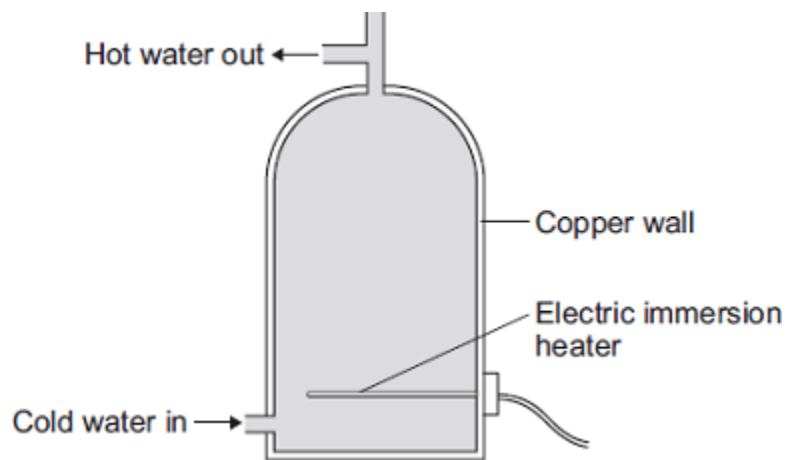
.....

.....

(2)
(Total 8 marks)

17

An electric immersion heater is used to heat the water in a domestic hot water tank. When the immersion heater is switched on the water at the bottom of the tank gets hot.



(a) Complete the following sentence.

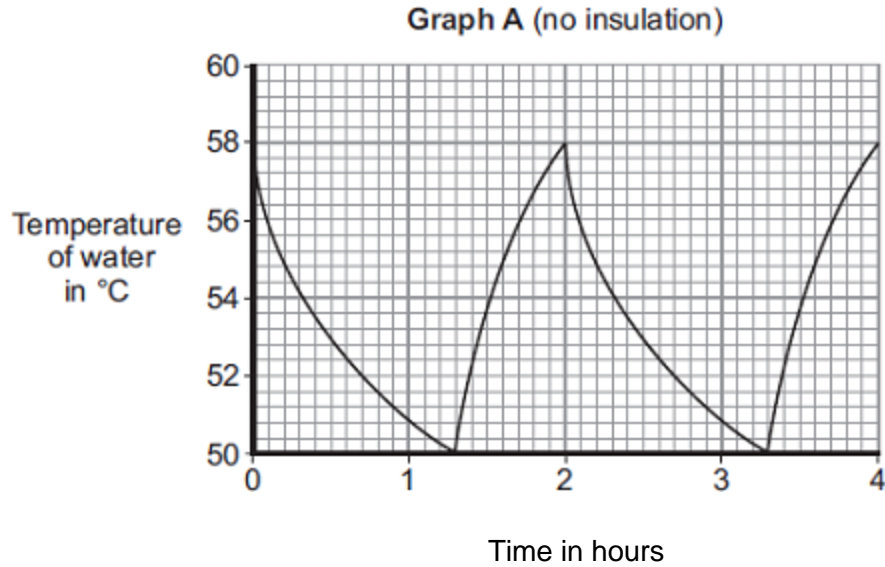
The main way the energy is transferred through the copper wall of the water tank is by the process of

(1)

- (b) The immersion heater has a thermostat to control the water temperature.

When the temperature of the water inside the tank reaches 58°C the thermostat switches the heater off. The thermostat switches the heater back on when the temperature of the water falls to 50°C.

Graph A shows how the temperature of the water inside a hot water tank changes with time. The tank is **not** insulated.



- (i) The temperature of the water falls at the fastest rate just after the heater switches off.

Explain why.

.....

.....

.....

.....

(2)

- (ii) To heat the water in the tank from 50°C to 58°C the immersion heater transfers 4032 kJ of energy to the water.

Calculate the mass of water in the tank.

Specific heat capacity of water = 4200 J/kg°C

.....

.....

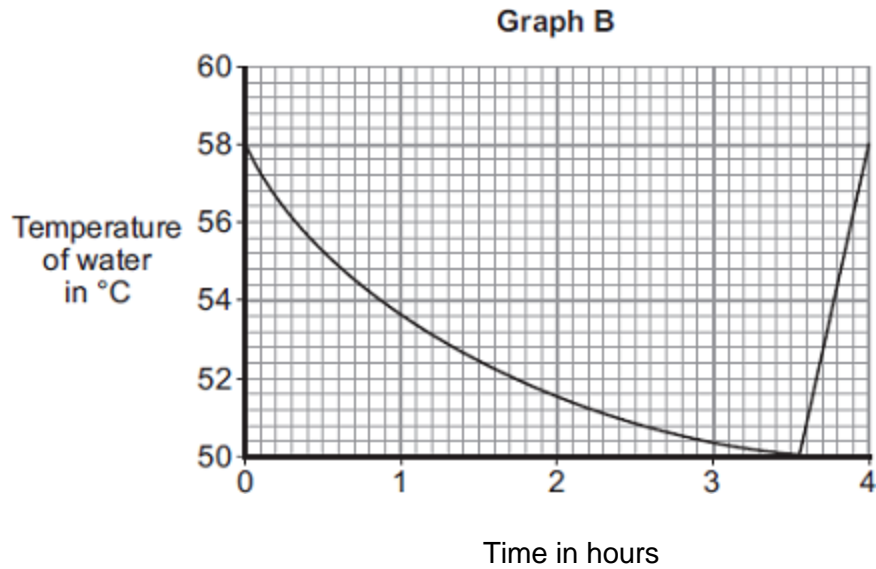
.....

Mass = kg

(3)

(iii) An insulating jacket is fitted to the hot water tank.

Graph B shows how the temperature of the water inside the insulated hot water tank changes with time.



An insulating jacket only costs £12.

By comparing **Graph A** with **Graph B**, explain why fitting an insulating jacket to a hot water tank saves money.

.....

.....

.....

.....

.....

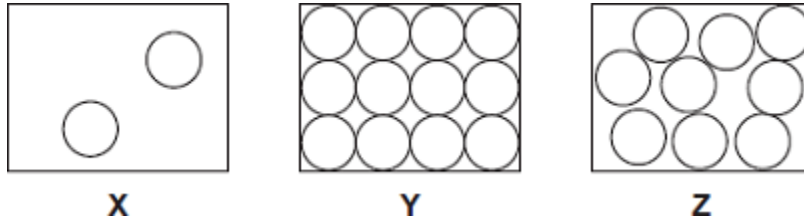
.....

.....

(3)
(Total 9 marks)

18

(a) The diagrams, **X**, **Y** and **Z**, show how the particles are arranged in the three states of matter.



(i) Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a liquid?

Write the correct answer in the box.

(1)

(ii) Which **one** of the diagrams, **X**, **Y** or **Z**, shows the arrangement of particles in a gas?

Write the correct answer in the box.

(1)

(b) Draw a ring around the correct answer in each box to complete each sentence.

(i) In a gas, the particles are

vibrating in fixed positions.
moving randomly.
not moving.

(1)

(ii) In a solid, the forces between the particles are

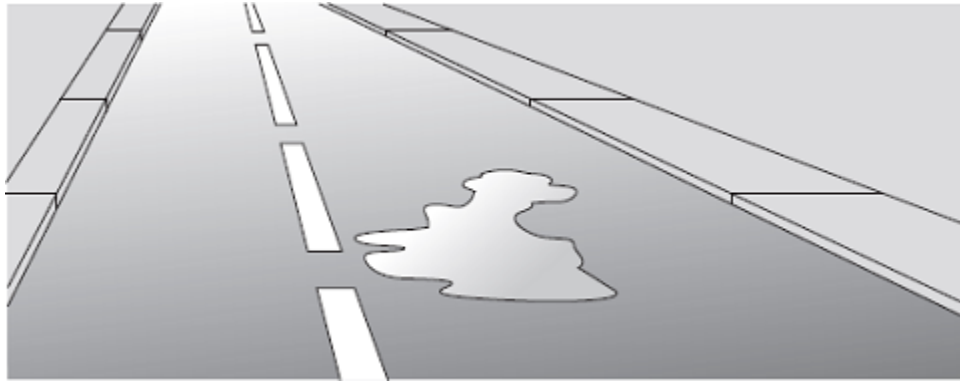
stronger than
equal to
weaker than

the forces between

the particles in a liquid.

(1)

(c) The picture shows a puddle of water in a road, after a rain shower.



(i) During the day, the puddle of water dries up and disappears. This happens because the water particles move from the puddle into the air.

What process causes water particles to move from the puddle into the air?

Draw a ring around the correct answer.

condensation

evaporation

radiation

(1)

(ii) Describe **one** change in the weather which would cause the puddle of water to dry up faster.

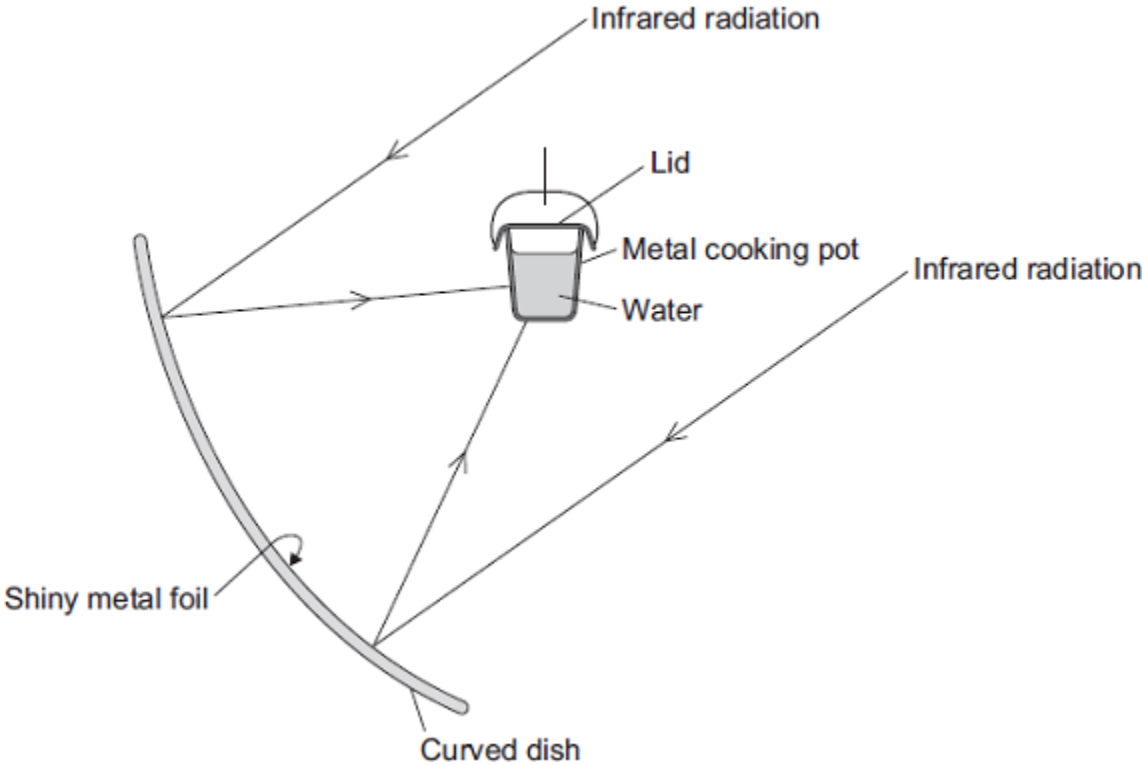
.....
.....

(1)

(Total 6 marks)

19

The diagram shows the design of a solar cooker. The cooker heats water using infrared radiation from the Sun.



(a) Why is the inside of the large curved dish covered with shiny metal foil?

.....
.....

(1)

(b) Which would be the best colour to paint the outside of the metal cooking pot?

Draw a ring around the correct answer.

black **silver** **white**

Give a reason for your answer.

.....
.....
.....

(2)

(c) Why does the cooking pot have a lid?

.....
.....

(1)

- (d) Calculate how much energy is needed to increase the temperature of 2 kg of water by 80 °C.

The specific heat capacity of water = 4200 J/kg °C.

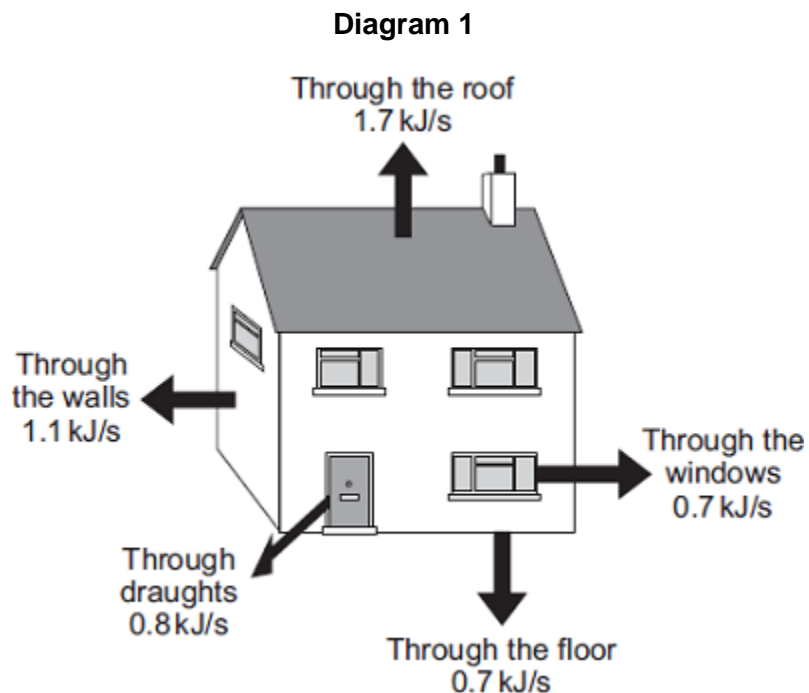
.....

Energy = J

(2)
 (Total 6 marks)

20

Diagram 1 shows the energy transferred per second from a badly insulated house on a cold day in winter.



- (a) (i) When the inside of the house is at a constant temperature, the energy transferred from the heating system to the inside of the house equals the energy transferred from the house to the outside.

Calculate, in kilowatts, the power of the heating system used to keep the inside of the house in **Diagram 1** at a constant temperature.

1 kilowatt (kW) = 1 kilojoule per second (kJ/s)

.....

Power of the heating system = kW

(1)

(ii) In the winter, the heating system is switched on for a total of 7 hours each day.

Calculate, in kilowatt-hours, the energy transferred each day from the heating system to the inside of the house.

.....

.....

Energy transferred each day = kWh

(2)

(iii) Energy costs 15 p per kilowatt-hour.

Calculate the cost of heating the house for one day.

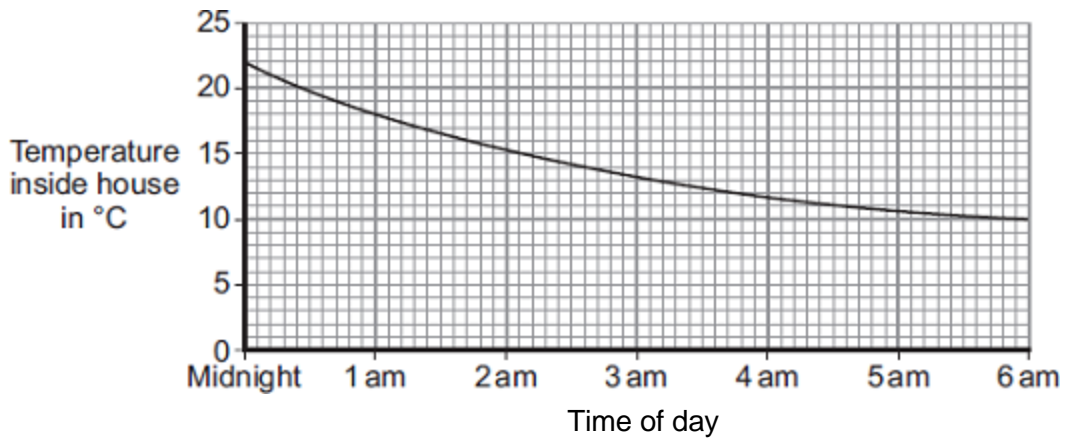
.....

Cost =

(1)

(iv) The heating system is switched off at midnight.

The graph shows how the temperature inside the house changes after the heating system has been switched off.



Draw a ring around the correct answer in the box to complete the sentence.

Between midnight and 6 am the rate of energy transfer from

the house

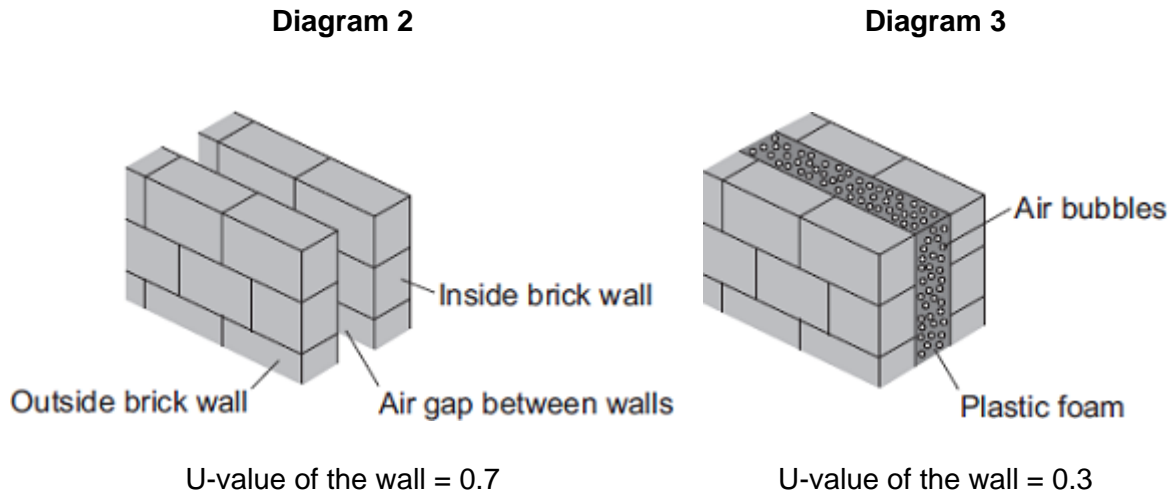
decreases.
decreases then stays constant.
increases.

Give the reason for your answer.

.....
.....

(2)

- (b) **Diagram 2** shows how the walls of the house are constructed.
Diagram 3 shows how the insulation of the house could be improved by filling the air gap between the two brick walls with plastic foam.



The plastic foam reduces energy transfer by convection.

Explain why.

.....

.....

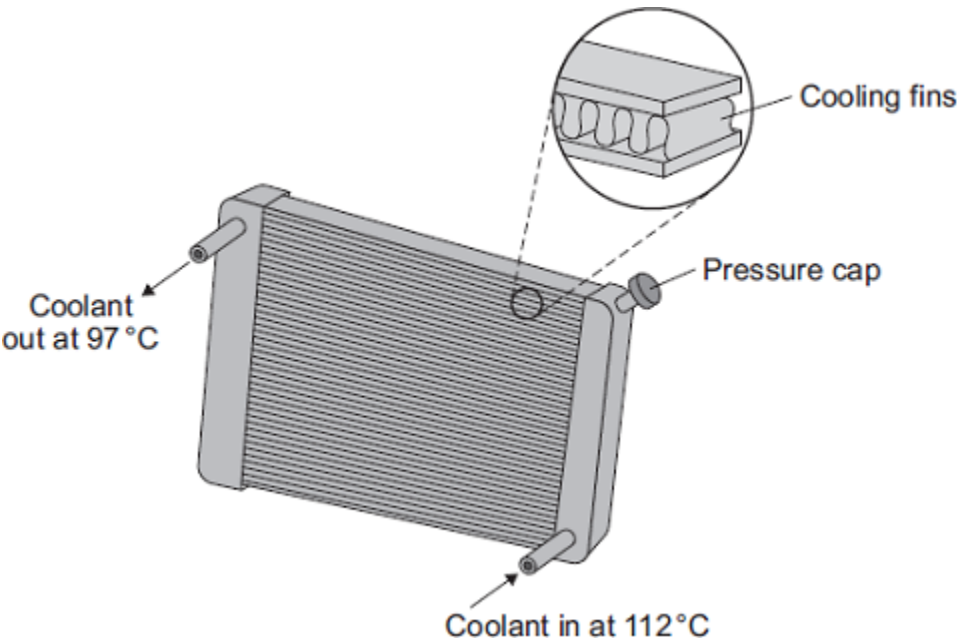
.....

.....

(2)
(Total 8 marks)

21

The diagram shows a car radiator. The radiator is part of the engine cooling system.



Liquid coolant, heated by the car engine, enters the radiator. As the coolant passes through the radiator, the radiator transfers energy to the surroundings and the temperature of the coolant falls.

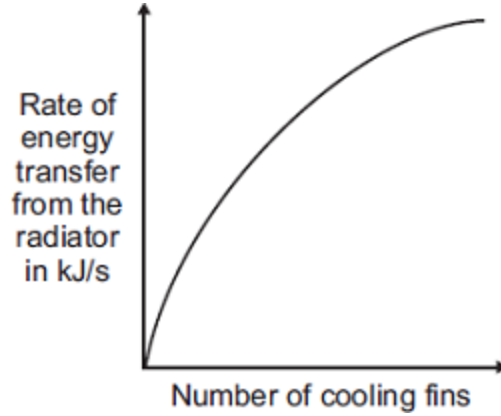
(a) Why is the radiator painted black?

.....
.....
.....
.....

(2)

- (b) Different radiators have different numbers of cooling fins along the length of the radiator.

The sketch graph shows how the number of cooling fins affects the rate of energy transfer from the radiator.



The number of cooling fins affects the rate of energy transfer from the radiator.

Explain how.

.....
.....
.....
.....

(2)

- (c) When the car engine is working normally, 2 kg of coolant passes through the radiator each second. The temperature of the coolant falls from 112 °C to 97 °C.

Calculate the energy transferred each second from the coolant.

Specific heat capacity of the coolant = 3800 J/kg °C.

.....
.....
.....
.....

Energy transferred each second = J

(3)

- (d) On cold days, some of the energy transferred from a hot car engine is used to warm the air inside the car. This is a useful energy transfer.

What effect, if any, does this energy transfer have on the overall efficiency of the car engine?

Draw a ring around the correct answer.

**decreases the
efficiency**

**does not change the
efficiency**

**increases the
efficiency**

Give a reason for your answer.

.....
.....
.....

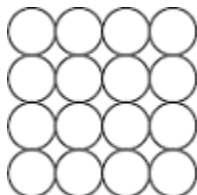
(2)
(Total 9 marks)

22

According to kinetic theory, all matter is made up of small particles. The particles are constantly moving.

Diagram 1 shows how the particles may be arranged in a solid.

Diagram 1



(a) One kilogram of a gas has a much larger volume than one kilogram of a solid.

Use kinetic theory to explain why.

.....

.....

.....

.....

.....

.....

.....

.....

.....

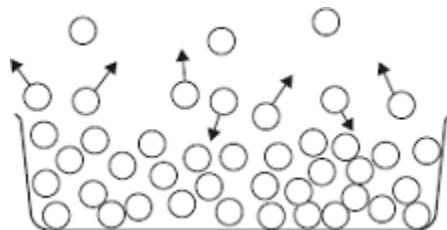
.....

.....

(4)

(b) **Diagram 2** shows the particles in a liquid. The liquid is evaporating.

Diagram 2



(i) How can you tell from **Diagram 2** that the liquid is evaporating?

.....
.....

(1)

(ii) The temperature of the liquid in the container decreases as the liquid evaporates.
Use kinetic theory to explain why.

.....
.....
.....
.....
.....
.....
.....
.....
.....
.....

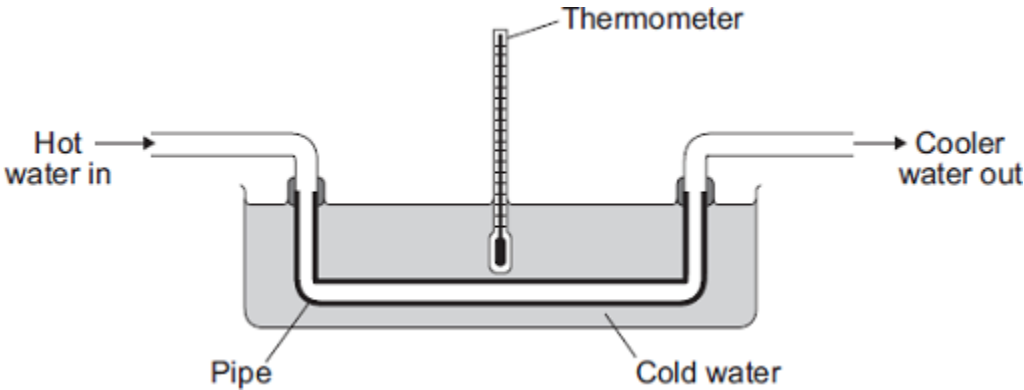
(3)
(Total 8 marks)

23

Heat exchangers are devices used to transfer heat from one place to another.

The diagram shows a pipe being used as a simple heat exchanger by a student in an investigation.

Heat is transferred from the hot water inside the pipe to the cold water outside the pipe.



(a) Complete the following sentence by drawing a ring around the correct word in the box.

Heat is transferred from the hot water inside the pipe

to the cold water outside the pipe by

- conduction.
- convection.
- radiation.

(1)

(b) The student wanted to find out if the efficiency of a heat exchanger depends on the material used to make the pipe. The student tested three different materials. For each material, the rate of flow of hot water through the pipe was kept the same.

The student's results are recorded in the table.

Material	Temperature of the cold water at the start in °C	Temperature of the cold water after 10 minutes in °C
Copper	20	36
Glass	20	23
Plastic	20	21

(i) The rate of flow of hot water through the pipe was one of the control variables in the investigation.

Give **one** other control variable in the investigation.

.....

(1)

(ii) Which **one** of the three materials made the best heat exchanger?

.....

Give a reason for your answer.

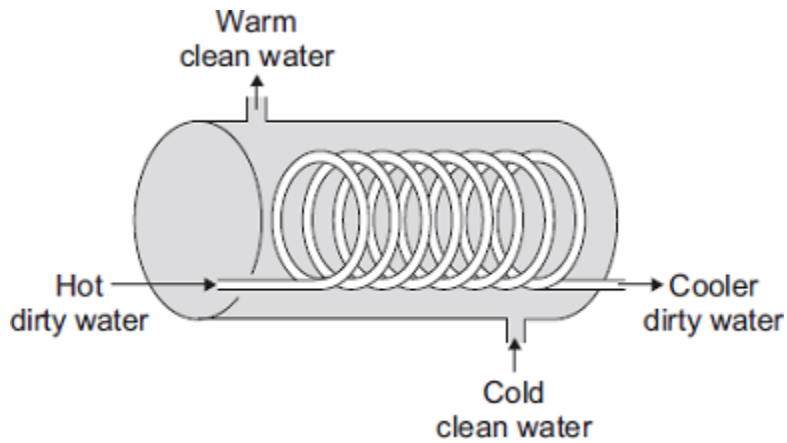
.....

.....

.....

(2)

(c) The student finds a picture of a heat exchanger used in an industrial laundry. The heat exchanger uses hot, dirty water to heat cold, clean water.



This heat exchanger transfers heat faster than the heat exchanger the student used in the investigation.

Explain why.

.....

.....

.....

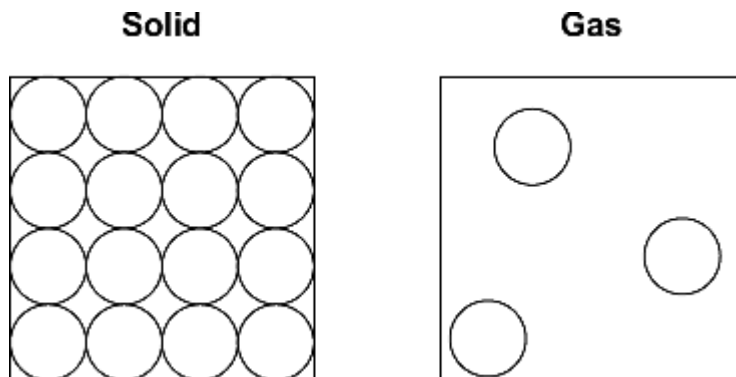
.....

(2)
(Total 6 marks)

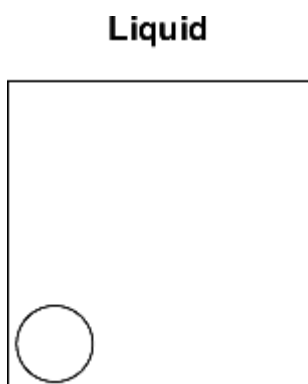
24

(a) The diagrams show the arrangement of the particles in a solid and in a gas.

Each circle represents one particle.



(i) Complete the diagram below to show the arrangement of the particles in a liquid.



(2)

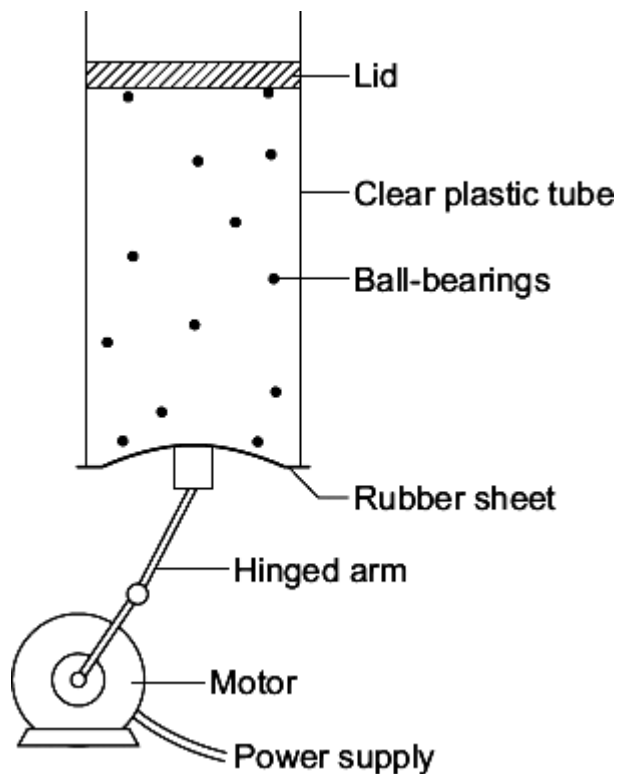
(ii) Explain, in terms of the particles, why gases are easy to compress.

.....
.....
.....
.....

(2)

- (b) The diagram below shows the model that a science teacher used to show her students that there is a link between the temperature of a gas and the speed of the gas particles.

The ball-bearings represent the gas particles. Switching the motor on makes the ball-bearings move around in all directions.



- (i) How is the motion of the ball-bearings similar to the motion of the gas particles?

.....
.....

(1)

- (ii) The faster the motor runs, the faster the ball-bearings move. Increasing the speed of the motor is like increasing the temperature of a gas.

Use the model to predict what happens to the speed of the gas particles when the temperature of a gas is increased.

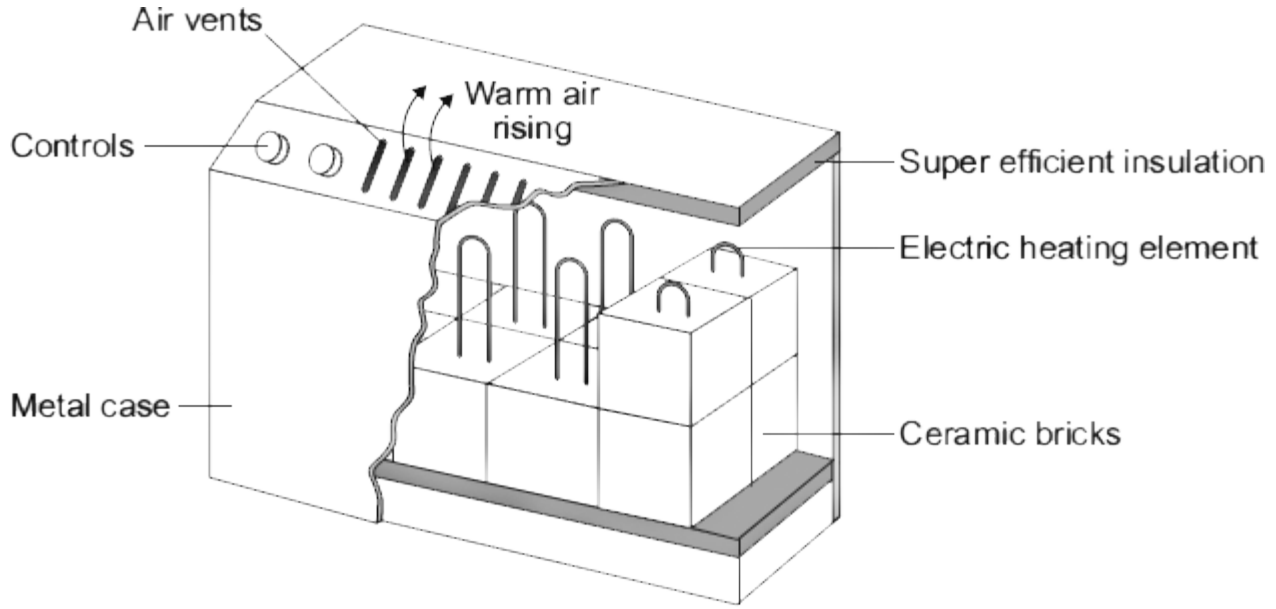
.....
.....

(1)

(Total 6 marks)

25

The diagram shows how one type of electric storage heater is constructed. The heater has ceramic bricks inside. The electric elements heat the ceramic bricks during the night. Later, during the daytime, the ceramic bricks transfer the stored energy to the room.



(a) (i) Complete the following sentences using words from the box.

conduction	convection	evaporation
-------------------	-------------------	--------------------

Energy is transferred through the metal casing by

The warm air rising from the heater transfers energy to the room by

(2)

(ii) The inside of the metal case is insulated.

Which **one** of the following gives the reason why?

Tick (✓) **one** box.

- To transfer energy from the ceramic bricks to the room faster
- To stop energy from the room transferring into the heater
- To keep the ceramic bricks hot for a longer time

(1)

(b) In winter, the electricity supply to a 2.6 kW storage heater is switched on for seven hours each day.

(i) Calculate the energy transferred, in kilowatt-hours, from the electricity supply to the heater in seven hours.

Show clearly how you work out your answer.

.....
.....

Energy transferred = kWh

(2)

(ii) The electricity supply to the heater is always switched on between midnight and 7 am. Between these hours, electricity costs 5 p per kilowatt-hour.

Calculate how much it costs to have the heater switched on between midnight and 7 am.

.....
.....

Cost = p

(1)

(c) Between 7 am and 8 am, after the electricity supply is switched off, the temperature of the ceramic bricks falls by 25 °C.

Calculate the energy transferred from the ceramic bricks between 7 am and 8 am.

Total mass of ceramic bricks = 120 kg.

Specific heat capacity of the ceramic bricks = 750 J/kg °C.

Show clearly how you work out your answer.

.....
.....
.....
.....

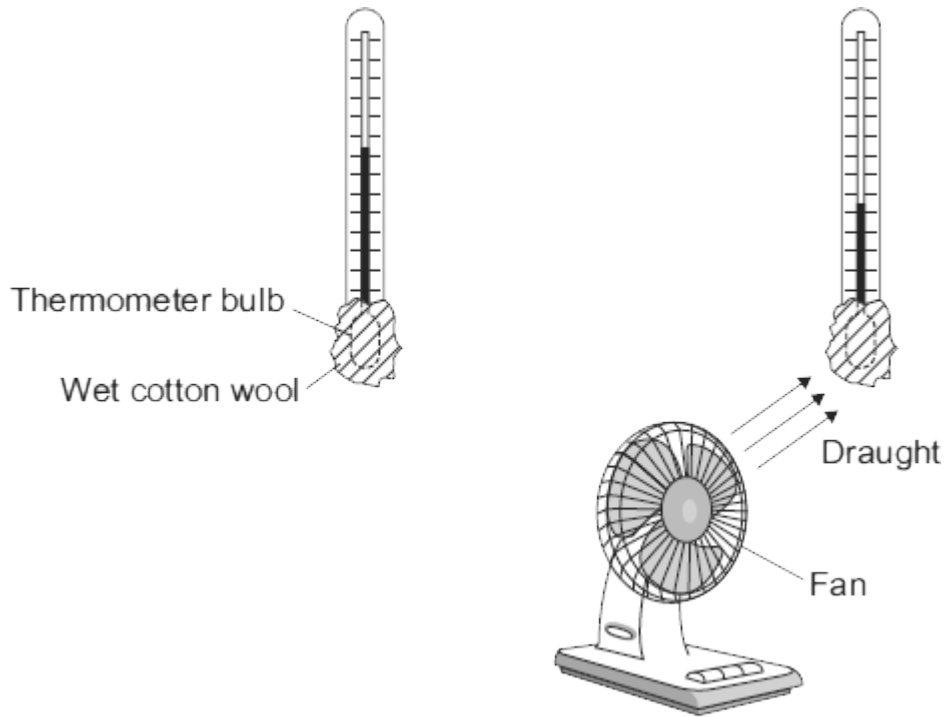
Energy transferred = J

(2)

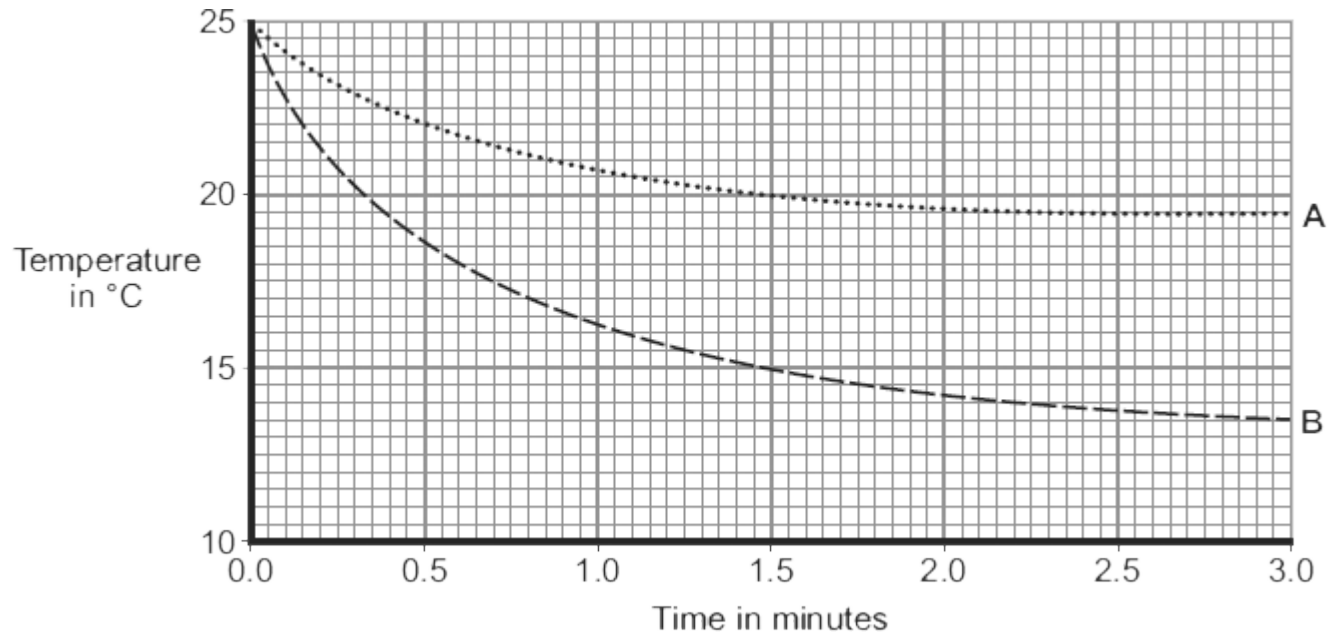
(Total 8 marks)

26

The diagram shows two thermometers. The bulb of each thermometer is covered with a piece of wet cotton wool. One of the thermometers is placed in the draught from a fan.



The graph shows how the temperature of each thermometer changes with time.



- (a) Which of the graph lines, **A** or **B**, shows the temperature of the thermometer placed in the draught?

Write the correct answer in the box.

Explain, in terms of evaporation, the reason for your answer.

.....
.....
.....
.....
.....
.....

(3)

- (b) A wet towel spread out and hung outside on a day without wind dries faster than an identical wet towel left rolled up in a plastic bag.

Explain why.

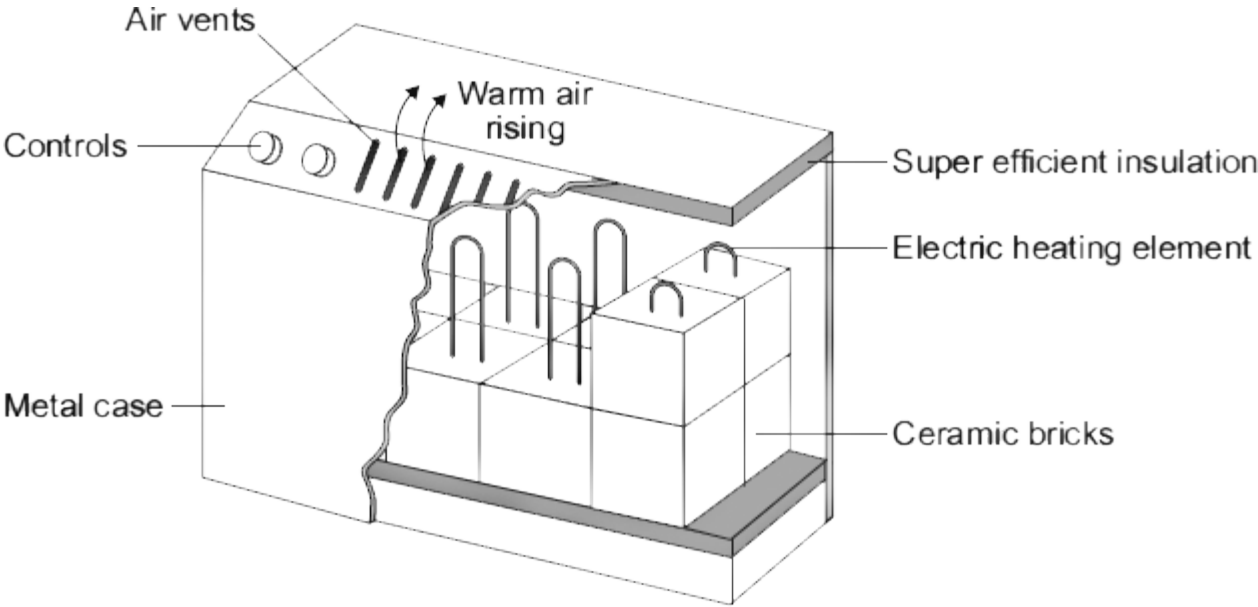
.....
.....
.....
.....

(2)

(Total 5 marks)

27

The diagram shows how one type of electric storage heater is constructed. The heater has ceramic bricks inside. The electric elements heat the ceramic bricks during the night. Later, during the daytime, the ceramic bricks transfer the stored energy to the room.



- (a) In winter, the electricity supply to a 2.6 kW storage heater is switched on each day between midnight and 7 am. Between these hours, electricity costs 5 p per kilowatt-hour.

Calculate the daily cost of using the storage heater.

Show clearly how you work out your answer.

.....

.....

.....

.....

.....

Cost = p

(3)

- (b) Homes with electric storage heaters have a separate meter to measure the electricity supplied between midnight and 7 am. Another meter measures the electricity supplied at other times. This electricity supplied at other times costs 15 p per kilowatt-hour.

Electricity companies encourage people to use electricity between midnight and 7 am by selling the electricity at a lower cost.

Suggest why.

.....
.....

(1)

- (c) By 7 am, the temperature at the centre of the ceramic bricks is about 800 °C. The temperature of the outside metal casing is about 80 °C.

The ceramic bricks are surrounded by 'super-efficient' insulation.

Explain why.

.....
.....
.....
.....

(2)

- (d) At 7 am, the electricity supply switches off and the temperature of the ceramic bricks starts to fall. The temperature of the bricks falls by 100 °C over the next four hours. During this time, 9 000 000 J of energy are transferred from the bricks.

Calculate the total mass of ceramic bricks inside the heater.

Specific heat capacity of the ceramic bricks = 750 J/kg °C.

Show clearly how you work out your answer.

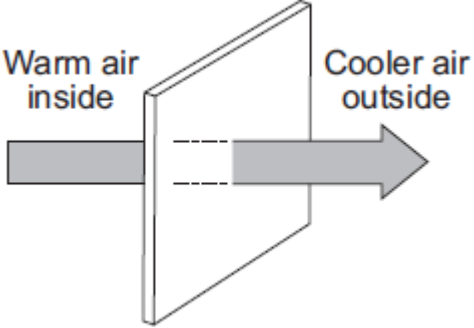
.....
.....
.....
.....

Mass = kg

(2)
(Total 8 marks)

28

The diagram shows the direction of heat transfer through a single-glazed window.



(a) (i) Name the process by which heat is transferred **through** the glass.

.....

(1)

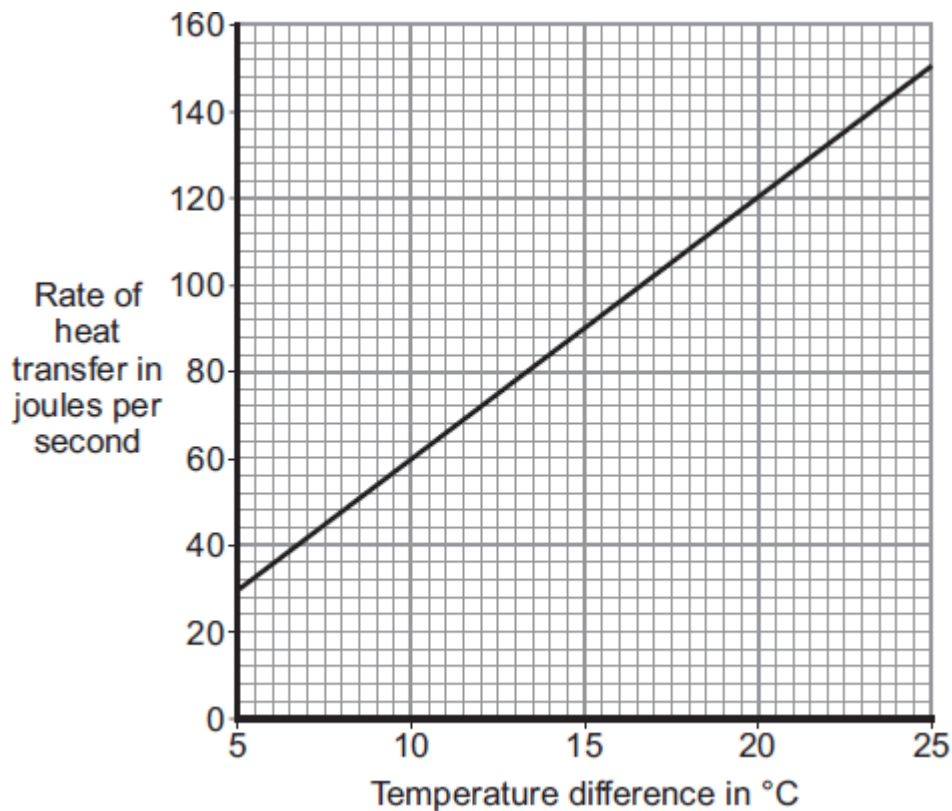
(ii) Explain how heat is transferred **through** the glass.

.....
.....
.....
.....

(2)

- (b) The rate of heat transfer through a window depends on the difference between the inside and outside temperatures.

The graph shows the rate of heat transfer through a 1 m² single-glazed window for a range of temperature differences.



- (i) What is the range of temperature differences shown in the graph?

From to

(1)

- (ii) A student looks at the graph and concludes:

'Doubling the temperature difference doubles the rate of heat transfer.'

Use data from the graph to justify the student's conclusion.

.....
.....
.....
.....

(2)

- (iii) A house has single-glazed windows. The total area of the windows in the house is 15 m².

On one particular day, the difference between the inside and outside temperatures is 20 °C.

Use the graph to calculate the total rate of heat transfer through all of the windows on this particular day.

Show clearly how you work out your answer.

.....
.....
.....
.....

Rate of heat transfer = J/s

(2)

- (c) A homeowner plans to replace the single-glazed windows in his home with double-glazed windows. He knows that double-glazed windows will reduce his annual energy bills.

The table gives information about the double glazing to be installed by the homeowner.

Cost to buy and install	Estimated yearly savings on energy bills	Estimated lifetime of the double-glazed windows
£5280	£160	30 years

Explain, in terms of energy savings, why replacing the single-glazed windows with these double-glazed windows is not cost effective.

To gain full marks you must complete a calculation.

.....
.....
.....
.....

(2)
(Total 10 marks)

29

A wood burning stove is used to heat a room.



Photograph supplied by iStockphoto/Thinkstock

The fire in the stove uses wood as a fuel. The fire heats the matt black metal case of the stove.

(a) The air next to the stove is warmed by infrared radiation.

How does the design of the stove help to improve the rate of energy transfer by infrared radiation?

.....

.....

.....

.....

(2)

- (b) Burning 1 kg of wood transfers 15 MJ of energy to the stove. The stove then transfers 13.5 MJ of energy to the room.

Calculate the efficiency of the stove.

Show clearly how you work out your answer.

.....
.....
.....

Efficiency =

(2)

- (c) Some of the energy from the burning wood is wasted as the hot gases leave the chimney and warm the air outside the house.

Name **one** other way energy is wasted by the stove.

.....

(1)

- (d) Some people heat their homes using electric heaters. Other people heat their homes using a wood burning stove.

Give **two** environmental advantages of using a wood burning stove to heat a home rather than heaters that use electricity generated from fossil fuels.

1

.....

2

.....

(2)

(e) The metal case of the stove gets hot when the fire is lit.

Here is some information about the stove.

Mass of metal case	100 kg
Starting temperature of metal case	20 °C
Final temperature of metal case	70 °C
Specific heat capacity of metal case	510 J/kg °C

Calculate the energy required to raise the temperature of the metal case to 70 °C.

Show clearly how you work out your answer and give the unit.

.....

.....

.....

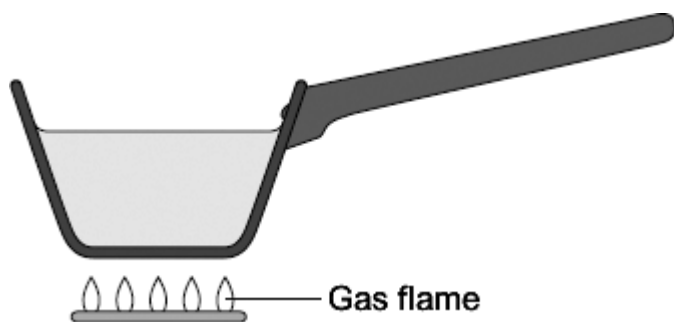
.....

Energy required =

(3)
(Total 10 marks)

30

The diagram shows a metal pan being used to heat water.



Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

.....

.....

.....

.....

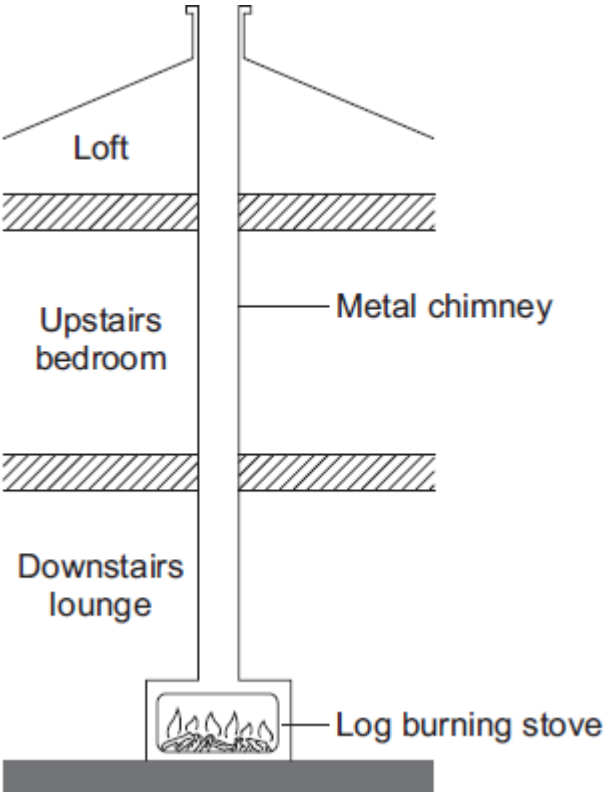
.....

.....

(4)
(Total 4 marks)

31

The diagram shows how the metal chimney from a log-burning stove passes through the inside of a house.



(a) Explain how heat is transferred by the process of convection from the inside of the stove to the top of the chimney.

.....

.....

.....

.....

.....

(2)

- (b) Although the outside of the chimney becomes very hot, there is no insulating material around the chimney.
- (i) Explain, in terms of the particles in a metal, how heat is transferred by conduction from the inside to the outside of the metal chimney.

.....

.....

.....

.....

.....

(2)

- (ii) Suggest **one** advantage of having no insulation around the chimney.

.....

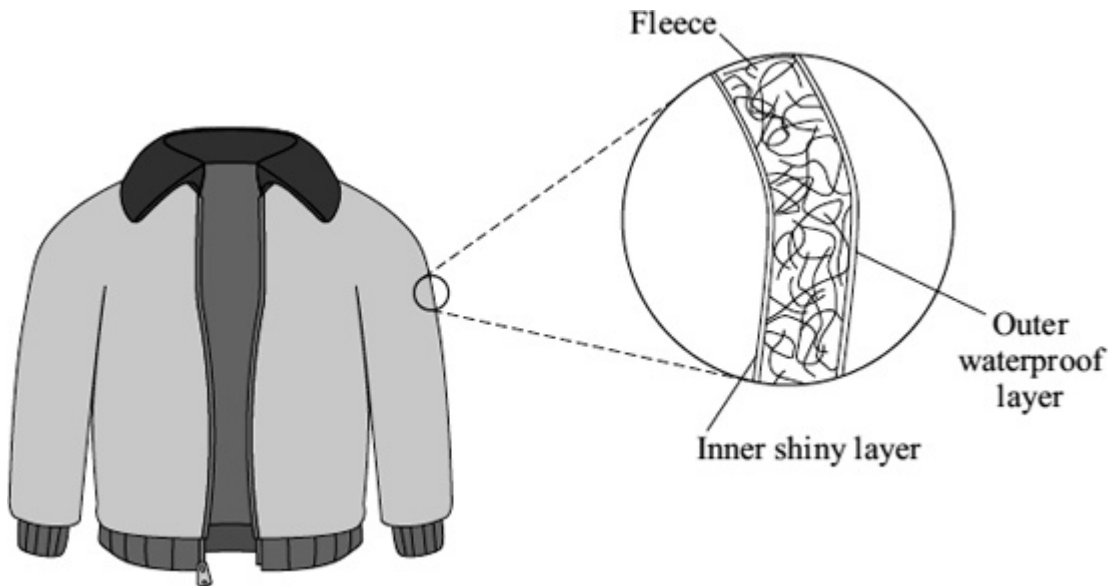
.....

(1)

(Total 5 marks)

32

- (a) The diagram shows a ski jacket that has been designed to keep a skier warm. The jacket is made from layers of different materials.



- (i) The inner layer is shiny to reduce heat transfer.

Which process of heat transfer will it reduce?

.....

(1)

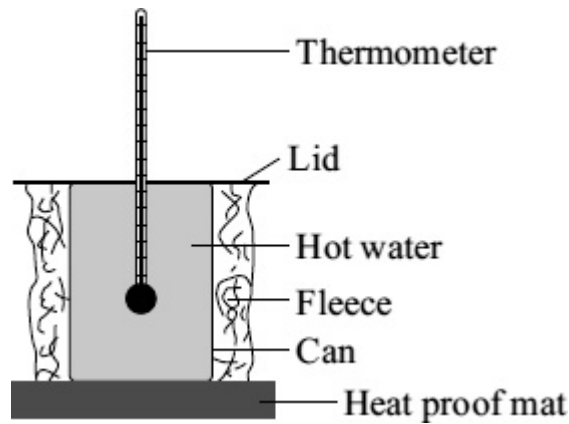
(ii) Why is the layer of fleece good at reducing the transfer of heat from a skier's body?

.....
.....

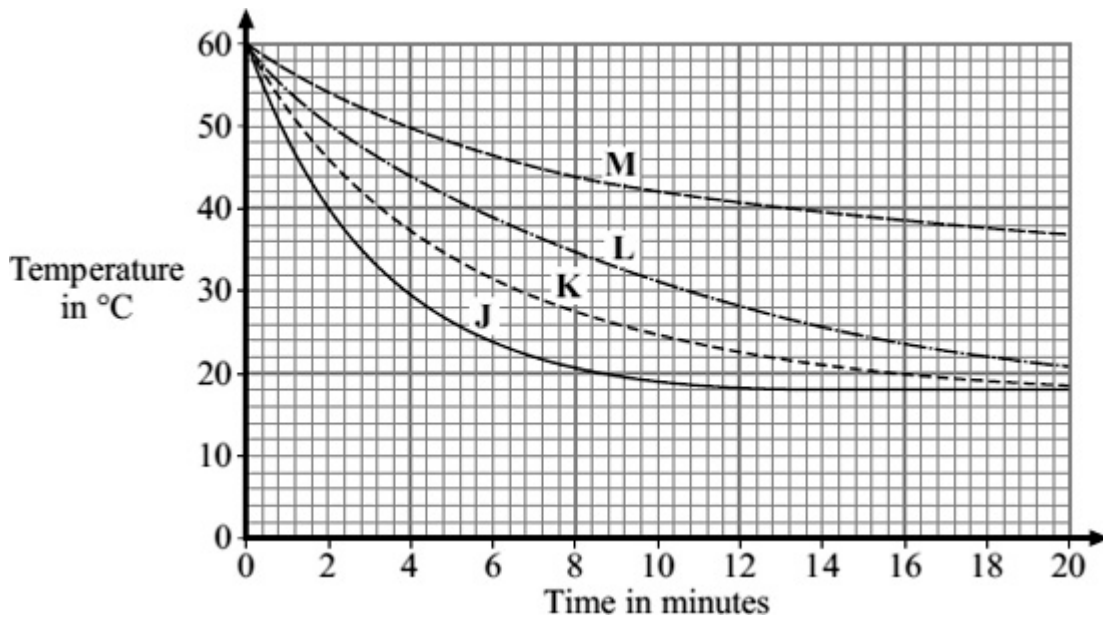
(1)

(b) A student tested four different types of fleece, **J**, **K**, **L** and **M**, to find which would make the warmest jacket. Each type of fleece was wrapped around a can which was then filled with hot water.

The temperature of the water was taken every two minutes for 20 minutes.



The graph shows the student's results.



(i) In each test, the water cooled faster during the first five minutes than during the last five minutes. Why?

.....
.....

(1)

- (ii) To be able to compare the results, it was important to use the same volume of water in each test.

Give **one** other quantity that was the same in each test.

.....
.....

(1)

- (iii) Look at the graph line for fleece **K**.

Estimate what the temperature of the water in the can wrapped in fleece **K** would be after 40 minutes.

.....

(1)

- (iv) Which type of fleece, **J**, **K**, **L** or **M**, should the student recommend to be used in the ski jacket?

.....

Give a reason for your answer.

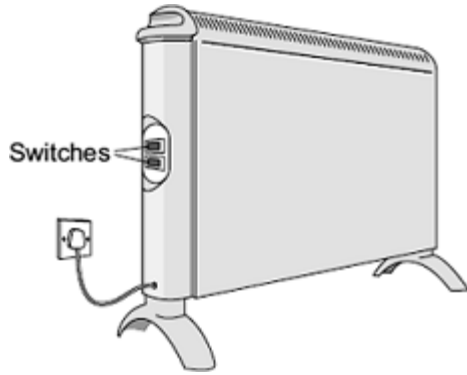
.....
.....
.....
.....

(2)

(Total 7 marks)

33

(a) The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.



Setting	Power in kW
Low	0.5
Medium	1.5
High	

(i) When both switches are on, the heater works at the high power setting.

What is the power of the heater when it is switched to the **high** power setting?

.....

Power = kW

(1)

(ii) The heater is used on the **medium** power setting. It is switched on for three hours.

Use the equation in the box to work out the energy transferred from the mains to the heater in three hours.

energy transferred (kilowatt-hour, kWh)	=	power (kilowatt, kW)	×	time (hour, h)
--	---	-------------------------	---	-------------------

Show clearly how you work out your answer.

.....

.....

Energy transferred = kWh

(2)

(iii) Electricity costs 12 pence per kilowatt-hour.

Use the equation in the box to calculate how much the heater costs to use on **medium** power for three hours.

$\text{total cost} = \text{number of kilowatt-hours} \times \text{cost per kilowatt-hour}$
--

Show clearly how you work out your answer.

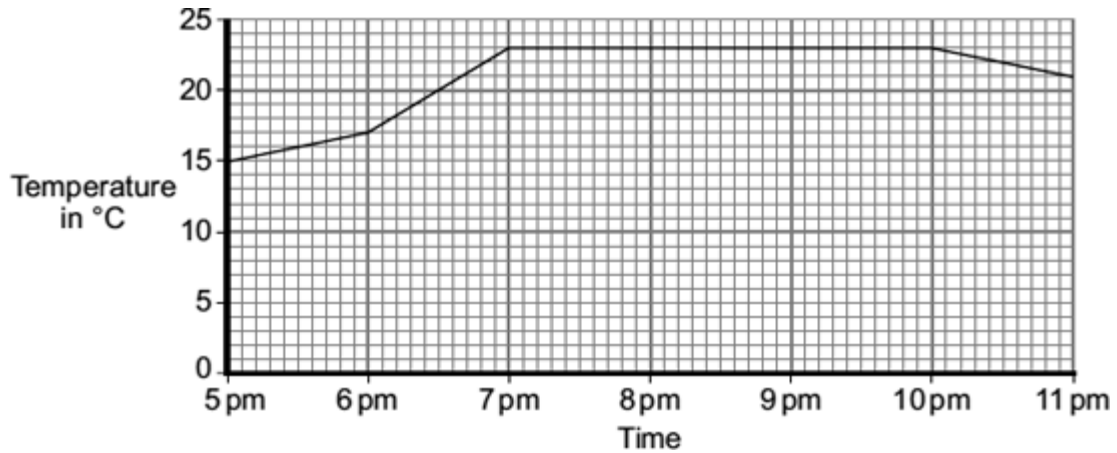
.....
.....

Total cost = pence

(2)

(b) The heater is used to warm a room.

The graph shows how the temperature of the room changes from the moment the heater is switched on.



The heater was first used on the medium setting.

(i) At what time was the heater setting changed to the **high** setting?

.....

Give a reason for your answer.

.....
.....
.....

(2)

(ii) From 7 pm until 10 pm, the temperature of the room is **not** changing.

Which **one** of the following statements gives the reason why the temperature of the room is **not** changing?

Put a tick (✓) in the box next to your answer.

The room is losing energy slower than the heater supplies energy.

The room is losing energy as fast as the heater supplies energy.

The room is losing energy faster than the heater supplies energy.

(1)
(Total 8 marks)