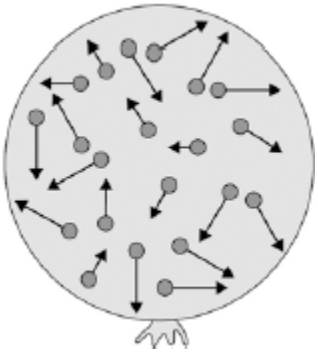
1 The figure below shows a balloon filled with helium gas.



(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 m^3.

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

m^3 / kg	**kg / m^3**	**kg m^3**

.....

.....

.....

.....

Density = ... Unit .....

(3)

(Total 7 marks)

2 Energy can be transferred through some materials by convection.

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

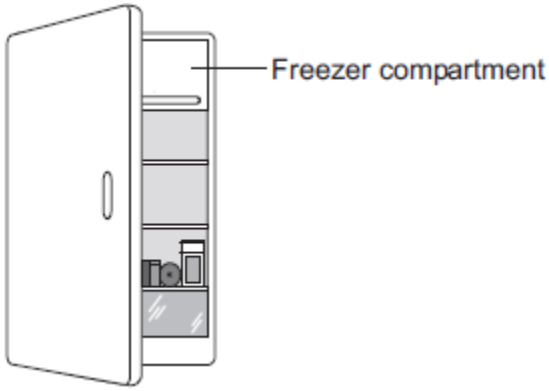
gas	**liquid**	**solid**

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 °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)

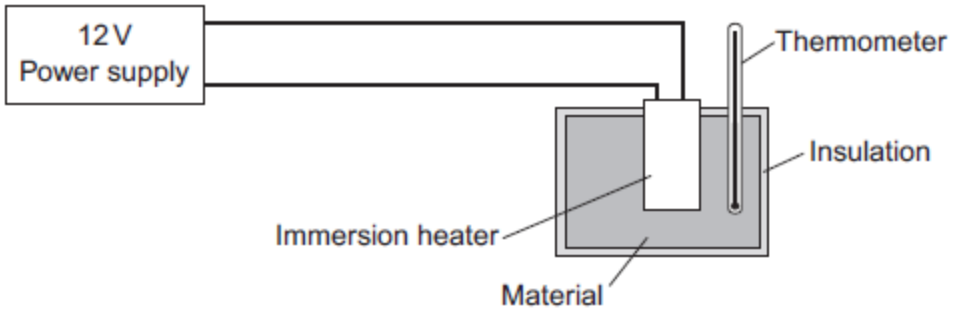
3 A student used the apparatus in **Figure 1** to compare the energy needed to heat blocks of different materials.

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.

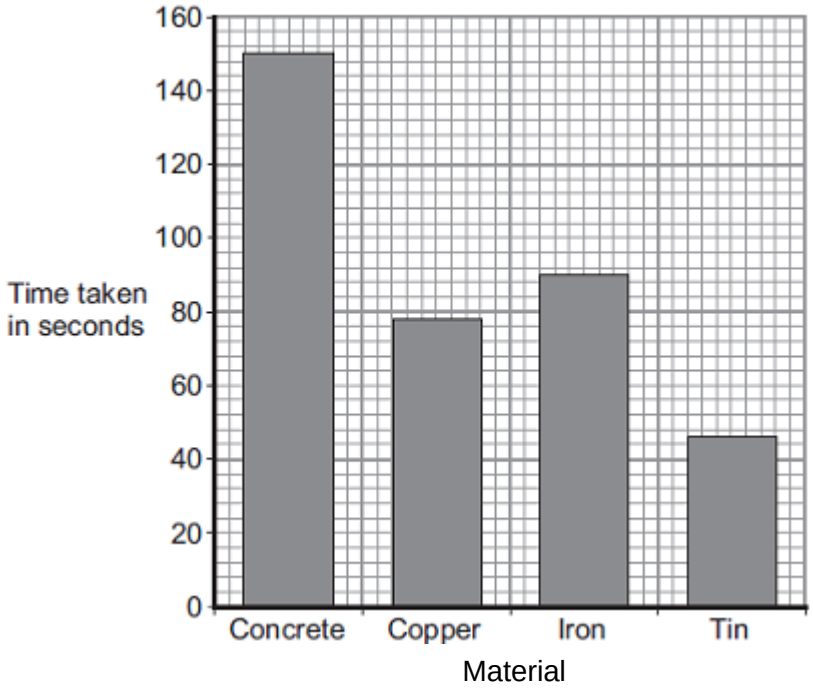
1 .....

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

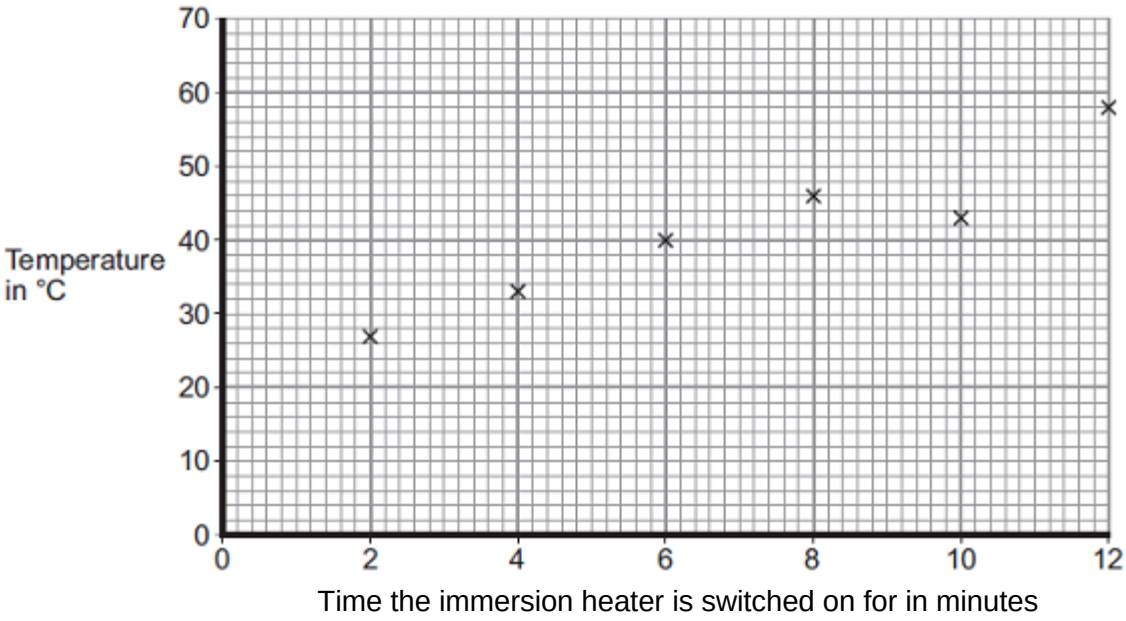
(2)

(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)

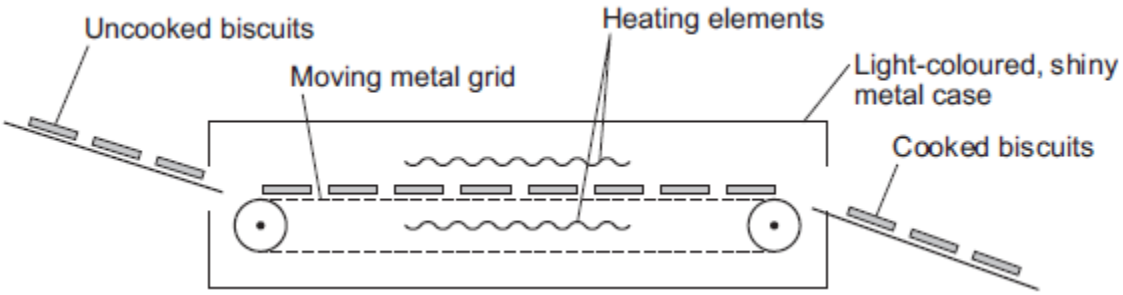
4 **Figure 1** shows one way that biscuit manufacturers cook large quantities of biscuits.

The uncooked biscuits are placed on a moving metal grid.

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

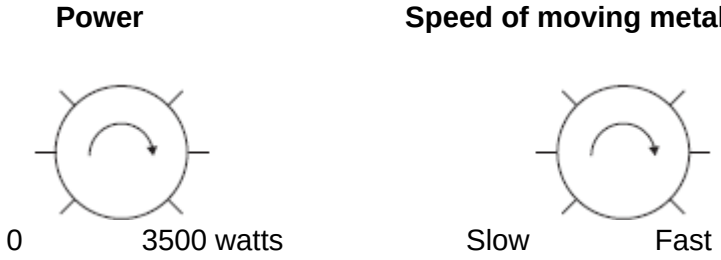
The biscuits turn brown as they cook.

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)

5 **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.

Solids:
- have a fixed shape
- are difficult to compress (to squash).

Gases:
- 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.

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Extra space .....

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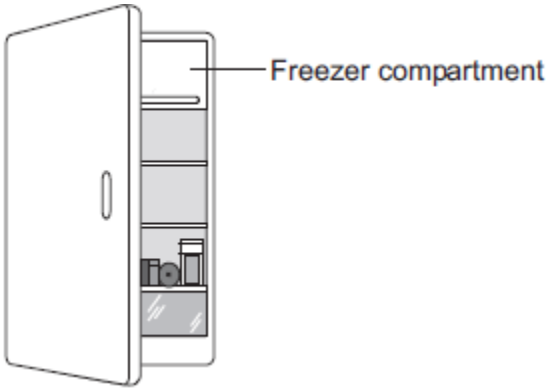
(Total 6 marks)

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

The temperature of the air inside the freezer compartment is –5 °C.



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

Explain why.

.....

.....

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.....

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.....

(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 .....

.....

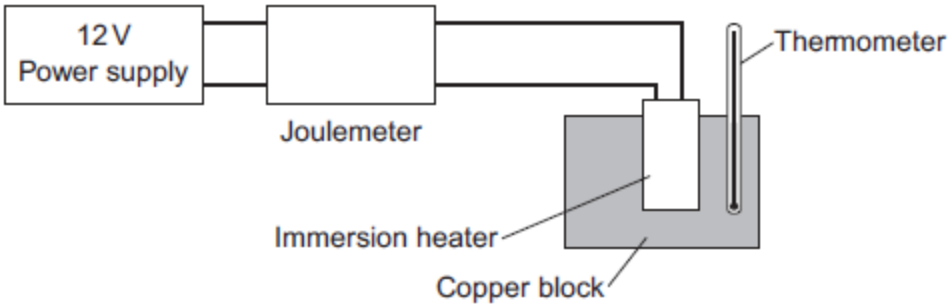
Disadvantage .....

.....

(2)
(Total 8 marks)

7 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.

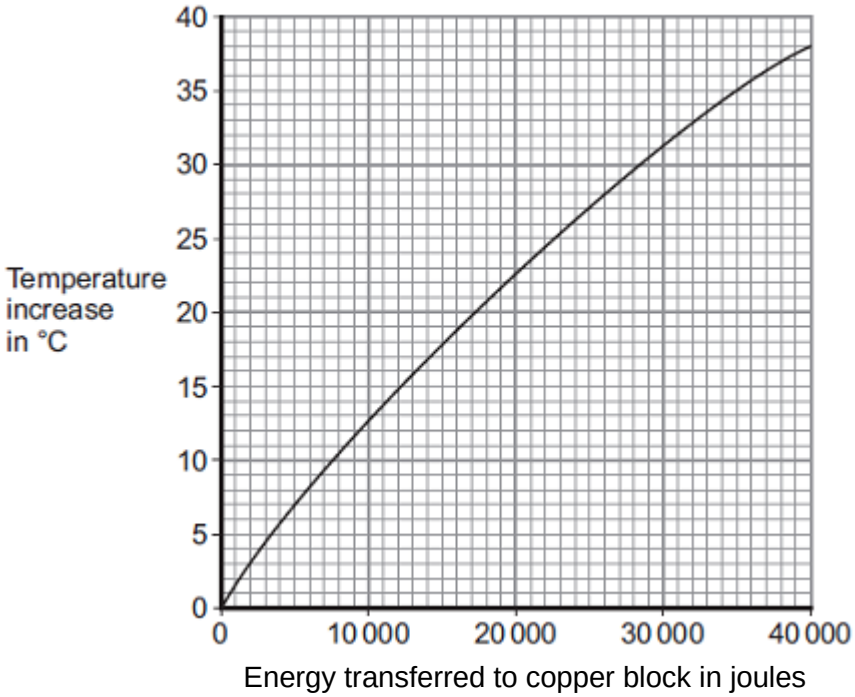
The energy transferred by the heater to the block was measured using the joulemeter.

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.

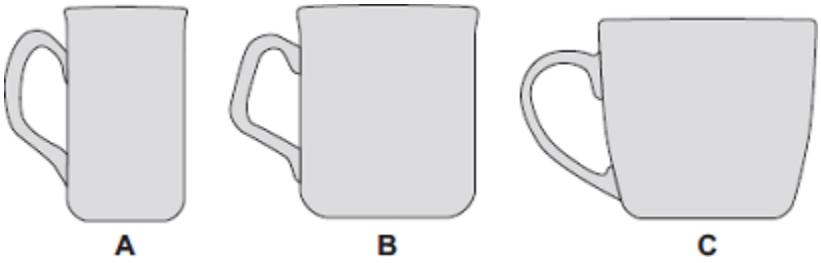
.....

.....

(1)

(Total 6 marks)

8 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 ..... .

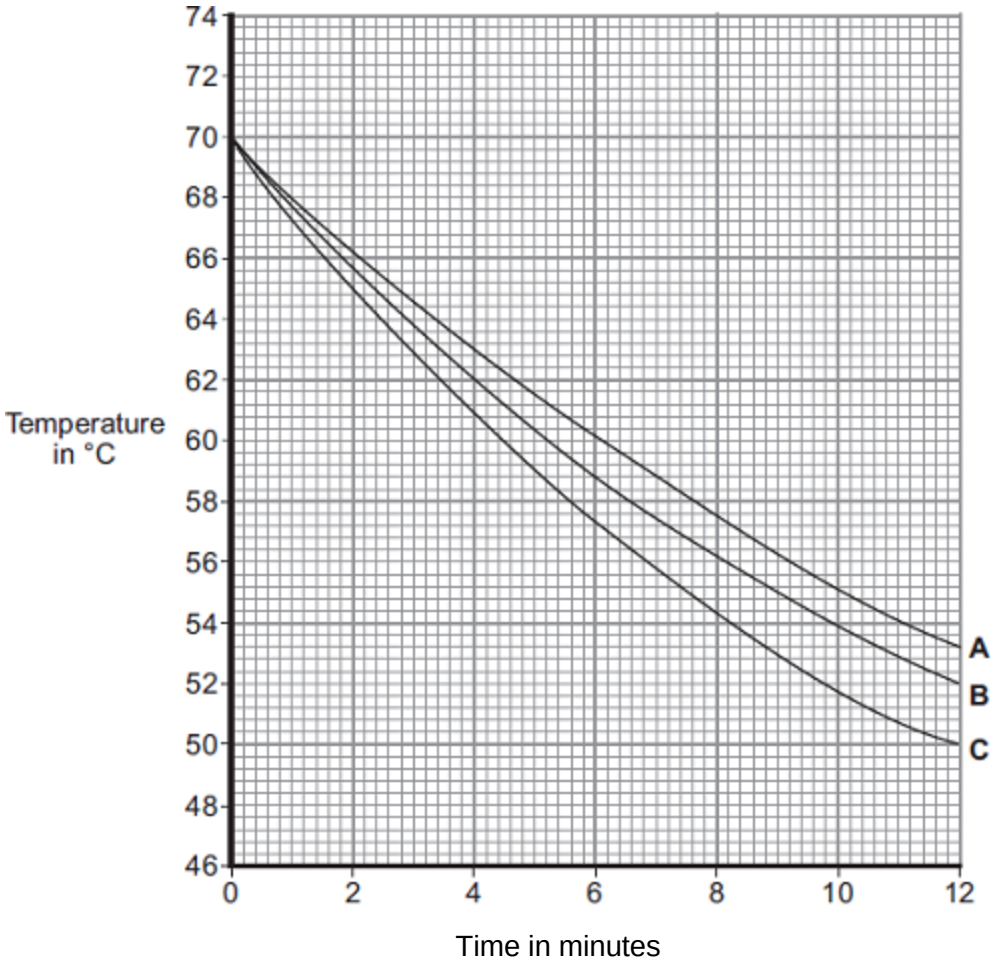
In the air around the cup, energy is transferred by ..... .

(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.

.....

.....

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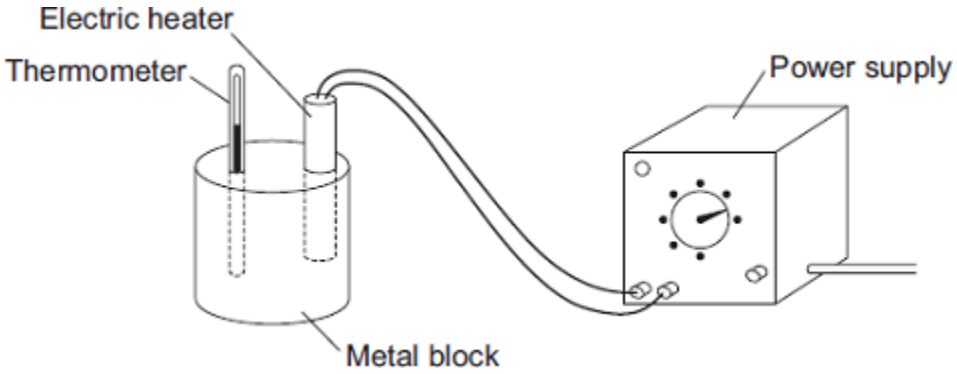
.....

.....

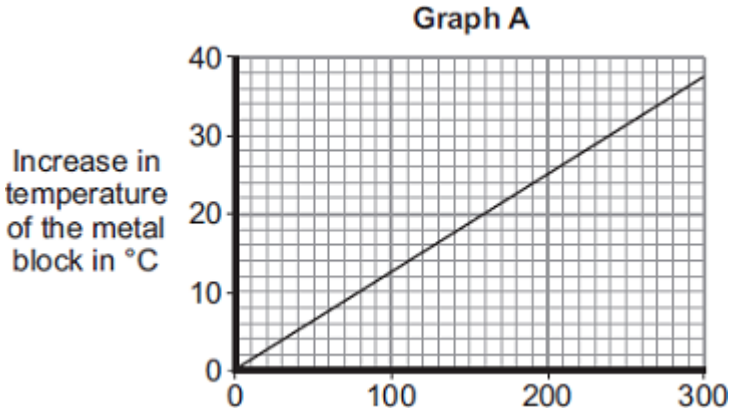
(4)
(Total 16 marks)

9 (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**.

.....

.....

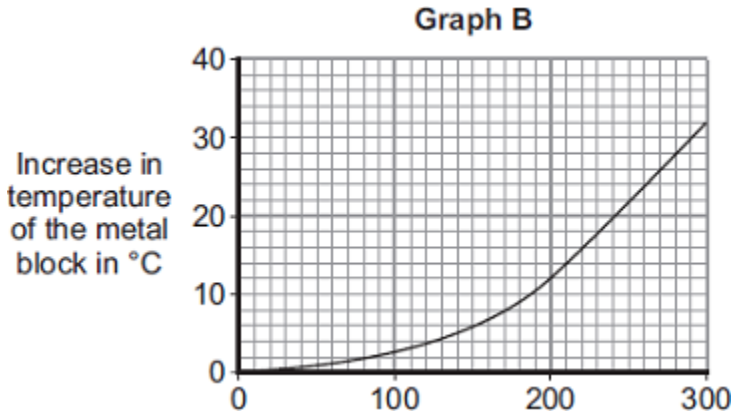
.....

.....

(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.

.....

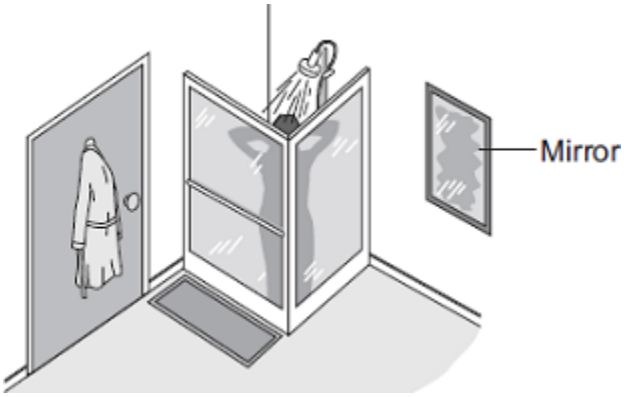
.....

.....

.....

(2)
(Total 7 marks)

10 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?

.....

.....

.....

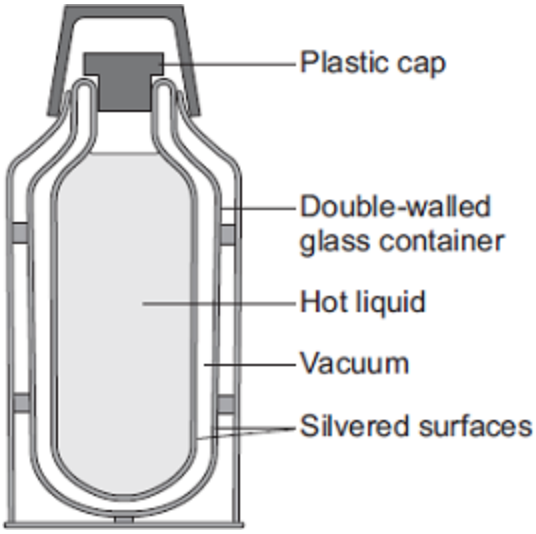
.....

.....

(2)
(Total 5 marks)

11 (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.

.....

.....

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.....

.....

.....

(6)

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

Arctic foxes have small ears.

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

.....

.....

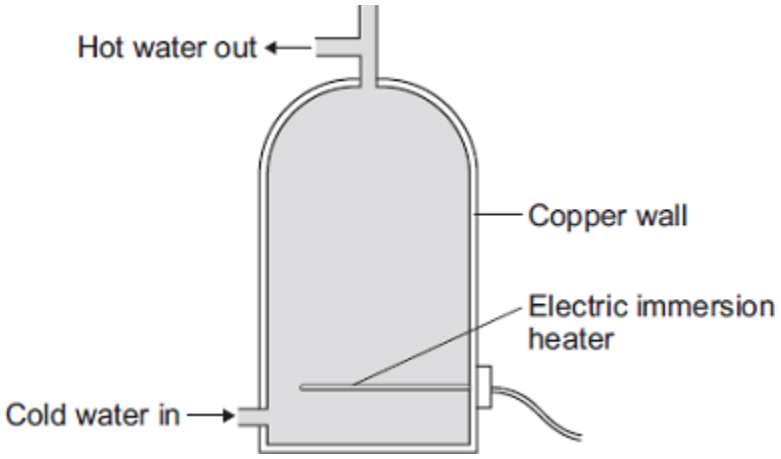
.....

.....

.....

(2)
(Total 8 marks)

12 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.

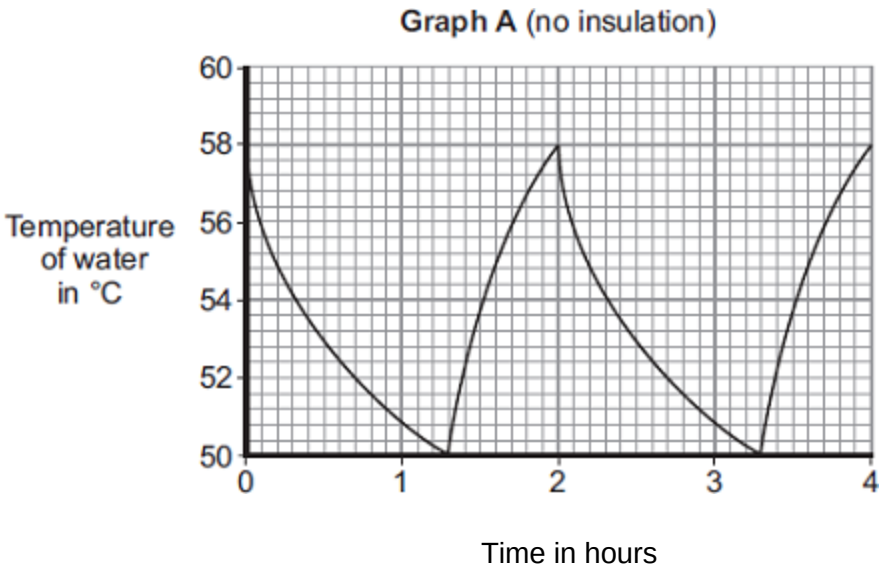
The main way the energy is transferred through the copper wall of the water tank is by the process of ..... .

(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

.....

.....

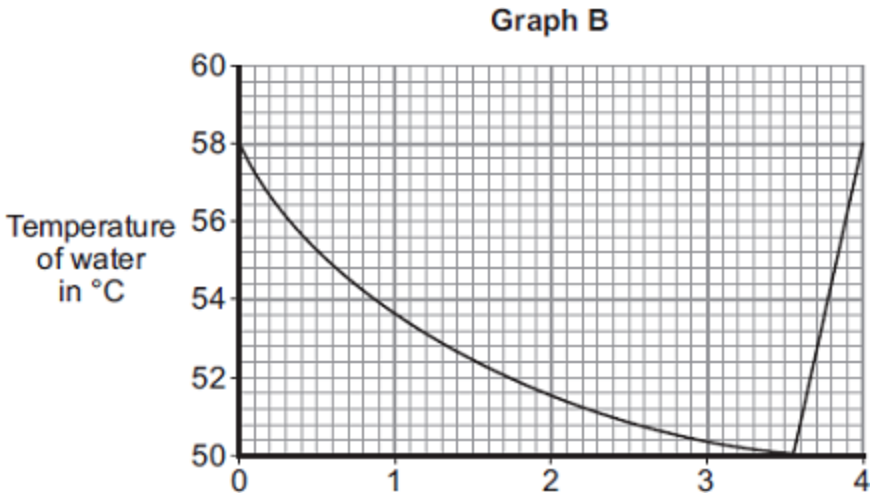
.....

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.

.....

.....

.....

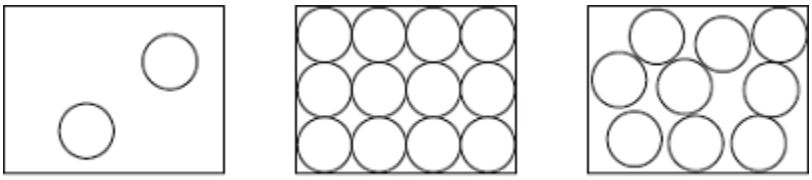
.....

.....

.....

(3)
(Total 9 marks)

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



X **Y** **Z**

(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)

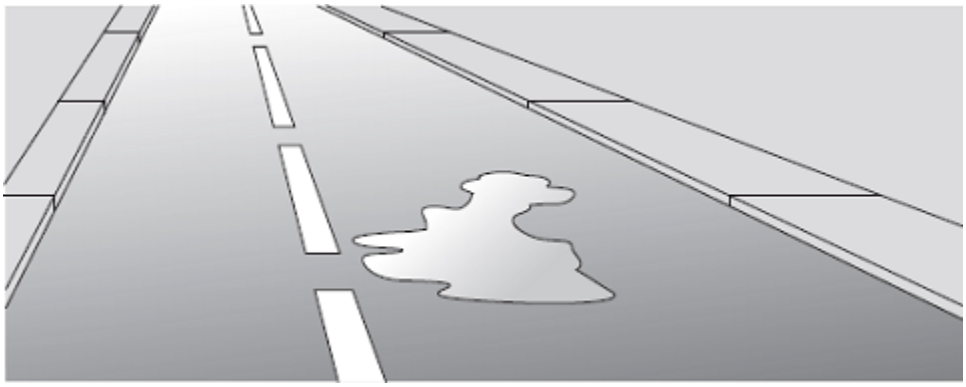
(ii) In a solid, the forces between the particles are

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)

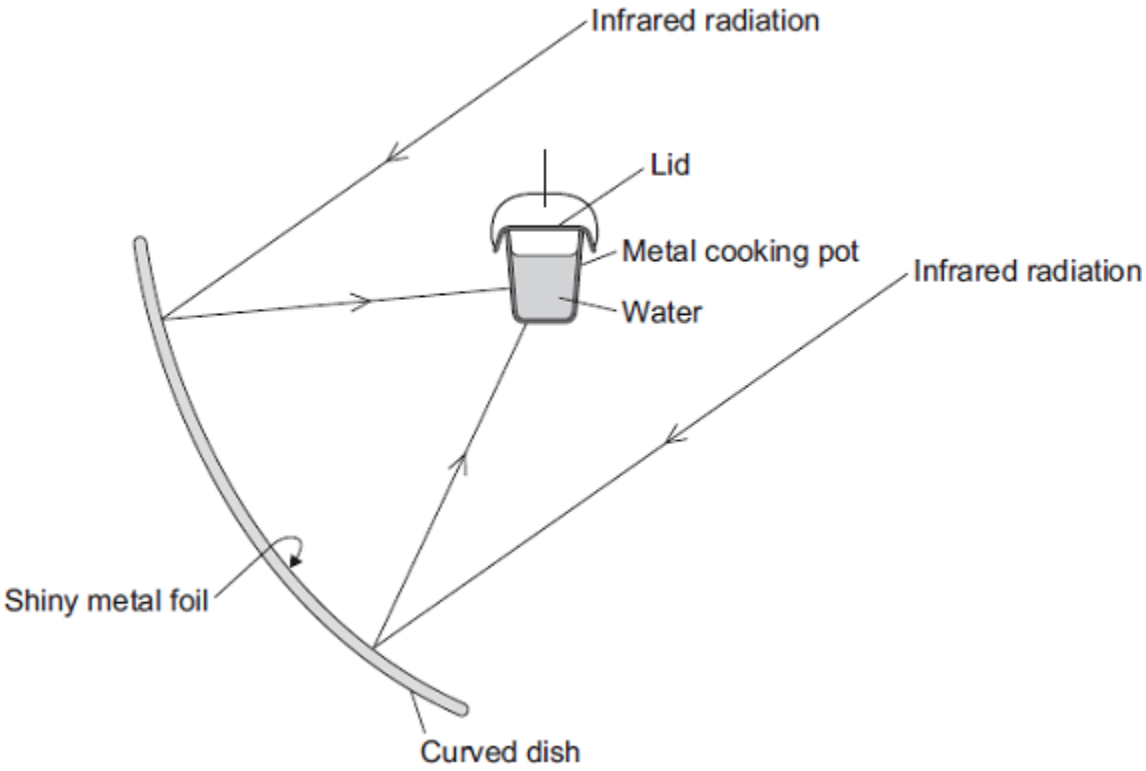
(ii) Describe **one** change in the weather which would cause the puddle of water to dry up faster.

.....

.....

(1)
(Total 6 marks)

14 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.

.....

.....

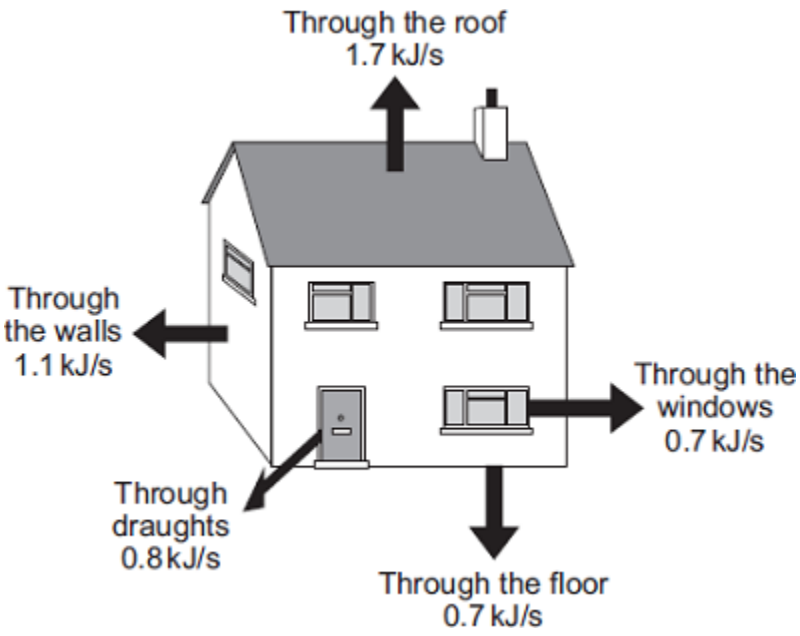
.....

Energy = ... J

(2)
(Total 6 marks)

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

Diagram 1



(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.

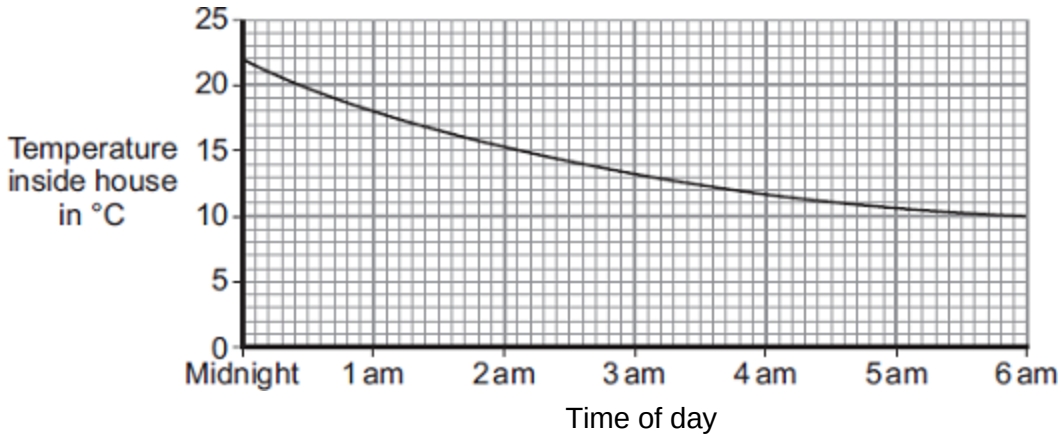
.....

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.

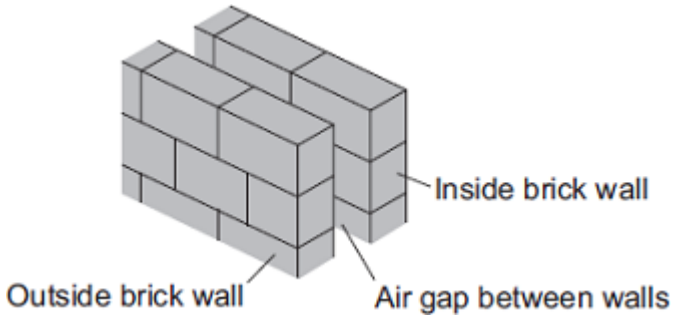
.....

.....

(2)

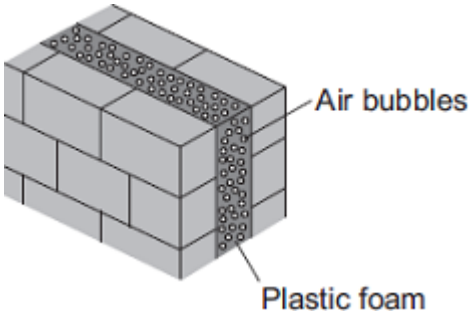
(b) **Diagram 2** shows how the walls of the house are constructed.
Diagram 3 shows how the insulation of the house could be improved by filling the air gap between the two brick walls with plastic foam.

Diagram 2



U-value of the wall = 0.7

Diagram 3



U-value of the wall = 0.3

The plastic foam reduces energy transfer by convection.

Explain why.

.....

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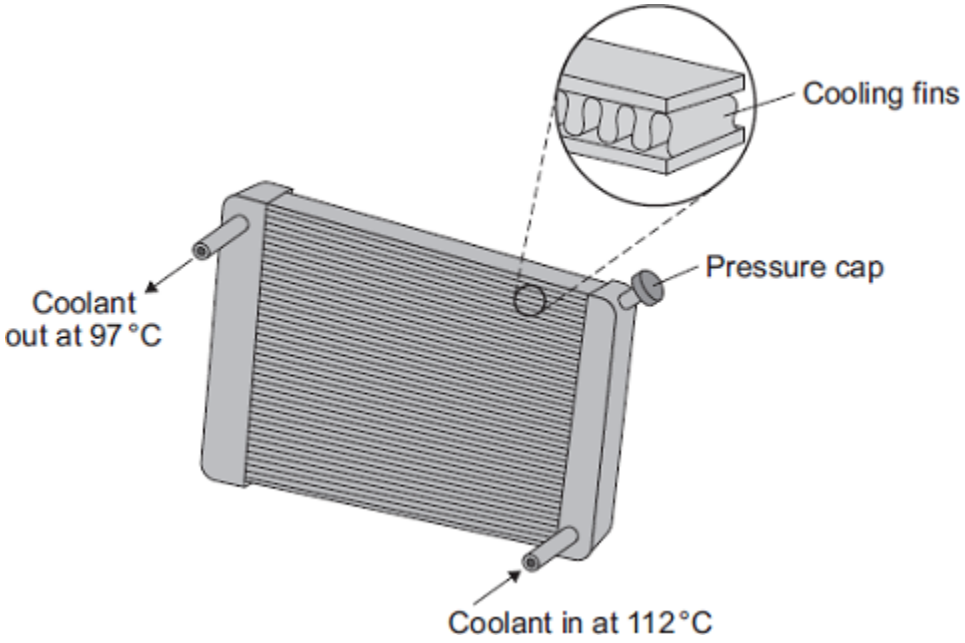
.....

.....

(2)
(Total 8 marks)

16 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?

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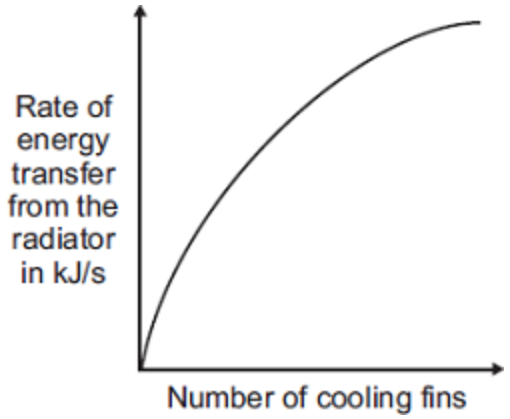
(2)

(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.

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(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.

.....

.....

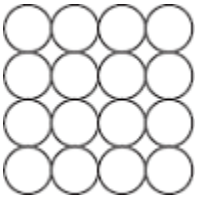
.....

(2)
(Total 9 marks)

17 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.

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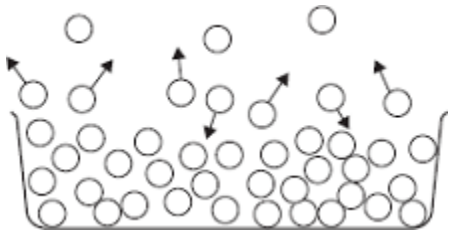
(4)

(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.

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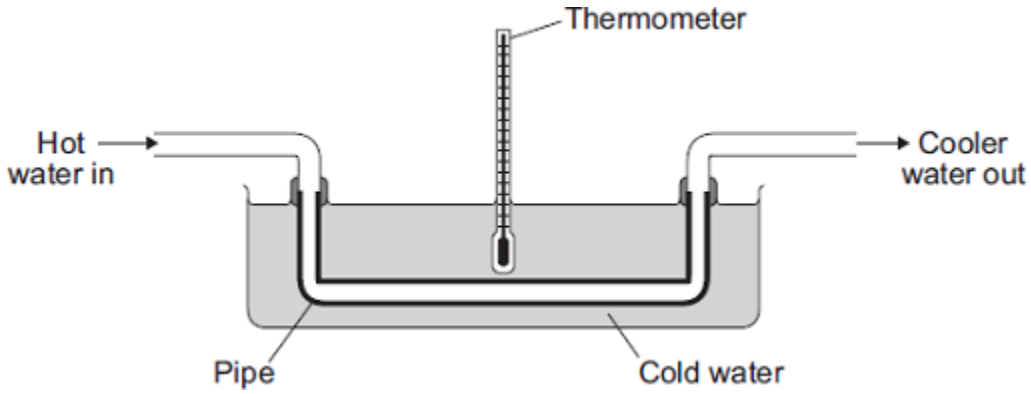
(3)
(Total 8 marks)

18 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.

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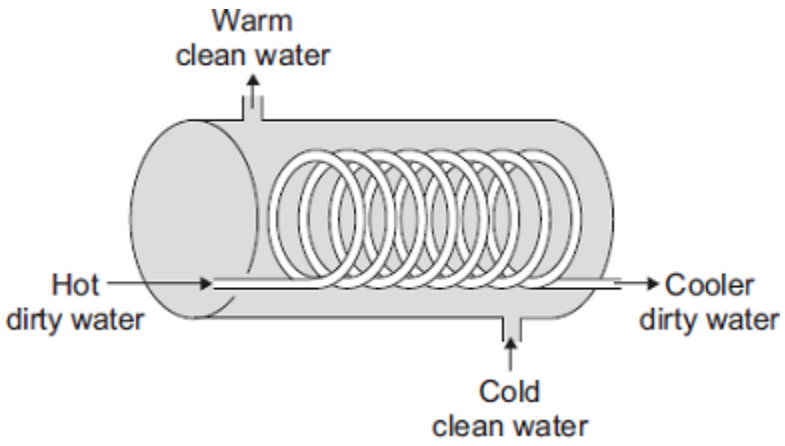
(2)

(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.

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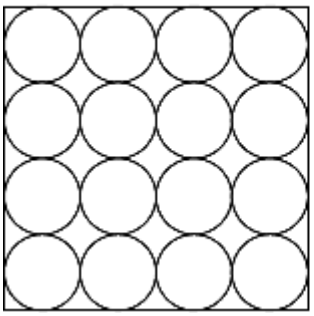
(2)
(Total 6 marks)

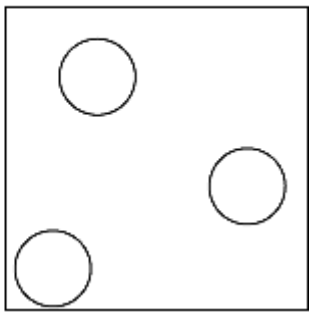
19 (a) The diagrams show the arrangement of the particles in a solid and in a gas.

Each circle represents one particle.

Solid

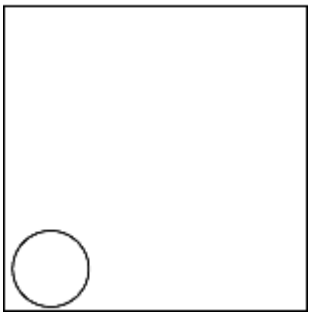


Gas



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

Liquid



(2)

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

.....

.....

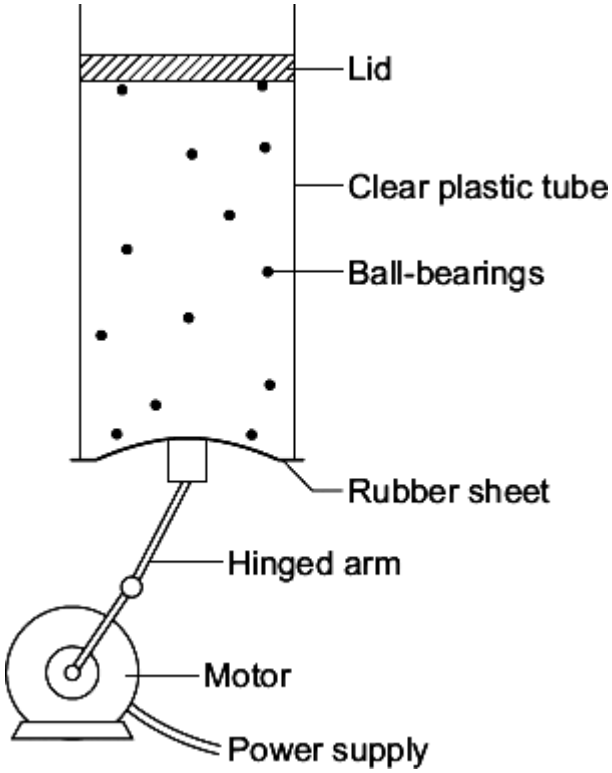
.....

.....

(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.

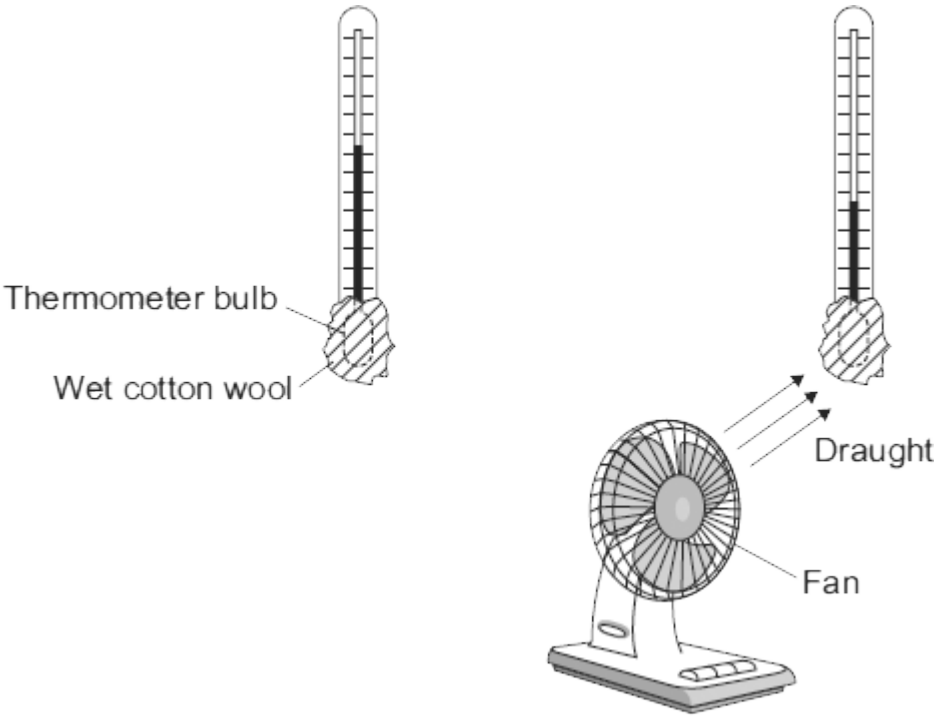
Use the model to predict what happens to the speed of the gas particles when the temperature of a gas is increased.

.....

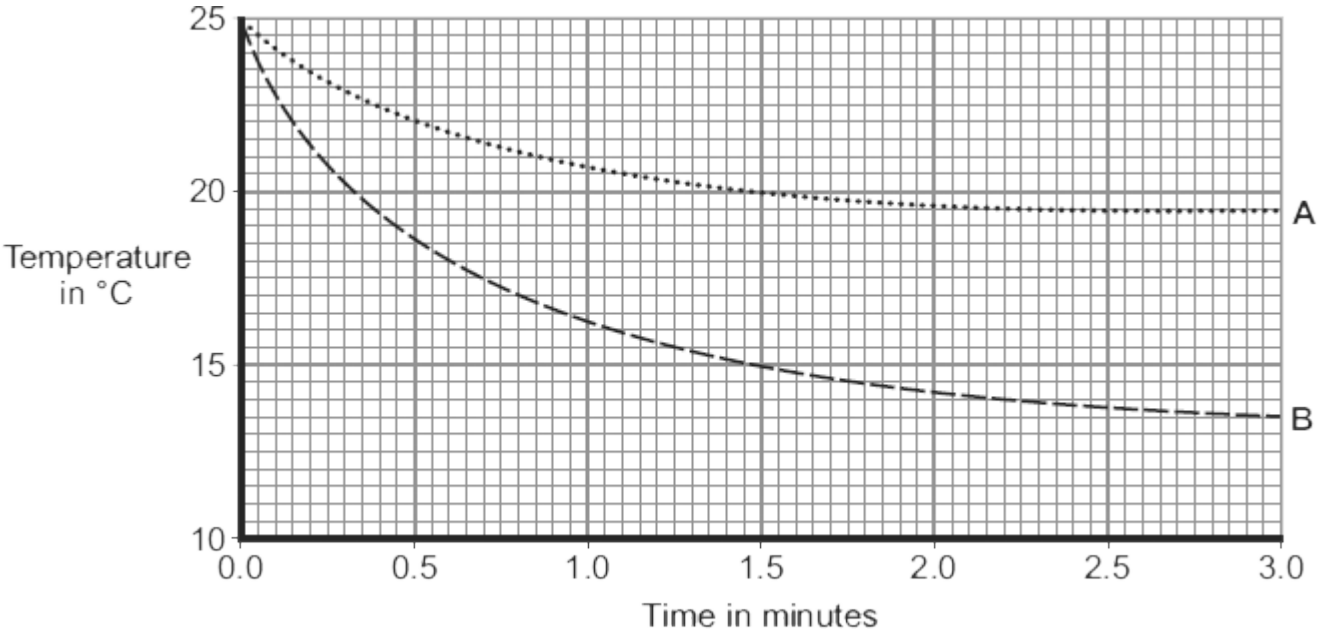
.....

(1)
(Total 6 marks)

20 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.

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.....

(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.

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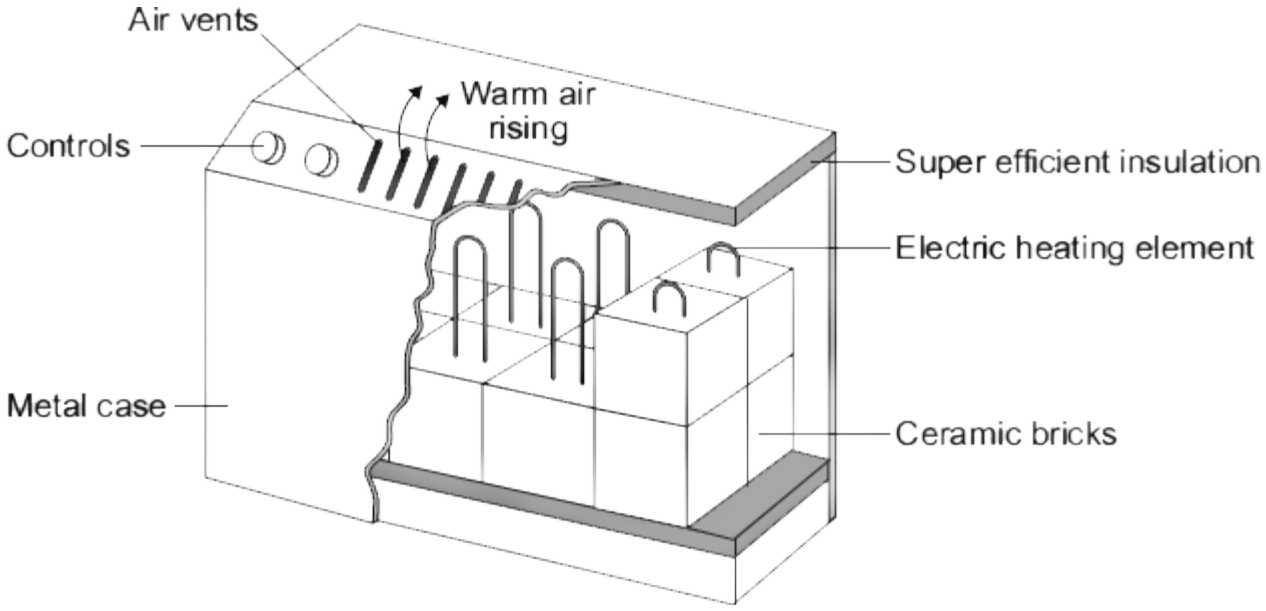
(2)
(Total 5 marks)

21 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.

.....

.....

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.....

.....

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.

.....

.....

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.....

(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.

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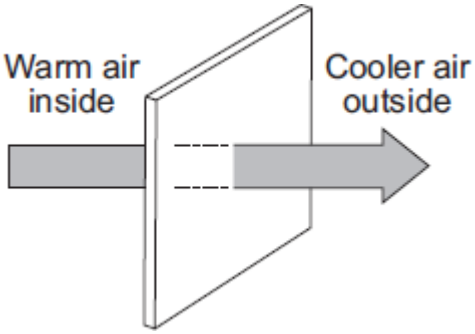
Mass = ... kg

(2)
(Total 8 marks)

22 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.

.....

.....

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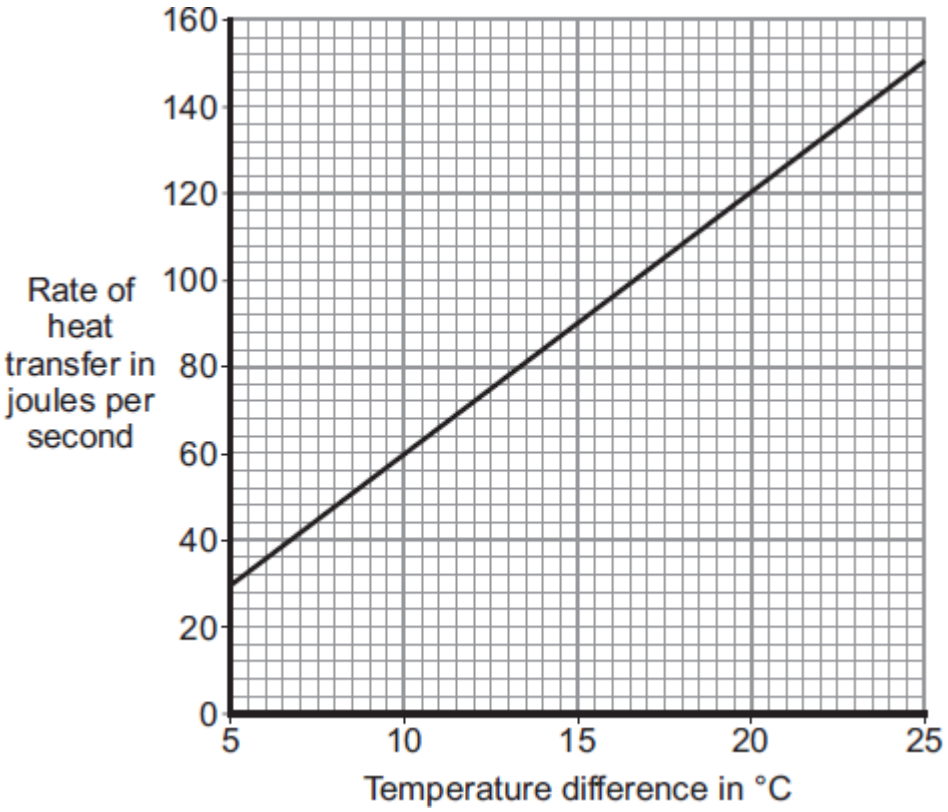
.....

(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 m^2 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.

.....

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.....

.....

(2)

(iii) A house has single-glazed windows. The total area of the windows in the house is 15 m^2.

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.

.....

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.....

.....

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.

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(2)
(Total 10 marks)

23 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?

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(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.

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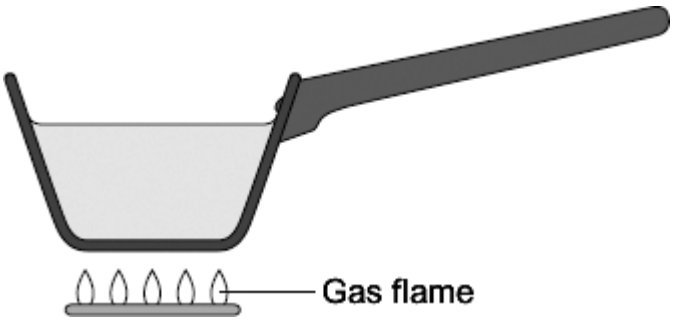
Energy required = ...

(3)

(Total 10 marks)

24 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.

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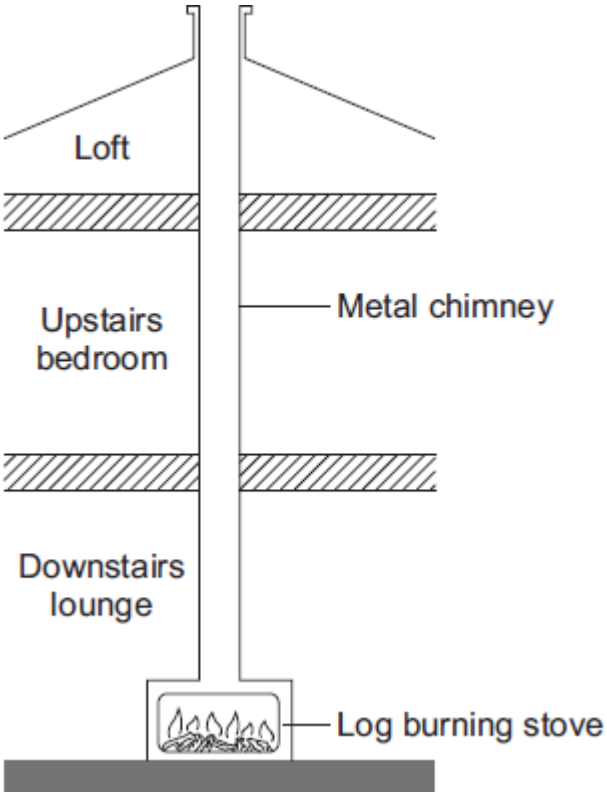
(4)
(Total 4 marks)

25 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.

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.....

(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.

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.....

.....

(2)

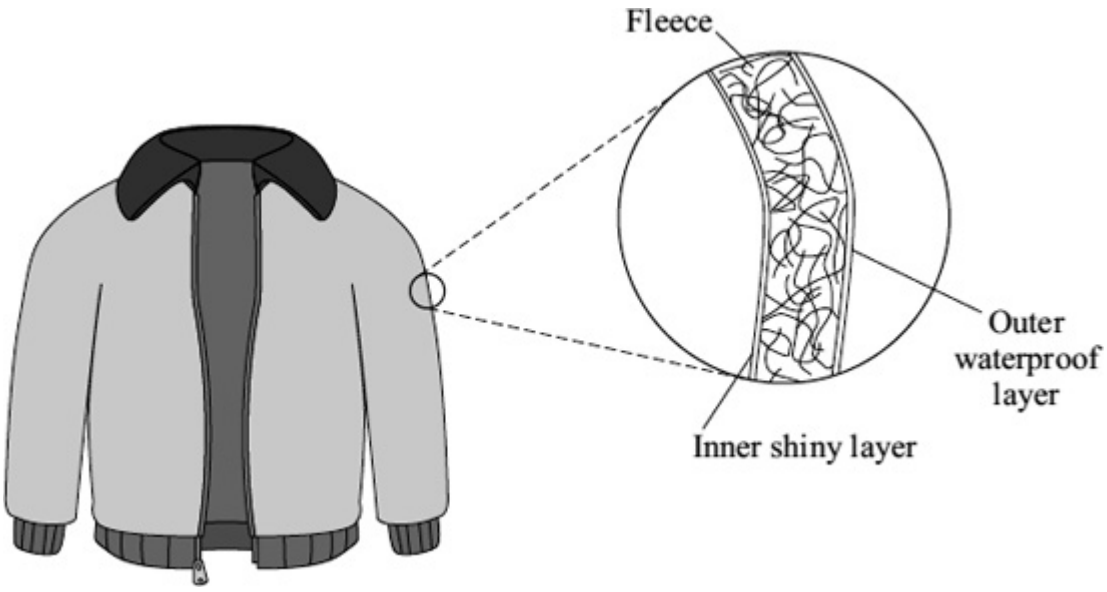
(ii) Suggest **one** advantage of having no insulation around the chimney.

.....

.....

(1)
(Total 5 marks)

26 (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)

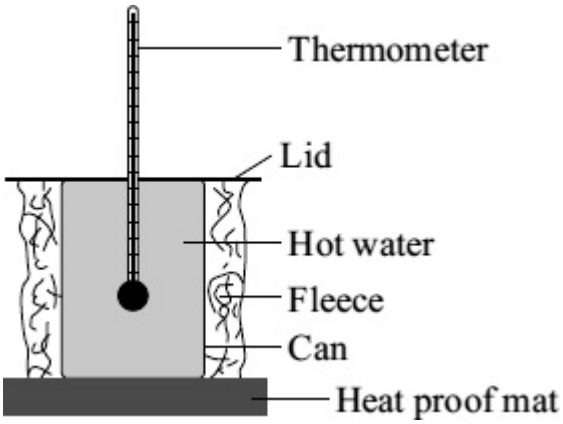
(ii) Why is the layer of fleece good at reducing the transfer of heat from a skier's body?

.....

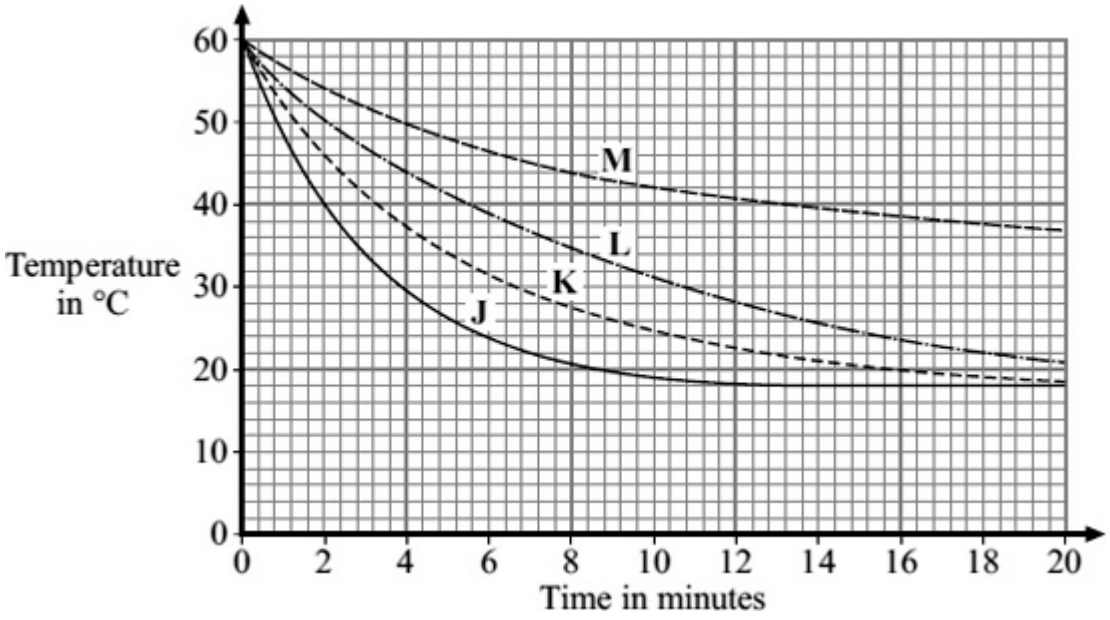
.....

(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.

.....

.....

.....

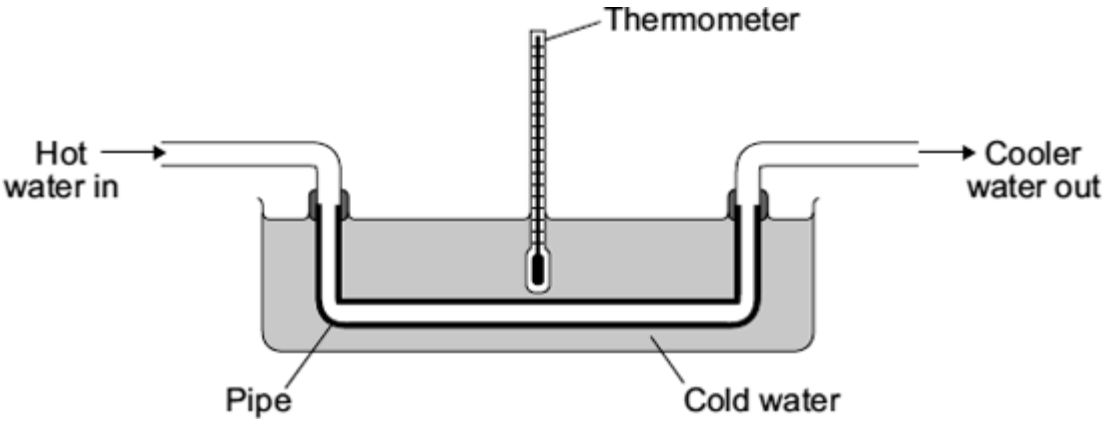
.....

(2)

(Total 7 marks)

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

The diagram shows a simple heat exchanger used by a student in an investigation.
Heat is transferred from the hot water inside the pipe to the cold water outside the pipe.



(a) By which process is heat transferred from the hot water inside the pipe to the cold water outside the pipe?

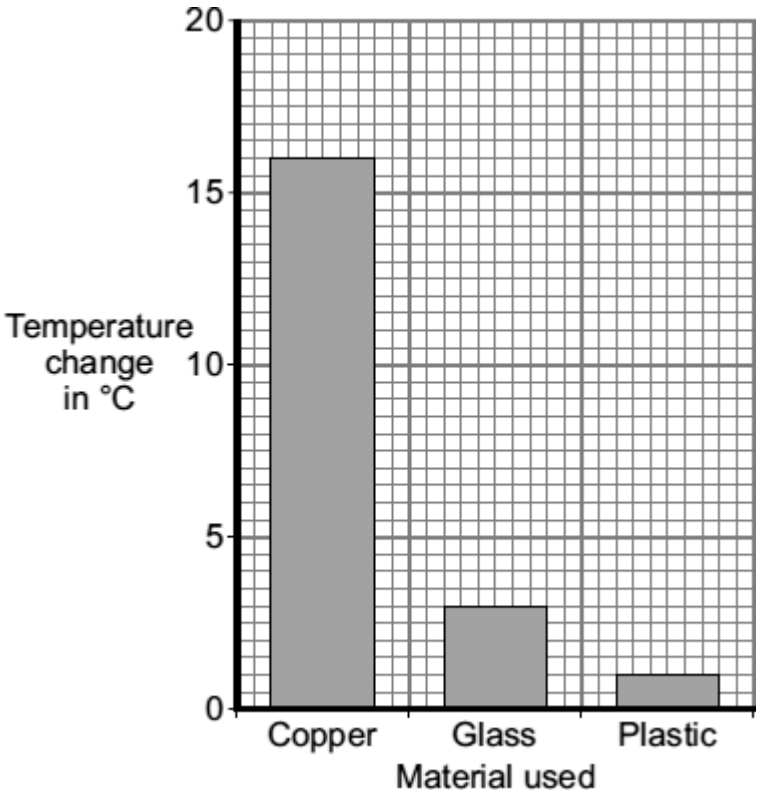
.....

(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 results obtained by the student are recorded in the table and displayed in the bar chart.

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) Why did the student draw a bar chart rather than a line graph?

.....

.....

(1)

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

.....

Give a reason for your answer.

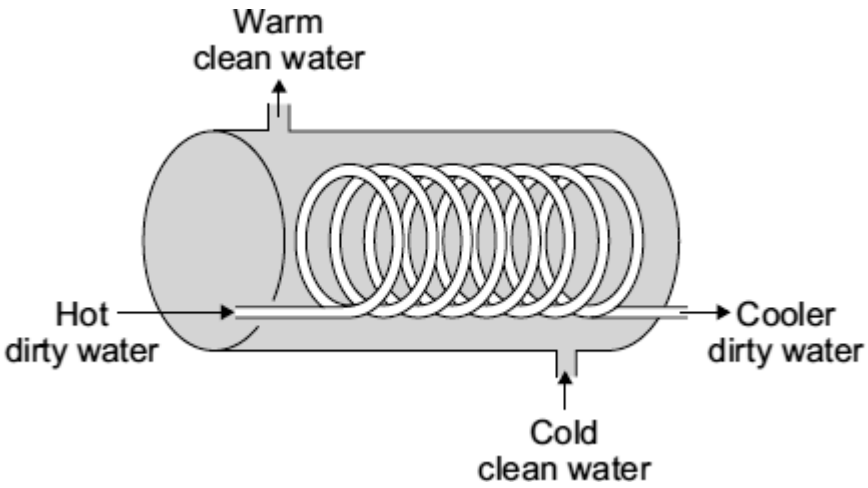
.....

.....

.....

(2)

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



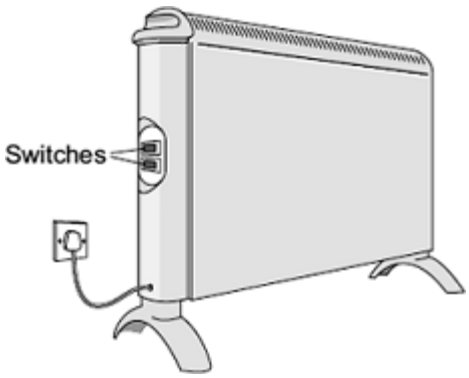
Why does this heat exchanger transfer heat faster than the heat exchanger used by the student in the investigation?

.....

.....

(1)
(Total 6 marks)

28 (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 watts
Low	700
Medium	1400
High	

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

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

.....

Power = ... kilowatts

(1)

(ii) The heater is used on the **high** power setting. It is switched on for 1½ hours.

Calculate the energy transferred from the mains to the heater in 1½ hours.

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

.....

.....

.....

Energy transferred = ...

(3)

(iii) This type of heater is a very efficient device.

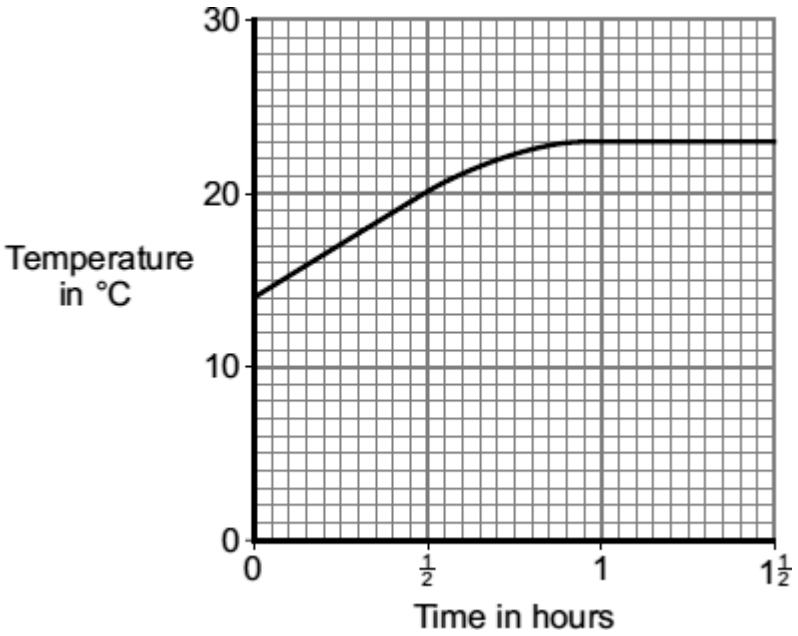
What is meant by a device being very efficient?

.....

.....

(1)

(b) The graph shows how the temperature of a room changes during the 1½ hours that the heater is used.



After 1 hour, the temperature of the room has become constant, even though the heater is still switched on.

Explain why.

.....

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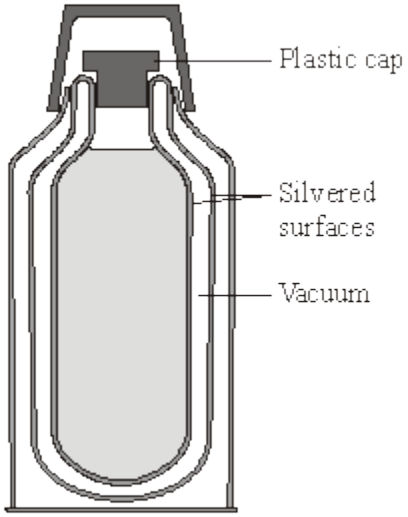
.....

.....

(2)
(Total 7 marks)

29 A vacuum flask is designed to reduce the rate of heat transfer.



(a) (i) Complete the table to show which methods of heat transfer are reduced by each of the features labelled in the diagram.

The first row has been done for you.

Feature	Conduction	Convection	Radiation
vacuum	*	*	
silveredsurfaces			
plastic cap			

(2)

(ii) Explain why the vacuum between the glass walls of the flask reduces heat transfer by conduction and convection.

.....

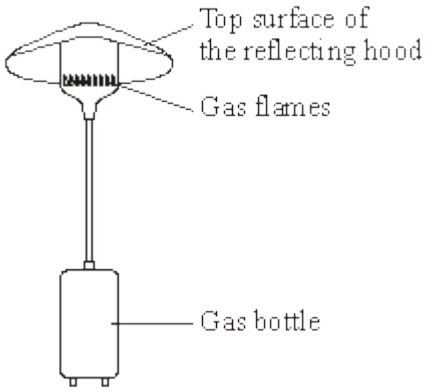
.....

.....

.....

(2)

(b) The diagram shows a gas flame patio heater.



(i) Explain why the top surface of the reflecting hood should be a light, shiny surface rather than a dark, matt surface.

.....

.....

.....

(2)

(ii) Most of the chemical energy in the gas is transformed into heat. A **small** amount of chemical energy is transformed into light.

Draw and label a Sankey diagram for the patio heater.

(2)

(iii) State why the total energy supplied to the patio heater must always equal the total energy transferred by the patio heater.

.....

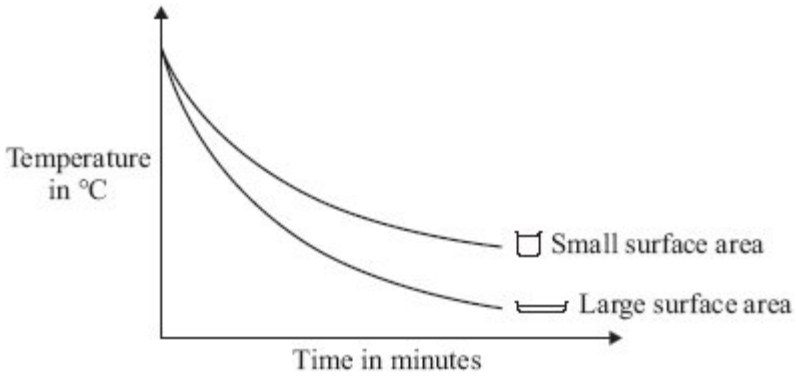
.....

(1)

(Total 9 marks)

30 (a) The graph compares how quickly hot water cooled down in two glass beakers with different surface areas.

The volume of water in each beaker was the same.



Describe how the surface area of the water affected how fast the water cooled down.

.....

.....

(1)

(b) Some foxes live in a hot desert environment.

This type of fox has very large ears.

Explain how the size of the fox's ears help it to keep cool in a hot desert.

.....

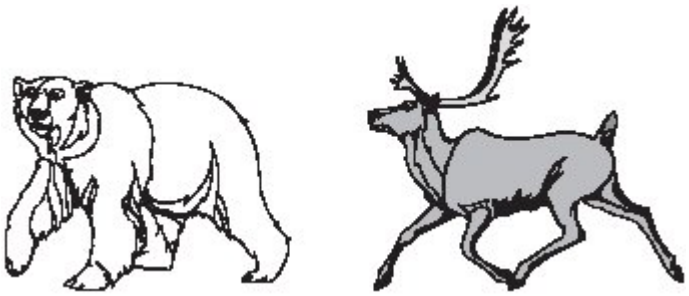
.....

.....

.....

(2)

(c) Polar bears and reindeer are adapted to live in cold environments.



Use the words in the box to complete the following sentences.

conduction	**convection**	**radiation**

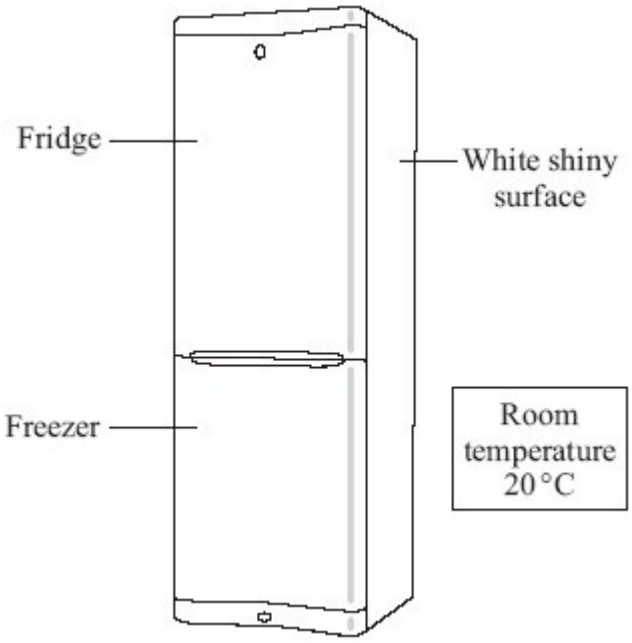
(i) The white colour of a polar bear's fur helps to keep the polar bear warm by reducing the heat lost by ..... .

(1)

(ii) The hairs of a reindeer are hollow. The air trapped inside the hairs reduces the heat lost by ..... .

(1)
(Total 5 marks)

31 The diagram shows a fridge-freezer.



(a) By which method is heat transferred through the walls of the fridge-freezer?

.....

(1)

(b) The inside of the fridge is at 4 °C. The inside of the freezer is at –18 °C.

Into which part of the fridge-freezer will the rate of heat transfer be greater?

Draw a ring around your answer.

the fridge **the freezer**

Give a reason for your answer.

.....

.....

(1)

(c) The outside surface of the fridge-freezer is white and shiny.

Give **two** reasons why this type of surface is suitable for a fridge-freezer.

1 .....

.....

2 .....

.....

(2)
(Total 4 marks)

32 (a) In winter, energy is transferred from the warm air inside a house to the air outside.

(i) What effect will the energy transferred from the house have on the air outside?

.....

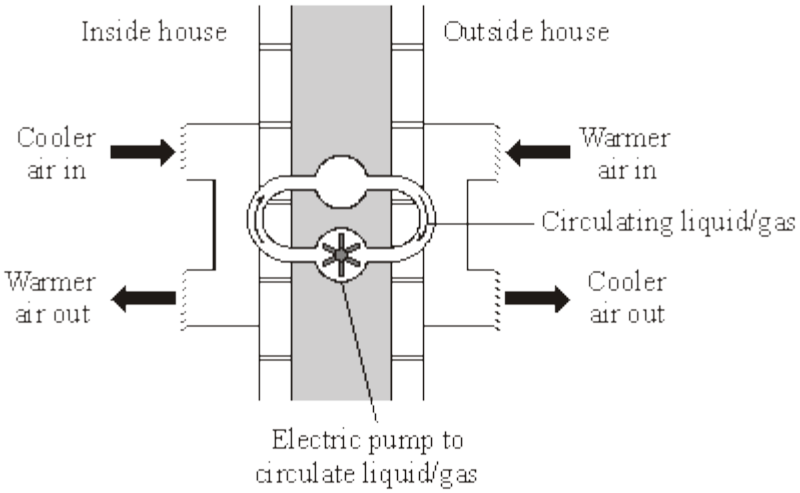
(1)

(ii) What would happen to the energy transfer if the temperature inside the house were reduced? Assume the temperature outside the house does not change.

.....

(1)

(b) To increase energy efficiency, a householder installs a heat exchanger to an outside wall of the house. The heat exchanger uses heat from the air outside to warm the inside of the house. The diagram shows the idea of the heat exchanger.



Physics Through Applications edited by J Jardine et el (OUP, 1989), *copyright © Oxford University Press, reprinted by permission of Oxford University Press.*

(i) Why does the heat exchanger cost money to run?

.....

(1)

(ii) The heat exchanger is cost effective in reducing energy consumption. Explain why.

.....

.....

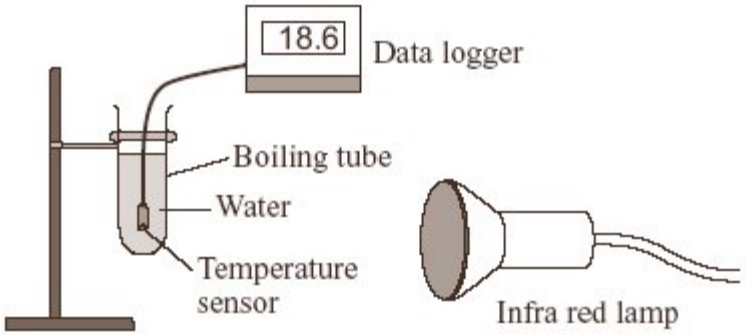
.....

.....

(2)
(Total 5 marks)

33 A student had read about a glacier that had been covered in insulating material. The idea was to slow down the rate at which the glacier melts in the summer.

She investigated this idea using the apparatus shown in the diagram.



(a) These are the steps taken by the student.

- Measure 30 cm^3 of cold water into a boiling tube.
- Place the boiling tube 25 cm from an infra red lamp.
- Record the temperature of the water.
- Switch on the infra red lamp.
- Record the temperature of the water every minute for 5 minutes.
- Repeat with boiling tubes covered in different insulating materials.

(i) Why did she use an infra red lamp?

.....

(1)

(ii) Name **one** control variable in this investigation.

.....

(1)

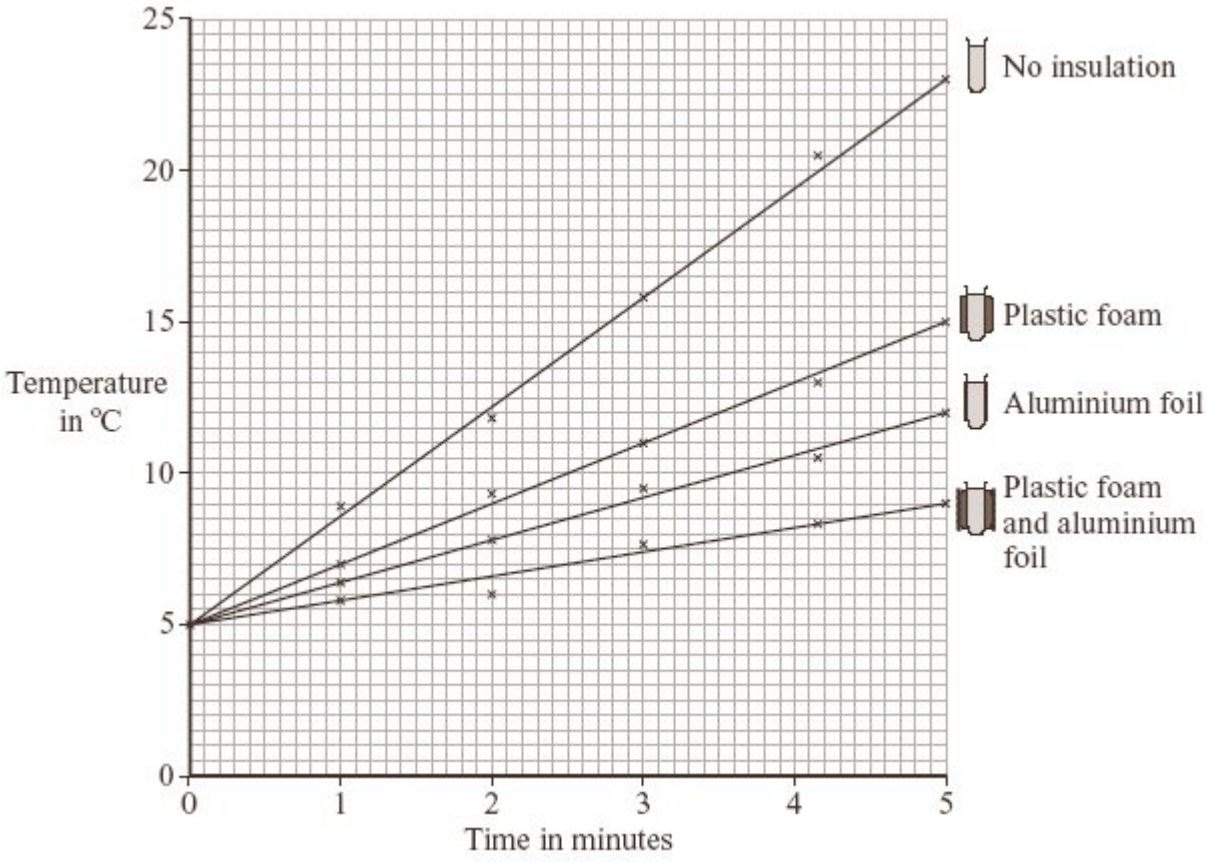
(iii) Give **one** advantage of using a temperature sensor and data logger instead of a glass thermometer to measure temperature.

.....

.....

(1)

(b) The results of the investigation are shown in the graph.



(i) Why did the student use a boiling tube with no insulation?

.....

.....

(1)

(ii) From her results, what should she recommend is used to insulate the glacier?

.....

(1)

(iii) Explain why the insulation recommended by the student will reduce the heat transfer from the Sun to the glacier.

.....

.....

.....

.....

.....

(2)

(c) Explain, in terms of particles, how heat is transferred through the glass wall of a boiling tube.

.....

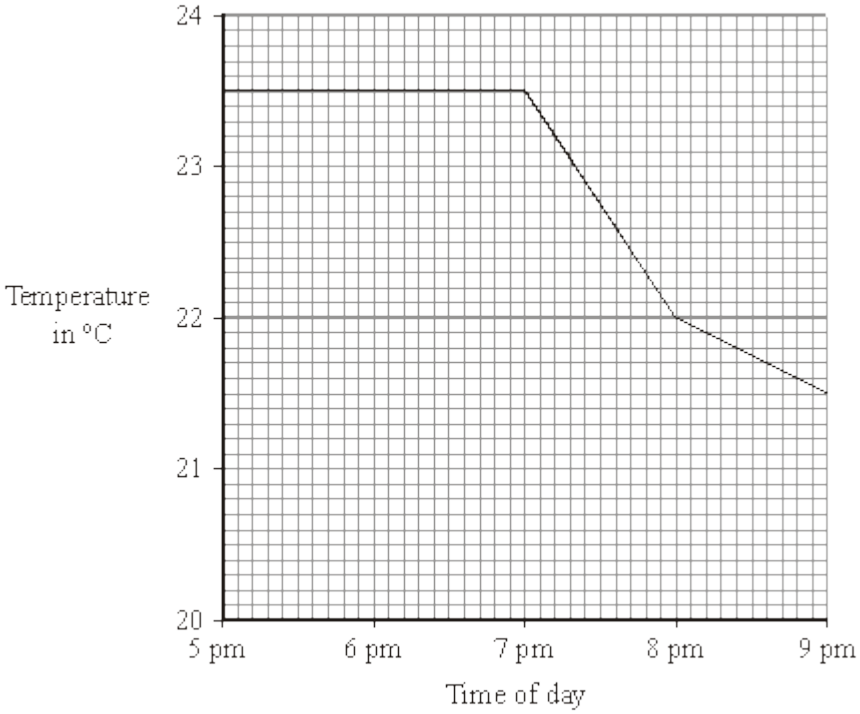
.....

.....

.....

(2)
(Total 9 marks)

34 (a) The graph shows the temperature inside a flat between 5 pm and 9 pm. The central heating was on at 5 pm.



(i) What time did the central heating switch off?

.....

(1)

(ii) Closing the curtains reduces heat loss from the flat.

What time do you think the curtains were closed?

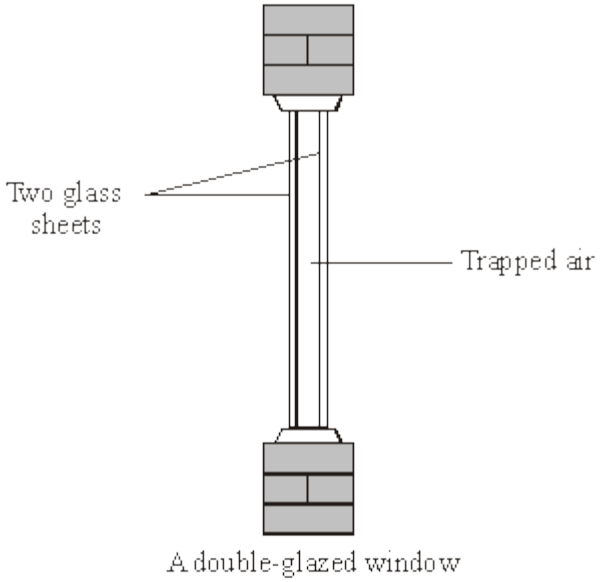
.....

Give a reason for your answer.

.....

(2)

(b) Less heat is lost through double-glazed windows than through single-glazed windows.



Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

conduction	**conductor**	**convection**	**evaporation**	**insulator**	**radiation**

Air is a good ..... . When trapped between two sheets of

glass it reduces heat loss by ..... and .....

(3)

(c) The table gives information about three types of house insulation.

Type of insulation	Cost to install	Money save each year on heating bills	Payback time
Double glazing	£4000	£200	20 years
Loft insulation	£300	£100	3 years
Cavity wallinsulation	£600	£150	

(i) Use the information in the table to calculate the payback time for cavity wall insulation.

.....

(1)

(ii) Explain why people often install loft insulation before installing double glazing or cavity wall insulation.

.....

.....

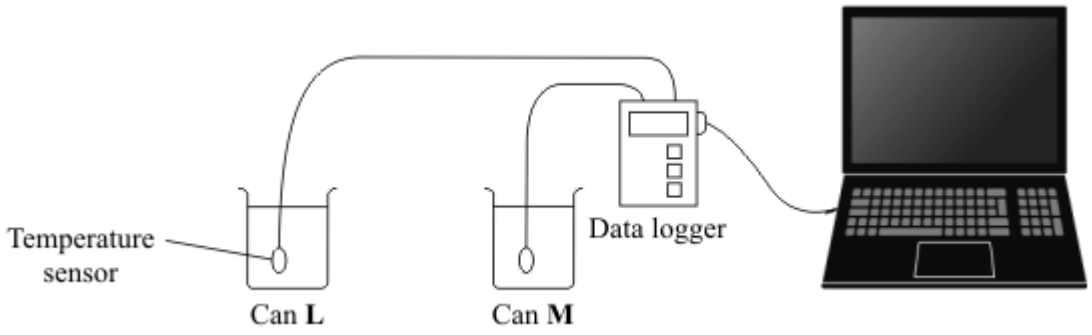
.....

.....

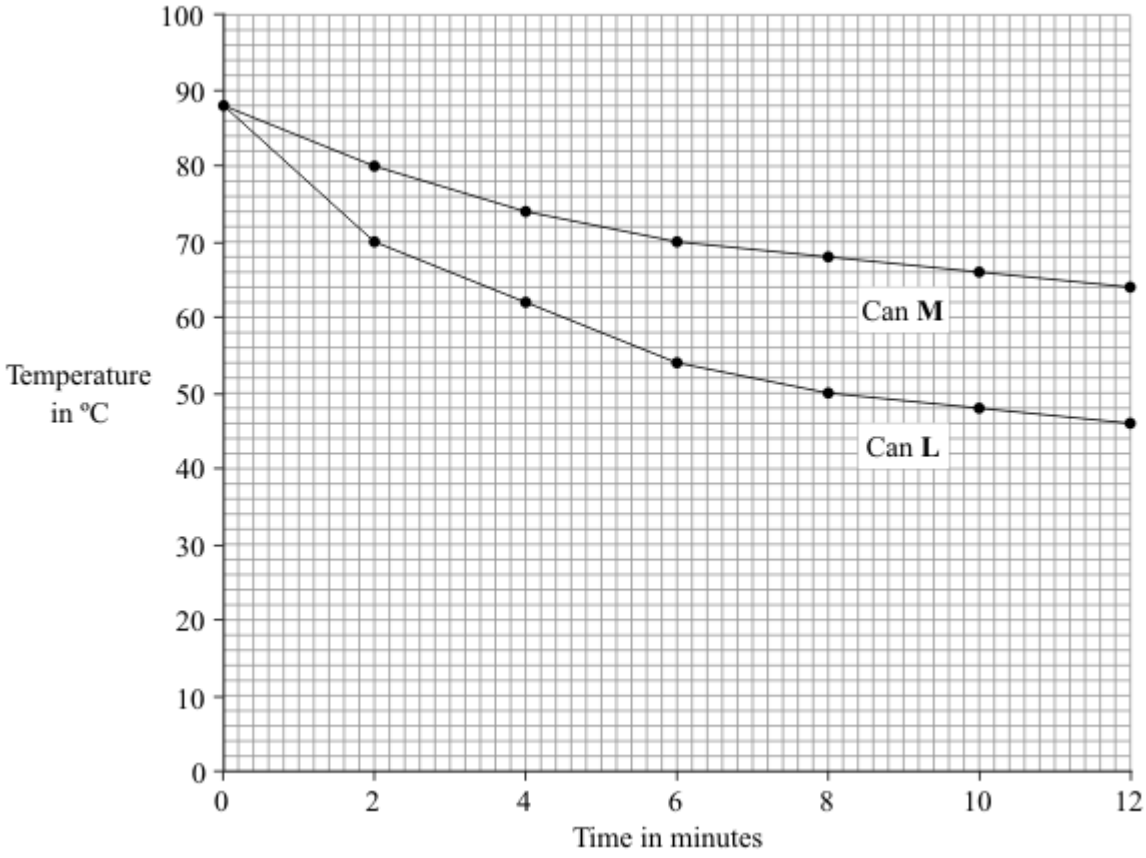
(2)

(Total 9 marks)

35 A student was asked to investigate the heat loss from two metal cans, L and M. The cans were identical except for the outside colour.



The student filled the two cans with equal volumes of hot water. He then placed the temperature sensors in the water and started the data logger. The computer used the data to draw the graph below.



(a) Which **one** of the following is a categoric variable?

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

the outside colour of the cans ☐

the starting temperature of the hot water ☐

the time ☐

the volume of hot water ☐

(1)

(b) For can **L**, state the temperature drop of the water:

(i) in the **first** two-minute interval

.....

(1)

(ii) in the **second** two-minute interval.

.....

(1)

(c) In both cans the water cooled faster at the start of the investigation than at the end of the investigation. Why?

.....

.....

(1)

(d) One can was black on the outside and the other can was white on the outside.

What colour was can **L**? .....

Explain the reason for your answer.

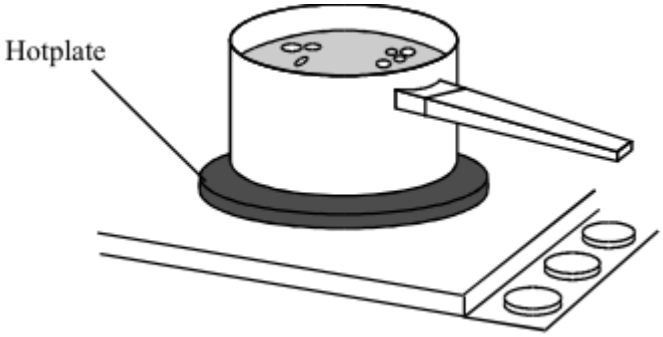
.....

.....

.....

(3)
(Total 7 marks)

36 The drawing shows water being heated in a metal saucepan.



(a) Explain, in terms of the particles in the metal, how heat energy is transferred through the base of the saucepan.

.....

.....

.....

.....

(2)

(b) Energy is transferred through the water by convection currents. Explain what happens to cause a convection current in the water. The answer has been started for you.

As heat energy is transferred through the saucepan, the water particles at the bottom

.....

.....

.....

.....

.....

.....

.....

.....

(3)

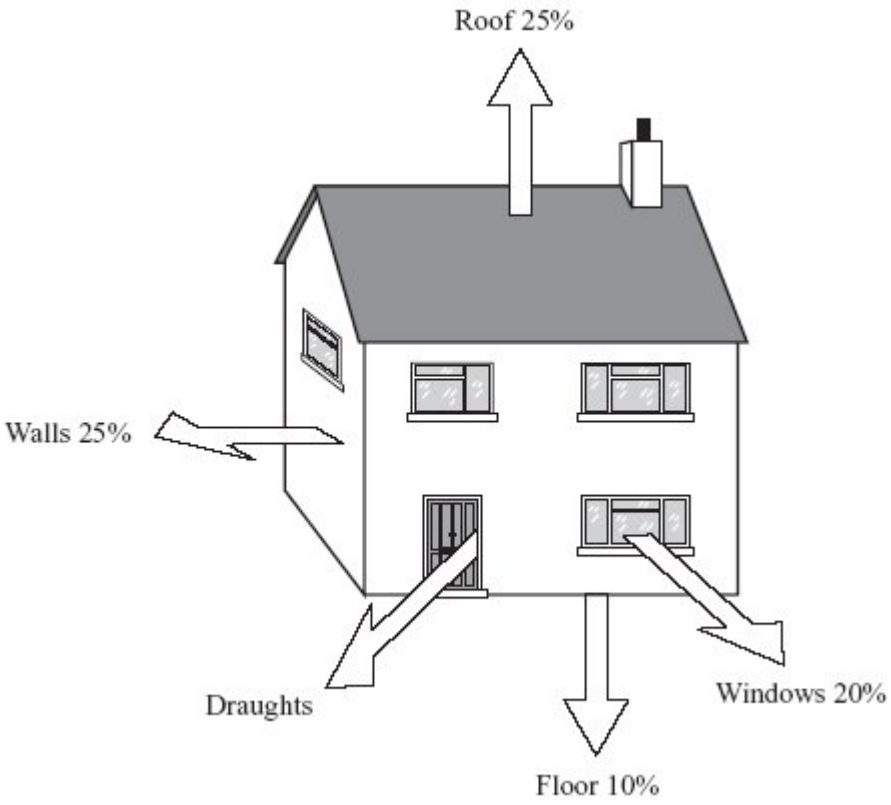
(c) Some energy is transferred from the hotplate to the air by *thermal radiation*. What is meant by *thermal radiation*?

.....

.....

(1)
(Total 6 marks)

37 (a) The diagram shows the ways in which heat energy can be transferred from an old house.



(i) Calculate the percentage of energy transferred by draughts.

% energy transferred by draughts = ...

(1)

(ii) Complete the following sentence using **one** of the words from the box.

conduction	**convection**	**radiation**

Draughts transfer heat energy by .....

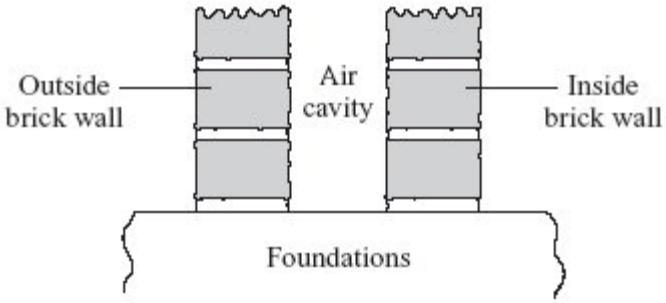
(1)

(iii) State **one** way of reducing the heat transfer by draughts.

.....

(1)

(b) The diagram shows a section through the walls of a house built in 1930.



Explain how the air cavity between the two walls reduces the heat transfer from the house.

.....

.....

.....

.....

(2)

(c) The table shows the installation costs and yearly savings on energy bills for different methods of insulating a house.

Method of insulation	**Installation costin £**	**Yearly saving on energy bills in £**
Double glazing	4000	65
Loft insulation	240	60
Cavity wall insulation	600	80

(i) Give **one** reason why loft insulation is often fitted to an old house before double glazing or cavity wall insulation.

.....

.....

(1)

(ii) The time it takes for the saving on energy bills to equal the cost of installing the insulation is called the pay-back time.

Calculate the pay-back time for loft insulation.

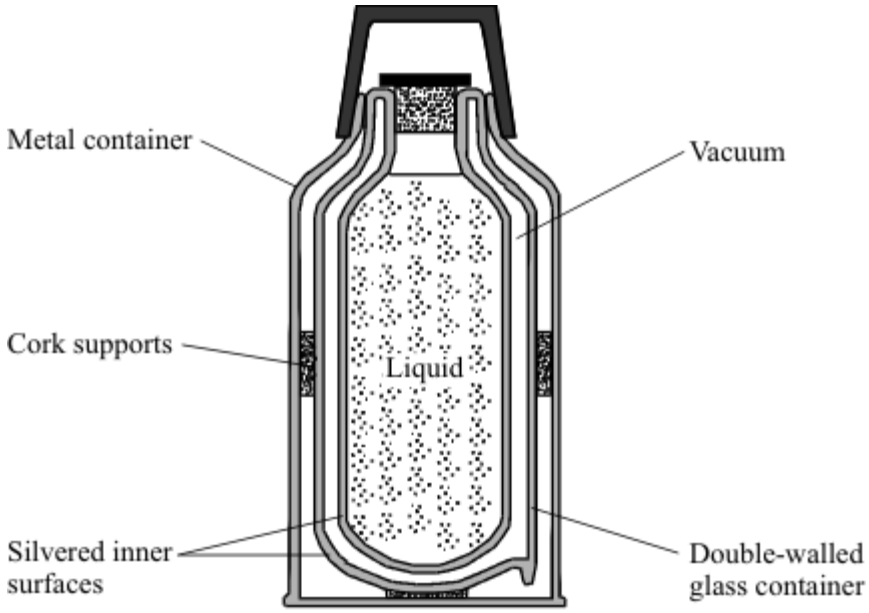
.....

Pay-back time = ... years

(1)

(Total 7 marks)

38 The vacuum flask shown has five features labelled, each one designed to reduce heat transfer.



(a) (i) Which labelled feature of the vacuum flask reduces heat transfer by both conduction and convection?

.....

(1)

(ii) Explain how this feature reduces heat transfer by **both** conduction and convection.

.....

.....

.....

.....

.....

(2)

(b) (i) Which labelled feature of the vacuum flask reduces beat transfer by radiation?

.....

(1)

(ii) Explain how this feature reduces heat transfer by radiation.

.....

.....

.....

.....

.....

.....

(2)
(Total 6 marks)

39 Many people use a sleeping bag when they sleep in a tent. Sleeping bags, designed to keep a person warm, have a fibre filling.

(i) Complete the sentence by choosing the correct words from the box.

conduction	convection	radiation

The fibre is designed to reduce heat transfer by ..... and

.....

(ii) Explain why the fibre is good at reducing heat loss from a person sleeping in the bag.

.....

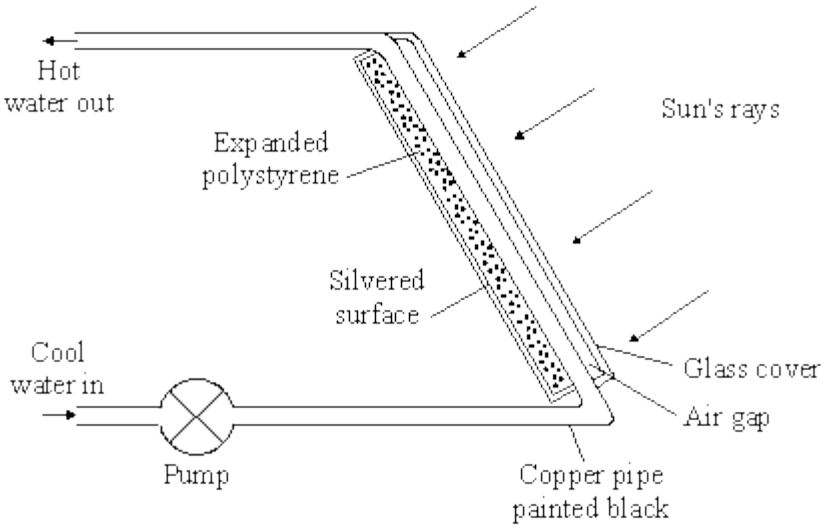
.....

.....

.....

(Total 3 marks)

40 The diagram shows part of a solar water heater. Water circulating through the solar panel is heated by the Sun.



(i) Complete the following sentence.

Heat energy is transferred from the Sun to the solar panel by

..... .

(1)

(ii) The pipe inside the solar panel is black. Why?

.....

.....

(1)

(iii) There is a layer of expanded polystyrene behind the black pipe. Why?

.....

.....

(1)

(iv) A silvered surface is used at the back of the solar panel. Explain why.

.....

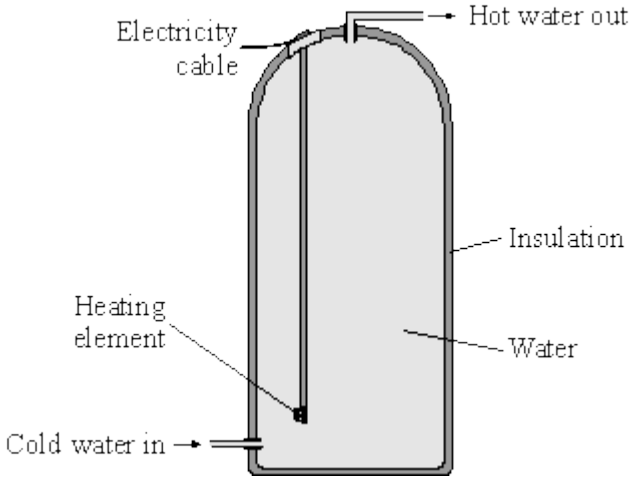
.....

.....

.....

(2)
(Total 5 marks)

41 (a) The diagram shows an immersion heater used to heat water inside a tank. Heat is transferred through the water by convection.



(i) Draw arrows on the diagram to show the movement of the water in the tank when the heating element is switched on.

(2)

(ii) Explain how a convection current is set up in the water. The explanation has been started for you.

When the heating element is switched on, the hot water nearest the element rises

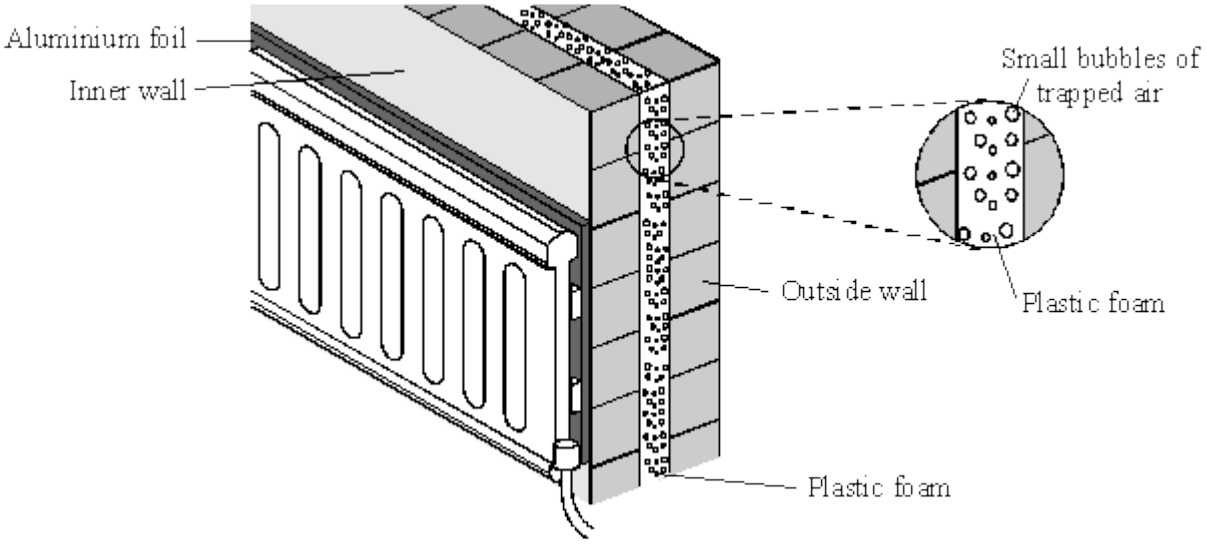
because .....

.....

.....

(2)

(b) The diagram shows **two** ways to reduce heat loss through the walls of a house.



(i) How is the aluminium foil able to reduce heat loss?

.....

.....

(1)

(ii) The plastic foam is good at reducing heat loss through the walls. Explain why.

.....

.....

.....

.....

.....

(3)

(c) Evaporation is an important heat transfer process. When sweat evaporates, it takes heat energy from your body. As humidity increases, you are more likely to feel hot and uncomfortable. Explain why.

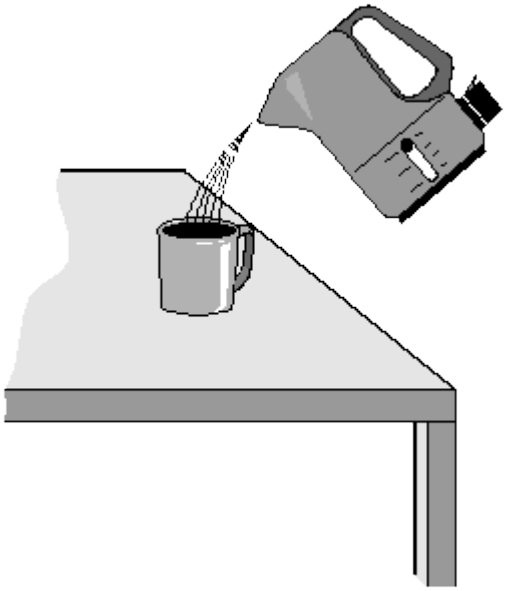
.....

.....

.....

(2)
(Total 10 marks)

42 (a) The diagram shows hot water being poured into a mug.



(i) Complete the sentence by choosing the correct words from the box. Each word may be used once or not at all.

air	mug	table	water

Heat energy is being transferred from the ..... to

the ..... .

(1)

(ii) When will this transfer of heat energy stop?

.....

.....

(1)

(b) In the box are the names of four types of fuel used to heat homes.

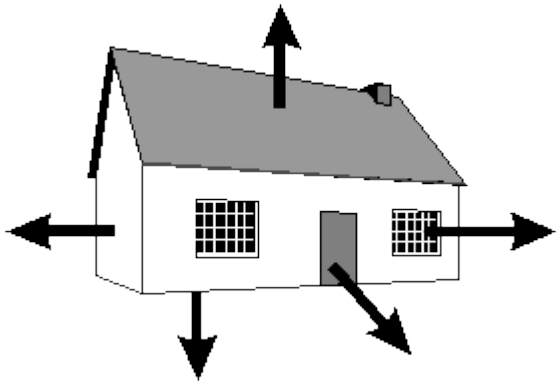
coal	gas	oil	wood

Which **one** of these types of fuel is renewable?

.....

(1)

(c) The diagram shows where heat energy is lost from a house.



(i) Complete the sentences by choosing the correct words from the box. Each word may be used once or not at all.

conduction	conductor	convection	electric	evaporation	insulator

The amount of heat energy lost through the windows by

..... can be reduced by using thick

curtains. The curtains trap a layer of air and air is a good

..... . The curtains will also stop

..... currents pulling cold air

into the room through small gaps in the window.

(3)

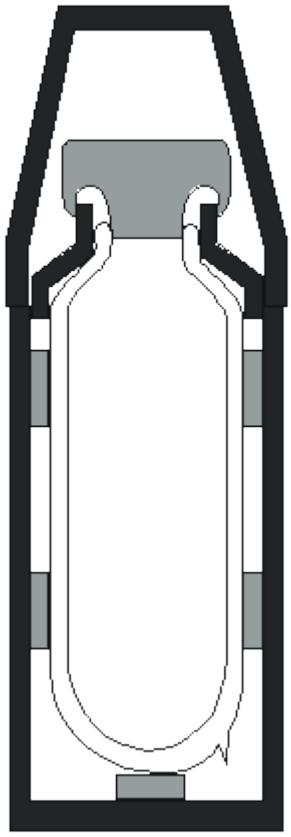
(ii) Write down **one** other way of reducing heat loss from a house.

.....

.....

(1)
(Total 7 marks)

43 The diagram below shows a vacuum flask.



(a) Give **two** features of the flask which reduce heat loss by conduction.

1. .....

2. .....

(2)

(b) Give **one** feature of the flask which reduces heat loss by radiation.

.....

(1)
(Total 3 marks)

44 (a) When an electric kettle is switched on it will take a few minutes to boil the water. Once switched off it will gradually cool down.

(i) When the kettle is switched on the water heats. Explain how all of the water is heated.

.....

.....

(ii) The kettle is now switched off and begins to cool.

(1) Describe how heat energy is transferred **through** the walls of the kettle.

.....

.....

.....

(2) Describe how the heat energy is transferred **from** the walls of the kettle.

.....

.....

.....

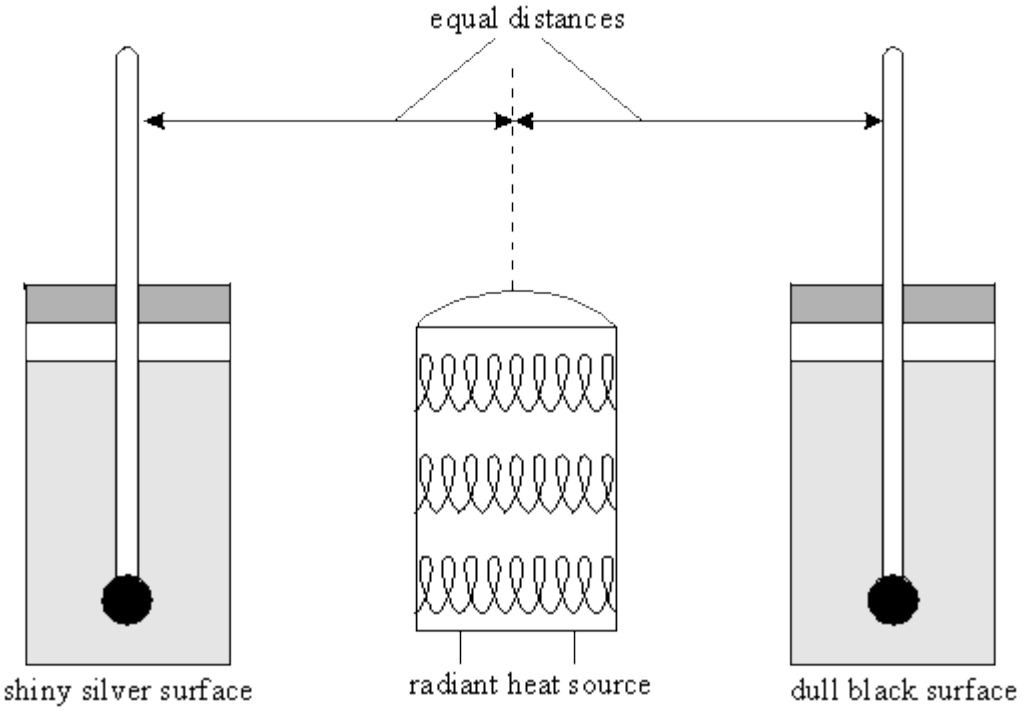
(iii) Describe how heat losses from the surface of a metal kettle may be kept small.

.....

.....

(4)

(b) A shiny metal can and a dull black can are filled with the same amounts of cold water. A radiant heater is placed exactly half way between the cans as shown in the diagram below.



Two thermometers are used to measure the temperature of the water in each can every minute.

(i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

.....

.....

(ii) Explain your answer to part (i).

.....

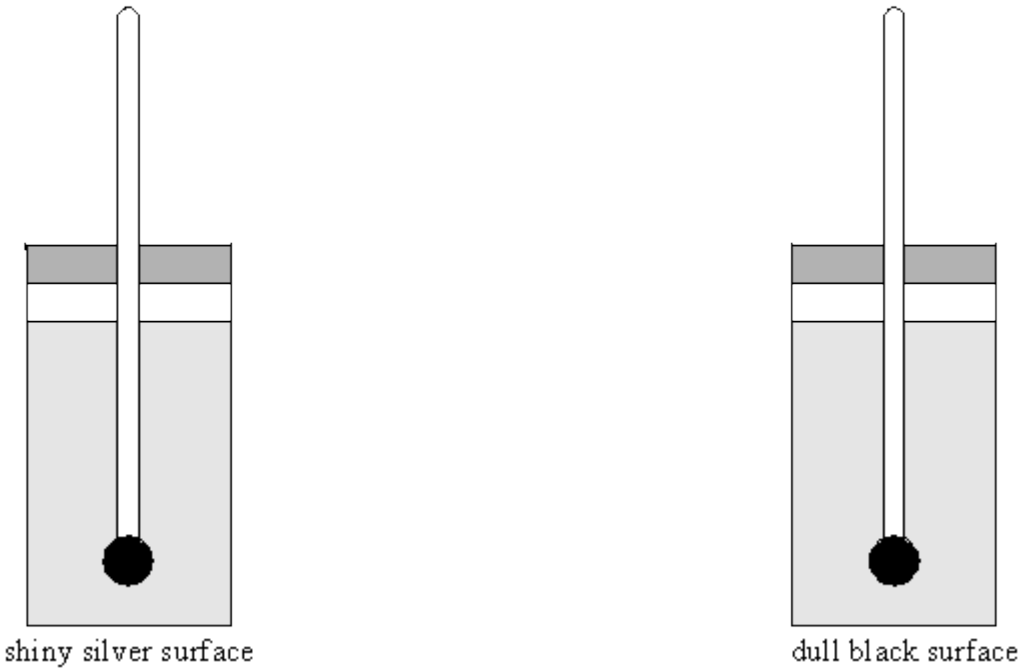
.....

.....

.....

(3)

(c) The radiant heater was removed and both the cans were filled with the same amount of boiling water, as shown in the diagram below.



The temperature was recorded every minute for ten minutes.

(i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

.....

.....

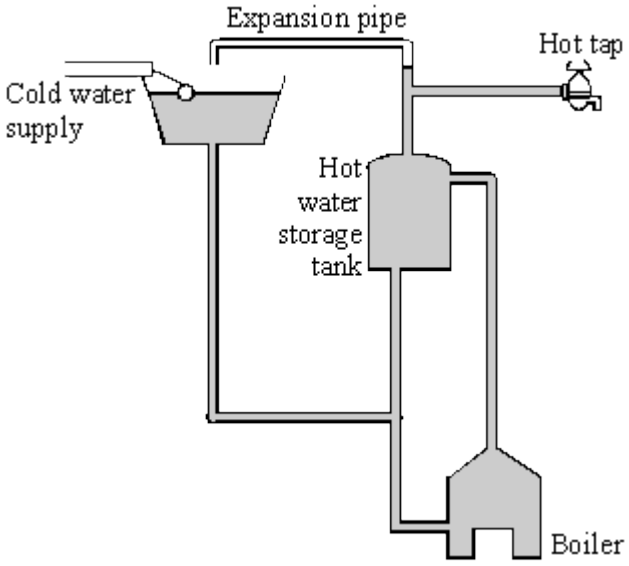
(ii) Explain your answer to part (i).

.....

.....

(3)
(Total 10 marks)

45 (a) The diagram shows a hot water system.



(i) Explain why the boiler is below the hot water tank.

.....

.....

.....

(ii) Why is heat energy transferred from hot water in the tank to the surrounding air?

.....

.....

(iii) Name the process by which energy is transferred through the sides of the tank.

.....

(iv) How may heat loss from the hot water tank be reduced?

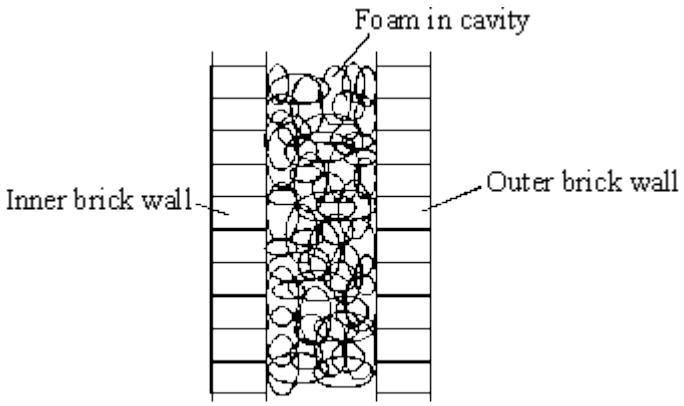
.....

.....

.....

(6)

(b) One way of reducing heat loss from a house is by cavity wall insulation. Foam is pumped between the inner and outer brick walls as shown in the diagram.



How is heat loss from a house reduced by:

(i) having a cavity wall?

.....

.....

.....

.....

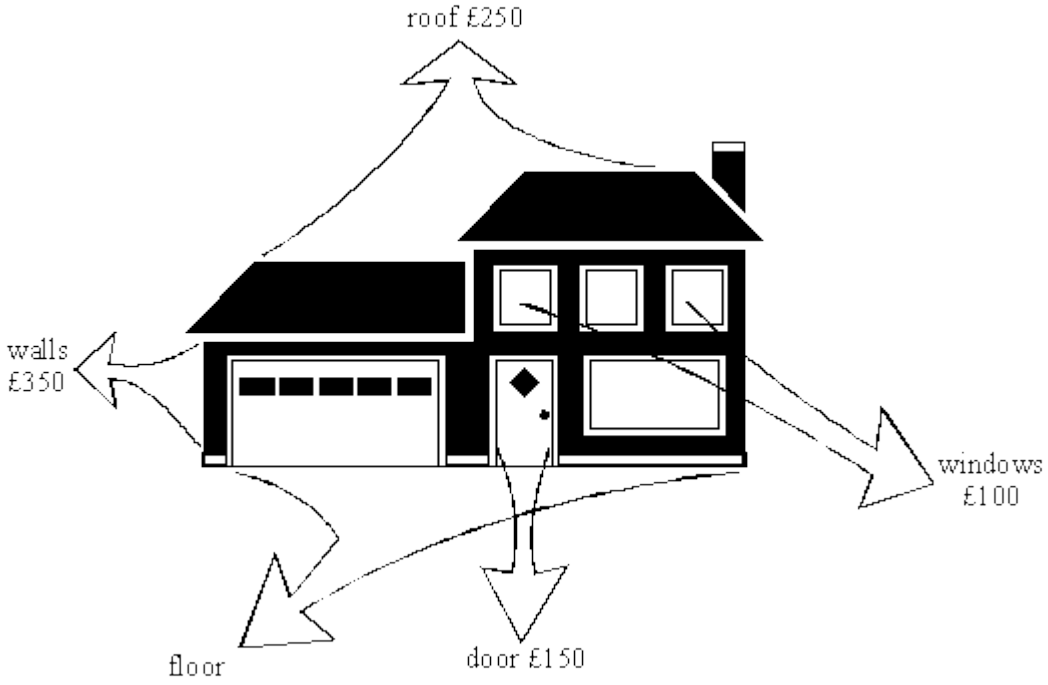
(ii) filling the cavity with foam?

.....

.....

(3)
(Total 9 marks)

46 The diagram below shows a house which has **not** been insulated. The cost of the energy lost from different parts of the house during one year is shown on the diagram.



(a) The total cost of the energy lost during one year is £1000.

(i) What is the cost of the energy lost through the floor?

.....

(2)

(ii) Suggest one way of reducing this loss.

.....

(1)

(b) The table below shows how some parts of the house may be insulated to reduce energy losses. The cost of each method of insulation is also given.

WHERE LOST	COST OF ENERGY LOST PER YEAR (£)	METOD OF INSULATION	COST OF INSULATION (£)
roof	250	fibre-glass in loft	300
walls	350	foam filled cavity	800
windows	100	double glazing	4500
doors	150	draught proofing	5

(i) Which method of insulation would you install first? Explain why.

.....

.....

.....

.....

(3)

(ii) Which method of insulation would you install last? Explain why.

.....

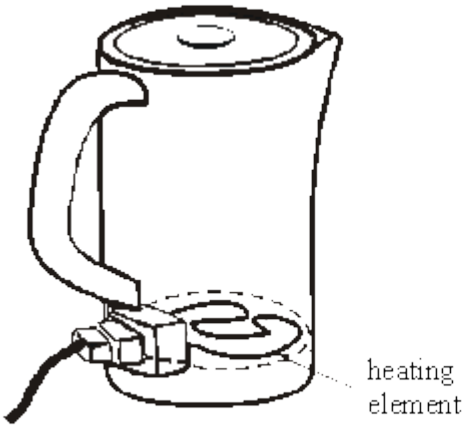
.....

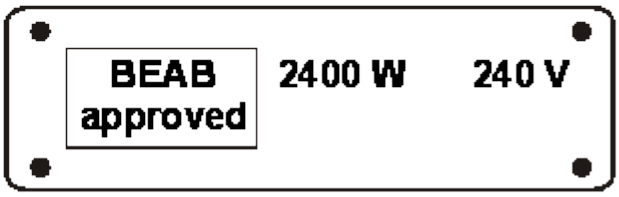
.....

.....

(3)
(Total 9 marks)

47 The diagram below shows an electric kettle and the label on the bottom of the kettle.





The water at the bottom of the kettle will heat up first.
This is because the heating element is near the bottom of the kettle.
Convection currents will then cause the rest of the water in the kettle to be heated.

(i) What are convection currents?

.....

(1)

(ii) Explain how convection currents are produced.
(Your answer should refer to **density** and **temperature**.)

.....

.....

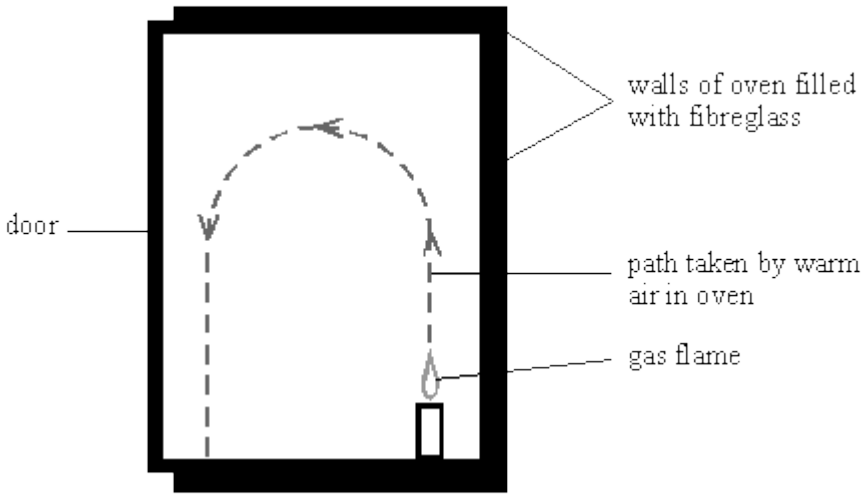
.....

.....

.....

(4)
(Total 5 marks)

48 The diagram shows a section through a gas oven.



Use words from the list to complete the sentences.

conduction **convection** **insulation** **radiation** **resistance**

The outside of the door gets hot because energy is transferred through

the door by .....

Energy is transferred from the gas flame to the rest of the oven by the movement of air.

This type of energy transfer is called .....

The walls of the oven are packed with fibreglass to reduce energy transfer. Energy transfer

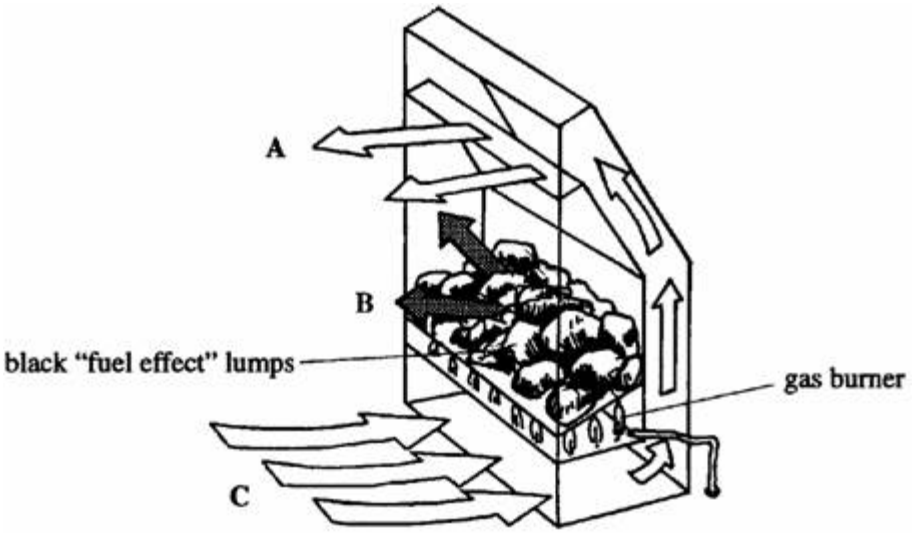
is reduced because fibreglass provides good .....

The outside of the cooker is white and shiny.

This reduces energy transfer by .....

(Total 4 marks)

49 The diagram comes from a leaflet about a “coal effect” gas fire.
It shows how air circulates through the fire.



(a) Explain in detail why the air travels from **C** to **A**.

.....

.....

.....

.....

.....

.....

(4)

(b) The black “fuel effect” lumps become very hot.

(i) Name the process by which the lumps transfer thermal energy to the room as shown at **B**.

.....

(1)

(ii) Suggest **one** feature of the black “fuel effect” lumps which make them efficient at transferring energy.

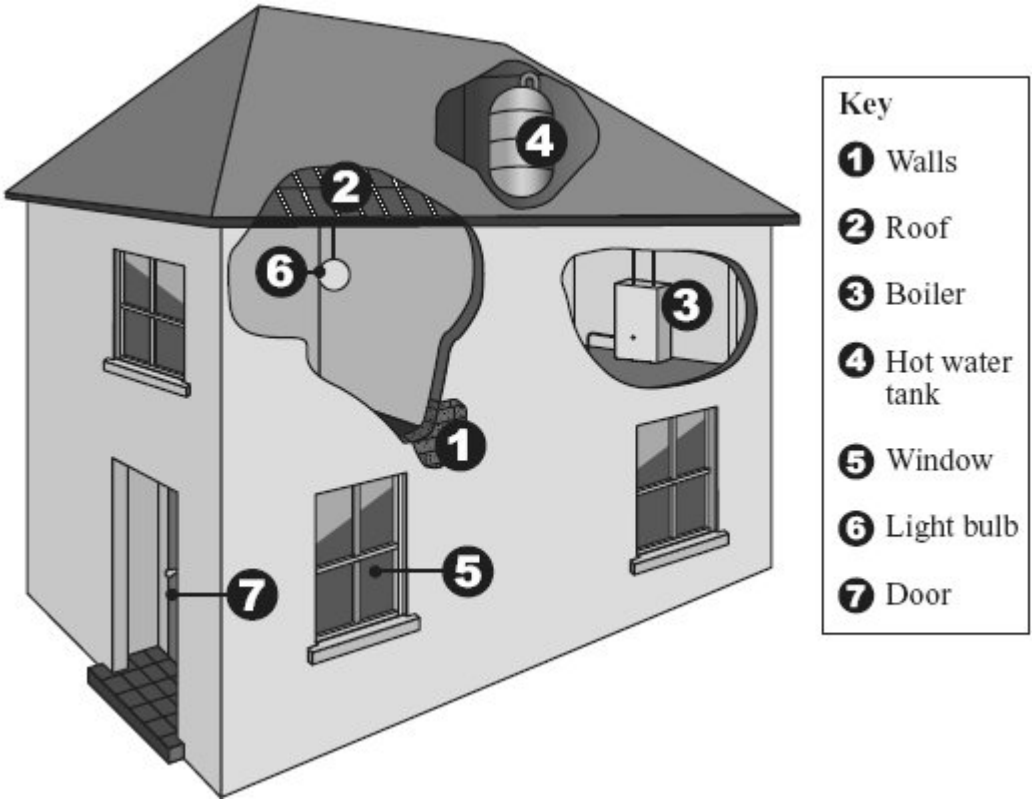
.....

.....

(1)

(Total 6 marks)

50 The drawing shows parts of a house where it is possible to reduce the amount of energy lost.



(a) Give **one** way in which the amount of energy lost can be reduced from each of the following parts of the house.

1, **2** and **4** .....

5 .....

7 .....

(3)

(b) Energy consumption can be reduced by using a more efficient boiler or more efficient light bulbs.

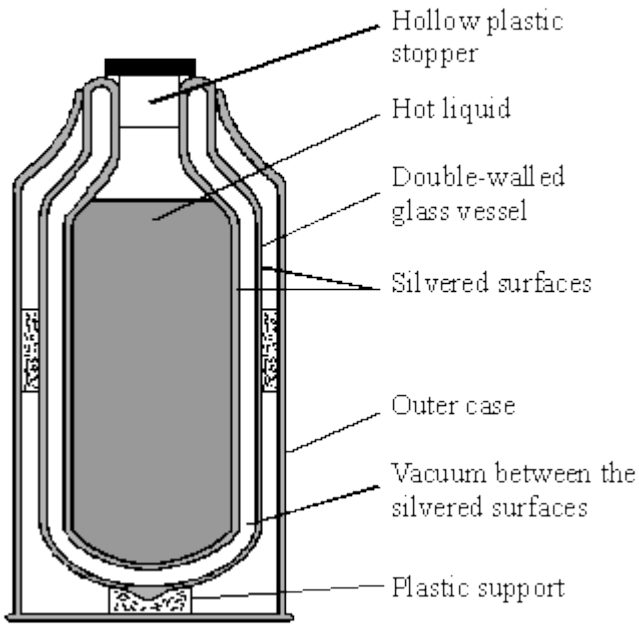
What is meant by a *more efficient* light bulb?

.....

.....

(1)
(Total 4 marks)

51 The drawing shows a section of a vacuum flask.



(a) Heat is slowly "lost" from the hot liquid in the closed flask. It may be transferred by:

conduction	convention	evaporation	radiation

Choose from the words above to complete the following sentences. You may use a word once, more than once or not at all.

(i) The vacuum between the glass walls reduces

..... and .....

(2)

(ii) The silvered surfaces of the glass walls reduce

.....

(1)

(iii) The stopper in the opening of the flask reduces

..... and .....

(2)

(iv) Heat is transferred by the air molecules, away from the vacuum flask, by

.....

(1)

(v) The plastic of the plastic stopper is preferred to metal because it cuts down

.....

(1)

(b) Mark **X** on the diagram of the vacuum flask where the liquid in the flask is hottest.

(1)

(c) Explain, in terms of particles, how heat is conducted through a glass wall of the vacuum flask.

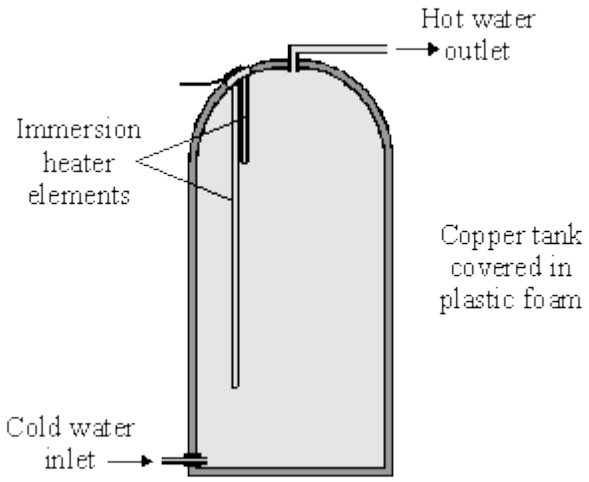
.....

.....

.....

(2)
(Total 10 marks)

52 The diagram shows a type of electric immersion heater in a hot water tank. These hot water tanks are normally found in airing cupboards.



Information on the immersion heater states:

230 V
10 A

(a) Immersion heaters for hot water tanks often have a switch on them labelled *bath* or *sink.* The *bath* position of the switch has **both** parts of the immersion heater elements in the circuit. The *sink* position has only the short heater element in the circuit.

(i) Explain why the hot water outlet is at the top of the tank, and the cold water inlet is at the bottom of the tank.

.....

.....

.....

(2)

(ii) Explain how the *sink* position for the immersion heater is able to save energy.

.....

.....

.....

(2)

(b) The copper tank is surrounded by plastic foam to minimise energy loss.

Explain why a pale, shiny surface to the foam also helps to minimise energy loss.

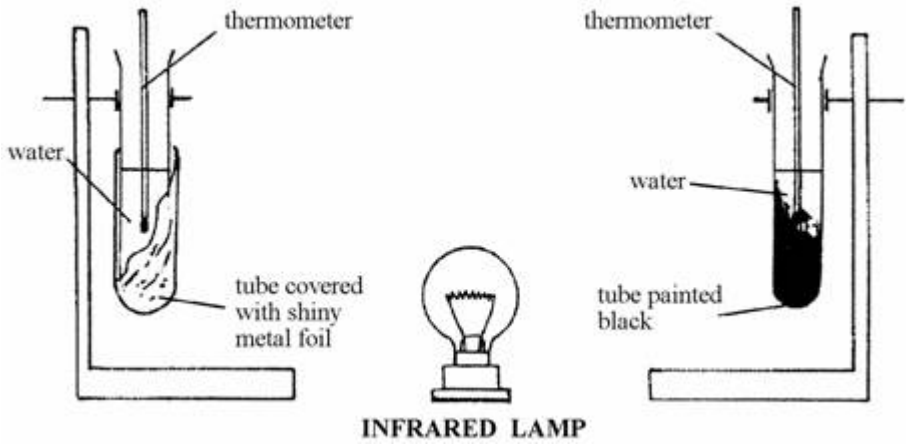
.....

.....

.....

(2)
(Total 6 marks)

53 The diagram shows an experiment to find out what happens to infrared waves when they strike different surfaces.



(a) The water in the black tube gets hotter than the water in the shiny tube.
Choose words from the list to complete the sentences below.

absorbs conducts convects radiates reflects

The infrared lamp ..... energy to the tubes of water.

The black surface ..... most of the energy that reaches it.

The shiny surface ..... most of the energy that reaches it.

(3)

(b) Put the sentences A- E below into the correct boxes on the flow diagram so that they tell you how to do the experiment

(You may use just the letters if you want to.)

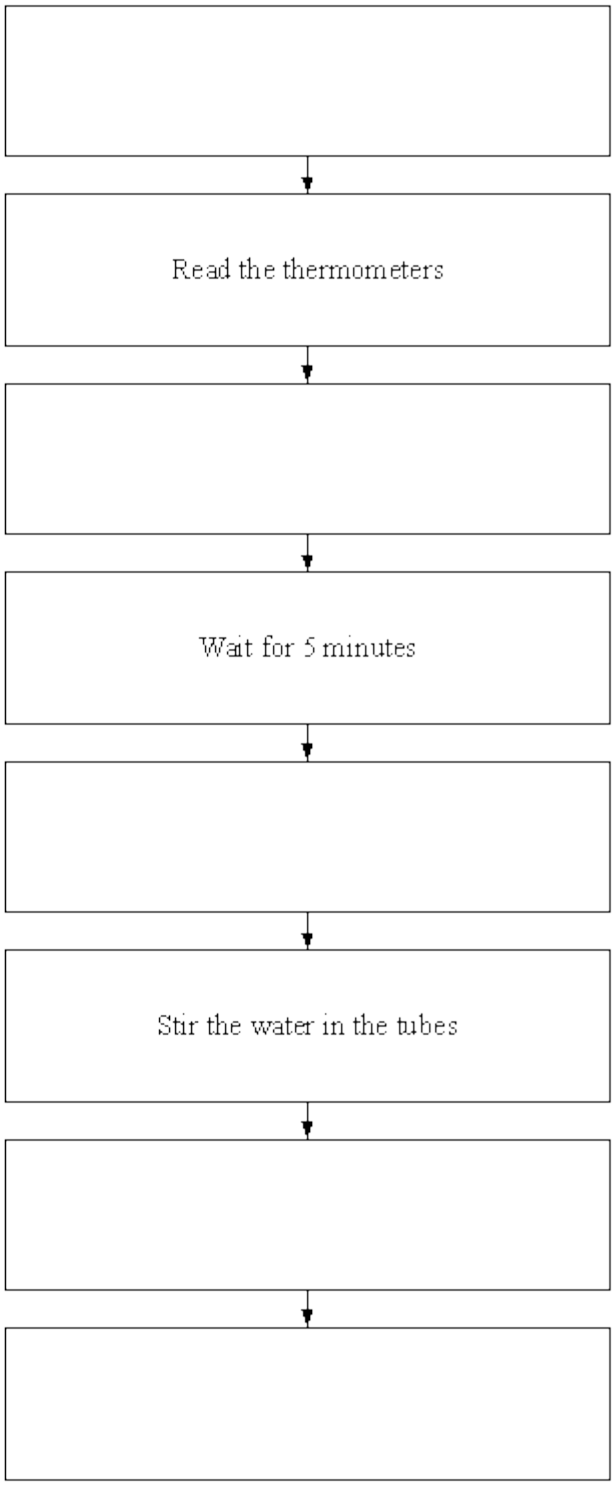
A Switch off the lamp

B Switch on the lamp

C Make sure the lamp is the same distance from both tubes

D Read the thermometers

E Wait for the temperature to stop rising



(5)
(Total 8 marks)

1 (a) range of speeds

1

moving in different directions

accept random motion

1

(b) internal energy

1

(c) density = mass / volume

1

(d) 0.00254 / 0.0141

1

0.18

1

*accept 0.18 with no working shown for the **2** calculation marks*

kg / m^3

1

[7]

2 (a) solid

1

(b) decreased

correct order only

1

decreased

1

increased

1

(c) (i) A

reason only scores if A chosen

1

uses least / less energy (in 1 year)

a comparison is required

accept uses least power

accept uses least kWh

1

(ii) greater the volume the greater the energy it uses (in 1 year)

1

(iii) a very small number sampled

accept only tested 3

accept insufficient evidence / data

allow not all fridges have the same efficiency ***or*** *a correct description implying different efficiencies*

only tested each fridge once is insufficient

there are lots of different makes is insufficient

1

[8]

3 (a) (i) any **two** from:

- mass (of block)

  accept weight for mass
- starting temperature
- final / increase in temperature

  temperature is insufficient
- voltage / p.d.

  same power supply insufficient
- power (supplied to each block)
- type / thickness of insulation

  same insulation insufficient

2

(ii) one of variables is categoric

or

(type of) material is categoric

accept the data is categoric

accept a description of categoric

do ***not*** *accept temp rise is categoric*

1

(iii) concrete

reason only scores if concrete chosen

1

(heater on for) longest / longer time

a long time or quoting a time is insufficient

do ***not*** *accept it is the highest bar*

1

(iv) 4500 (J)

allow ***1*** *mark for correct substitution ie*

2 × 450 × 5 provided no subsequent step shown

2

(b) (i) point at 10 minutes identified

1

(ii) line through all points except anomalous

line must go from at least first to last point

1

(iii) 20 (°C)

if 20°C is given, award the mark.

If an answer other than 20°C is given, look at the graph. If the graph shows a correct extrapolation of the candidate's best-fit line and the intercept value has been correctly stated, allow 1 mark.

1

(iv) 2 (minutes)

1

[11]

4 (a) infrared / IR

correct answer only

1

(b) any **two** from:

- increase the power / watts

  allow increase the temperature of the oven or make the oven hotter
- decrease the speed

  allow leave the biscuits in for longer
- put biscuits through again

  increase radiation is insufficient

  ignore changes to the design of the oven

2

(c) (inside) surface is a (good) reflector or poor absorber (of IR)

Ignore bounce for reflect

surface is a (good) reflector of light does not score

surface is a (good) reflector of light and infrared / heat does score

1

(and) <u>outside</u> surface is poor emitter (of IR)

1

(so) increases the energy reaching the biscuits

allow reduces energy loss or makes oven more efficient

*do **not** accept no energy losses*

keeps oven hotter is insufficient

1

[6]

5 Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1–2 marks)
Considers either solid or gas and describes at least one aspect of the particles.

or

Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)
Considers both solids and gases and describes aspects of the particles.

or

Considers one state and describes aspects of the particles and explains at least one of the properties.

or

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)
Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

extra information

Solids

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

any explanation of a property must match with the given aspect(s) of the particles.

Gases

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container)

[6]

6 (a) air near freezer compartment is cooled or loses energy

accept air at the top is cold

1

cool air is (more) dense or particles close(r) together (than warmer air)

*do **not** allow the particles get smaller / condense*

1

so (cooler) air falls

1

air (at bottom) is displaced / moves upwards / rises

*do **not** allow heat rises*

accept warm air (at the bottom) rises

1

(b) if volume is doubled, energy use is not doubled
or
volume ÷ energy not a constant ratio

1

correct reference to data, eg 500 is 2×250 but 630 not 2×300

1

(c) accept suitable examples, eg

advantage:

- reduces emissions into atmosphere
- lower input power or uses less energy or wastes less energy
- costs less to run

cost of buying or installing new fridge is insufficient

ignore reference to size of fridge

1

disadvantage:

- land fill
- energy waste in production
- cost or difficulty of disposal
- transport costs

1

[8]

7 (a) conduction

1

(b) 35 000

1

(c) 500

*their (b) = 2 x c x 35 correctly calculated scores **2** marks*

*allow **1** mark for correct substitution,*

ie 35000 = 2 x c x 35

or

their (b) = 2 x c x 35

2

J / kg°C

1

(d) energy lost to surroundings

or

energy needed to warm heater

accept there is no insulation (on the copper block)

*do **not** accept answers in terms of human error or poor results or defective equipment*

1

[6]

8 (a) conduction

must be in correct order

1

convection

1

(b) (i) 70

accept ± half a square
(69.8 to 70.2)

1

(ii) 15

*accept 14.6 to 15.4 for **2** marks*

*allow for **1** mark 70 − 55*

ecf from (b)(i) ± half a square

2

(iii) C

1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature

accept same temperature as surroundings

1

(c) (i) 6720

*correct answer with or without working gains **3** marks*

*6 720 000 gains **2** marks*

*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*

*correct substitution of E = 200 × 4200 × 8 gains **1** mark*

3

(ii) the fastest particles have enough energy

accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy

1

[16]

9 (a) (i) temperature (increase) and time switched on are directly proportional

accept the idea of equal increases in time giving equal increases in temperature

answers such as:

- *as time increases, temperature increases*
- *positive correlation*
- *linear relationship*
- *temperature and time are proportional*

*score **1** mark*

2

(ii) any **one** from:

"it" refers to the metal block

- energy transfer (from the block) to the surroundings

accept lost for transfer

accept air for surroundings

- (some) energy used to warm the heater / thermometer (itself)

accept takes time for heater to warm up

- (metal) block is not insulated

1

(iii) 15 000

*allow **1** mark for correct substitution, ie 50 × 300 provided no subsequent step shown*

2

(b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

accept needs less energy to heat it (by the same amount)
lowest specific heat capacity is insufficient

1

[7]

10 (a) any **two** from:

- water evaporates

  accept steam / water vapour for water molecules
  accept water turns to steam

- water molecules / particles go into the air

- mirror (surface) is cooler than (damp) air

  accept the mirror / surface / glass is cold

- water molecules / particles that hit the mirror lose energy

  accept water molecules / particles that hit the mirror cool down

- cooler air cannot hold as many water molecules / particles

2

(causes) condensation (on the mirror)

accept steam changes back to water (on the mirror)

or
particles move closer together

1

(b) mirror (surface) is warm

mirror is heated is insufficient

1

(rate of) condensation reduced

accept no condensation (happens)

1

[5]

11 (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance.

0 marks
No relevant content.

Level 1(1-2 marks)
There is a basic explanation of **one** feature
or
a simple statement relating reduction in energy transfer to **one** feature.

Level 2(3-4 marks)
There is a clear explanation of **one** feature
or
a simple statement relating reduction in energy transfer to **two** features.

Level 3(5-6 marks)
There is a detailed explanation of at least **two** features
or
a simple statement relating reduction in energy transfer to all **four** features.

Examples of the points made in response

extra information

accept throughout:
heat for energy
loss for transfer

plastic cap:

- plastic is a poor conductor

  accept insulator for poor conductor

- stops convection currents forming at the top of the flask so stopping energy transfer by convection

- molecules / particles evaporating from the (hot) liquid cannot move into the (surrounding) air so stops energy transfer by evaporation

- plastic cap reduces / stops energy transfer by conduction / convection / evaporation

glass container:

- glass is a poor conductor so reducing energy transfer by conduction

- glass reduces / stops energy transfer by conduction

vacuum:

- both conduction and convection require a medium / particles

- so stops energy transfer between the two walls by conduction and convection

- vacuum stops energy transfer by conduction / convection

silvered surfaces:

- silvered surfaces reflect infrared radiation

  accept heat for infrared

- silvered surfaces are poor emitters of infrared radiation

- infrared radiation (partly) reflected back (towards hot liquid)

- silvered surfaces reduce / stop energy transfer by radiation

6

(b) (the ears have a) small surface area

ears are small is insufficient

1

so reducing energy radiated / transferred (from the fox)

accept heat lost for energy radiated

*do **not** accept stops heat loss*

1

[8]

12 (a) conduction

1

(b) (i) there is a bigger temperature difference between the water and the surrounding air

accept the water is hottest / hotter

1

so the transfer of energy (from hot water) is faster

accept heat for energy

ignore temperature falls the fastest

1

(ii) 120

*allow **1** mark for converting kJ to J correctly, ie 4 032 000*

or

correctly calculating temperature fall as 8°C

or

allow **2** marks for correct substitution, ie 4 032 000 = m × 4200 × 8

answers of 0.12, 19.2 **or** 16.6 gain **2** marks

answers of 0.019 **or** 0.017 gain **1** mark

3

(iii) water stays hot for longer

1

so heater is on for less time

accept so less energy needed to heat water

1

so cost of the jacket is soon recovered from) lower energy costs / bills

accept short payback time

1

[9]

13 (a) (i) Z

1

(ii) X

1

(b) (i) moving randomly

1

(ii) stronger than

1

(c) (i) evaporation

1

(ii) any **one** from:

- becomes windy
- temperature increases

accept (becomes) sunny
"the sun" alone is insufficient

- less humid

1

[6]

14 (a) to reflect (the infrared)

accept (shiny surfaces) are good reflectors
ignore reference to incorrect type of wave

1

(b) black

1

best absorber (of infrared)

answer should be comparative
black absorbs (infrared) is insufficient
accept good absorber (of infrared)
ignore reference to emitter
ignore attracts heat
ignore reference to conduction

1

(c) to reduce energy loss

accept to stop energy loss
accept heat for energy
accept to stop / reduce convection

or
so temperature of water increases faster

accept to heat water faster
accept cooks food faster

or
reduces loss of water (by evaporation)

1

(d) 672 000

*allow **1** mark for correct substitution, ie 2 × 4200 × 80 provided no subsequent step shown*

2

[6]

15 (a) (i) 5(.0)

1

(ii) 35 **or** their (a)(i) × 7 correctly calculated

*allow **1** mark for correct substitution, ie 5 **or** their (a)(i) × 7 provided no subsequent step shown*

2

(iii) 525(p)
or
(£) 5.25
or
their (a)(ii) × 15 correctly calculated

if unit p or £ given they must be consistent with the numerical answer

1

(iv) decreases

1

temperature difference (between inside and outside) decreases

accept gradient (of line) decreases

*do **not** accept temperature (inside) decreases*

*do **not** accept graph goes down*

1

(b) air (bubbles are) trapped (in the foam)

*do **not** accept air traps heat*
foam has air pockets is insufficient

1

(and so the) air cannot circulate / move / form convection current

air is a good insulator is insufficient
no convection current is insufficient

answers in terms of warm air from the room being trapped are incorrect and score no marks

1

[8]

16 (a) (matt) black is a good <u>emitter</u> of infrared / radiation

accept heat for infrared / radiation
ignore reference to good absorber
attracts heat negates this marking point

1

to give maximum (rate of) energy transfer (to surroundings)

accept temperature (of coolant) falls fast(er)

*accept black emits more radiation for **1** mark*

*black emits most radiation / black is the best emitter of radiation for **2** marks*

1

(b) the fins increase the surface area

accept heat for energy

1

so increasing the (rate of) energy transfer

or

so more fins greater (rate of) energy transfer

1

(c) 114 000

*allow **1** mark for correct temperature change, ie 15 (°C)*

or

*allow **2** marks for correct substitution, ie 2 × 3 800 × 15*

*answers of 851 200 **or** 737 200 gain **2** marks*

or

*substitution 2 × 3800 × 112 **or** 2 × 3800 × 97 gains **1** mark*

*an answer of 114 kJ gains **3** marks*

3

(d) increases the efficiency

1

less (input) energy is wasted

accept some of the energy that would have been wasted is (usefully) used

or

more (input) energy is usefully used

accept heat for energy

1

[9]

17 (a) there are strong forces (of attraction) between the particles in a solid

accept molecules / atoms for particles throughout

accept bonds for forces

1

(holding) the particles close together

particles in a solid are less spread out is insufficient

1

or

(holding) the particles in a fixed pattern / positions

but in a gas the forces between the particles are negligible

accept very small / zero for negligible
accept bonds for forces

1

so the particles spread out (to fill their container)

accept particles are not close together
gas particles are not in a fixed position is insufficient

1

(b) (i) particles are (shown) leaving (the liquid / container)

accept molecules / atoms for particles throughout
accept particles are escaping
particles are getting further apart is insufficient

1

(ii) *accept molecules / atoms for particles throughout*
accept speed / velocity for energy throughout

particles with most energy leave the (surface of the) liquid

accept fastest particles leave the liquid

1

so the mean / average energy of the remaining particles goes down

1

and the lower the average energy (of the particles) the lower the temperature (of the liquid)

1

[8]

18 (a) conduction

1

(b) (i) any **one** from:

- starting temperature (of cold water)
  temperature is insufficient
- pipe length
  accept size of pipe
- pipe diameter
- pipe (wall) thickness
- volume of cold water
  accept amount for volume
- temperature of hot water (in)
- time

1

(ii) copper

1

greatest temperature change
only scores if copper chosen
accept heat for temperature
accept heated water the fastest
accept it was hottest (after 10 minutes)
accept it is the best / a good conductor

1

(c) the pipe has a larger (surface) area
accept pipe is longer

1

(so) hot / dirty water (inside pipe) is in contact with cold / clean water (outside pipe) for longer

1

[6]

19 (a) (i) random distribution of circles in the box with at least 50 % of circles touching

1

random distribution of circles occupies more than 50 % of the space
judged by eye

1

(ii) (large) gaps between particles
accept particles do not touch
accept particles are spread out

1

(so) easy to push particles closer (together)
or
forces between particles are negligible / none

an answer in terms of number of particles is insufficient

1

(b) (i) (both are) random

accept a correct description of random eg unpredictable or move around freely or in all directions

they take up all the space is insufficient

they are spread out is insufficient

they move in straight lines is insufficient

1

(ii) (speed also) increases

1

[6]

20 (a) **B**

*no mark for **B** - marks are for the explanation*

*first two mark points can score even if **A** is chosen*

draught increases (the rate of) evaporation

accept more evaporation happens

accept draught removes (evaporated) particles faster

*do **not** accept answers in terms of particles gaining energy from the fan / draught*

1

evaporation has a cooling effect

accept (average) kinetic energy of (remaining) particles decreases

1

so temperature will fall faster / further

1

(b) larger surface area

1

increasing the (rate of) evaporation

accept more / faster evaporation

accept easier for particles to evaporate

or

for water to evaporate from

accept more particles can evaporate

accept water / particles which have evaporated are trapped (in the bag)

answers in terms of exposure to the Sun are insufficient

1

[5]

21 (a) $E = P \times t$

91 (p)

an answer £0.91 gains 3 marks

an answer 0.91 gains 2 marks

*allow **2** marks for energy transferred = 18.2 (kWh)*

or

substitution into 2 equations combined, ie 2.6 × 7 × 5

*allow **1** mark for correct substitution into E = P × t, ie E = 2.6 × 7*

or

*allow **1** mark for multiplying and correctly calculating an incorrect energy transfer value by 5*

3

(b) answers should be in terms of supply exceeding demand

accept there is a surplus / excess of electricity (at night)

1

(c) reduce (rate of) energy transfer (from ceramic bricks)

accept heat for energy

*do **not** accept no energy / heat escapes*

*do **not** accept answers in terms of lost / losing heat if this implies heat is wasted energy*

1

so keeping the (ceramic) bricks hot for longer

accept increase time that energy is transferred to the room

accept keep room warm for longer

or

to stop the casing getting too hot

accept so you do not get burnt (on the casing)

1

(d) $E = m \times c \times \theta$

120

*allow **1** mark for correct substitution*

ie 9 000 000 = m × 750 × 100

2

[8]

22 (a) (i) conduction

1

(ii) atoms gain (kinetic) energy

accept particles / molecules for atoms

*do **not** accept electrons for atoms*

or

atoms vibrate with a bigger amplitude

accept vibrate faster / more

*do **not** accept start to vibrate*

or

atoms collide with neighbouring atoms

1

transferring energy to (neighbouring / other) atoms

*do **not** accept heat for energy*

or

making these other atoms vibrate with a bigger amplitude

accept faster / more for bigger amplitude

mention of (free) electrons moving and passing on energy negates this mark

1

(b) (i) 5 (°C) to 25 (°C)

either order

1

(ii) a correct example of doubling temperature difference doubling heat transfer

eg going from 5 to 10 (°C) difference doubles heat transfer from 30 to 60 (J/s)

accept for heat transfer number of joules / it

*allow **1** mark for correctly reading 1 set of data eg at 5 °C the heat transfer is 30*

or

for every 5°C increase in temperature difference heat transfer increases by 30 (J/s)

no credit for stating they are directly proportional

2

(iii) 1800

*allow **1** mark for obtaining heat transfer value = 120*

2

(c) payback time calculated as 33 years

calculations must be correct to score the first mark point

explanations must relate to it not being cost effective

1

this is greater than lifetime of windows

or

total savings (over 30 years) = £4800 (1)

this is less than cost of windows (1)

or

$\frac{5280}{30}$ = 176 (1)

this is more than the yearly savings (1)

1

[10]

23 (a) any **two** from:

- black is a good emitter of (infrared radiation)

  accept heat for radiation

  ignore reference to absorbing radiation

- large surface (area)

- matt surfaces are better emitters (than shiny surfaces)

  accept matt surfaces are good emitters

  ignore reference to good conductor

2

(b) 90% or 0.9(0)

$$efficiency = \frac{useful\ energy\ out\ (\times 100\%)}{total\ energy\ in}$$

allow 1 mark for correct substitution, ie $\frac{13.5}{15}$

provided no subsequent step shown

*an answer of 90 scores **1** mark*

*an answer of 90 / 0.90 with a unit scores **1** mark*

2

(c) (producing) light

allow (producing) sound

1

(d) any **two** from:

- wood is renewable

  accept wood grows again / quickly
  accept wood can be replanted

- (using wood) conserves fossil fuels

  accept doesn't use fossil fuels

- wood is carbon neutral

  accept a description

  cheaper / saves money is insufficient

2

(e) $E = m \times c \times \theta$

2 550 000

*allow **1** mark for correct substitution*
ie 100 × 510 × 50
provided no subsequent step shown
*answers of 1 020 000, 3 570 000 gain **1** mark*

2

joules /J

accept kJ / MJ
*do **not** accept j*
for full credit the unit and numerical answer must be consistent

1

[10]

24

accept atoms / particles for ions throughout

(a metal has) free <u>electrons</u>

accept mobile for free

1

(kinetic) energy of (free) electrons increases

accept energy of ions increases
accept ions vibrate with a bigger amplitude
accept ions vibrate more
*do **not** accept electrons vibrate more*

1

(free) <u>electrons</u> move faster

1

or

electrons move through metal

accept electrons collide with other electrons / ions

(so) electrons transfer energy to other electrons / ions

accept ions transfer energy to neighbouring ions

1

[4]

25 (a) any **two** from:

- (air) particles / molecules / atoms gain energy
- (air) particles / molecules / atoms move faster

  *do **not** accept move more*
  *do **not** accept move with a bigger amplitude / vibrate more*
- (air) particles / molecules / atoms move apart
- air expands

  ignore particles expand
- air becomes less dense

  ignore particles become less dense
- warm / hot air / gases / particles rise

  *do **not** accept heat rises*

  answers in terms of heat particles negates any of the mark points that includes particles

2

(b) (i) any **two** from

- free / mobile electrons gain (kinetic) energy

  accept free / mobile electrons move faster

  accept vibrate faster for gain energy
- free electrons collide with other (free) electrons / ions / atoms / particles
- atoms / ions / particles collide with other atoms / ions / particles

  answers in terms of heat particles negates this mark point

2

(ii) (faster) energy / heat transfer to room(s) / house

accept room(s) / house gets warm(er)

accept lounge / bedroom / loft for rooms

1

[5]

26 (a) (i) radiation

1

(ii) traps (small pockets of) air

*do **not** accept it's an insulator*

*do **not** accept reduces conduction and / or convection*

*do **not** allow it doesn't allow heat to escape*

1

(b) (i) bigger temperature difference (between the water and surroundings) at the start (than at the end)

*do **not** accept water is hotter*

1

(ii) starting temperature (of the water)

accept thickness of fleece

*do **not** accept same amount of fleece*

*do **not** accept thermometer / can*

*do **not** accept time is the same*

1

(iii) 18 (°C)

correct answer only

1

(iv) **M**

1

smallest temperature drop (after 20 mins)

*cannot score if **M** is not chosen*

accept it's the best insulator

accept smallest loss in heat

accept keeps heat / warmth in for longer

1

[7]

27 (a) conduction

1

(b) (i) any **one** from:

- starting temperature (of cold water)
  temperature is insufficient
- pipe length
  accept size of pipe
- pipe diameter
- pipe (wall) thickness
- volume of cold water
  accept amount for volume
- temperature of hot water (in)
- time

1

(ii) (type of) material is categoric
accept one variable is categoric
accept variable(s) are categoric
accept it is categoric
accept variable(s) are not continuous
descriptions of variables ie names and numbers is insufficient

1

(iii) copper

1

greatest temperature change
only scores if copper chosen
accept heat for temperature
accept heated water the fastest
accept it was hottest (after 10 minutes)
accept it is the best / a good conductor

1

(c) larger (surface) area
accept the pipe is longer
accept hot (dirty) water (inside pipe) is in contact with the cold water (outside pipe) for a longer time
he pipe is a spiral is insufficient

1

[6]

28 (a) (i) 2.1

correct answer only

1

(ii) 3.15

or

their (a)(i) × 1.5 correctly calculated

*allow **1** mark for correct substitution*

ie 2.1 × 1.5

or

their (a)(i) × 1.5

2

kilowatt-hour

accept kWh

or

*a substitution 2100 × 5400 scores **1** mark*

*2100 × 5400 incorrectly calculated with answer in joules scores **2** marks*

*an answer of 11 340 000 scores **2** marks*

*an answer of 11 340 000 J scores **3** marks*

1

(iii) most (input) energy is usefully transformed

accept does not waste a lot of energy

accept most of the output / energy is useful

*do **not** accept it does not waste energy*

1

(b) the room is losing energy / heat

1

at the same rate as the heater supplies it

this mark only scores if the first is scored

*do **not** accept heater reaches same temperature as room / surroundings*

rate of heat gain = rate of heat loss scores both marks

1

[7]

29 (a) (i) silvered surfaces

more than the correct number of ticks in a row negates the mark

radiation

2

plastic cap

conduction, convection (both required)

	conduction	convection	radiation	
vacuum	✓	✓		
silvered surfaces			✓	(1)
plastic cap	✓	✓		(1)

(ii)

any mention of air or any other substance in a vacuum scores zero

because there are no particles in a vacuum

accept atoms / molecules for particles

accept vacuum is empty space

accept there is nothing in a vacuum

accept there is no air / gas in the vacuum

conduction **and** convection need particles / medium

*need reference to both conduction **and** convection*

accept correct descriptions

2

(b) (i) less heat lost (to air above the heater)

*do **not** accept **no** heat lost*

light shiny surfaces are poor emitters (of radiation)

accept radiators for emitters
references to reflection are neutral

or dull, matt surfaces are good emitters (of radiation)

*do **not** credit answers which infer reflection from the underside of the hood*

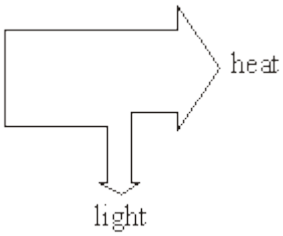
ignore correct reference to absorption

2

(ii) correct diagram drawn with one output arrow narrower than the other

ignore input

arrows correctly labelled with energy form
eg



flow charts score zero

2

(iii) energy cannot be destroyed

accept (principle of) conservation of energy

*do **not** accept because energy cannot be lost without clarification*

1

[9]

30 (a) the bigger the surface area, the faster the water cools down / temperature falls

answers must imply rate

accept heat for temperature provided rate is implied

*do **not** accept cools down more unless qualified*

1

(b) any **two** from:

the ears:

- have large surface / area

  not just has large ears

- radiate heat

  accept loses heat, but does not score if the reason given for heat loss is wrong

- keep blood cooler

2

(c) (i) radiation

1

(ii) conduction

1

[5]

31 (a) conduction

*do **not** accept conductor*

1

(b) the freezer

both parts needed

greater <u>temperature</u> difference (between freezer and room)

*do **not** accept because it is the coldest*

1

(c) any **two** from:

- poor absorber of heat / radiation

  accept does not absorb heat poor emitter of heat / radiation is neutral

- reflects heat / radiation (from room away from fridge-freezer)

- reduces heat transfer <u>into</u> the fridge-freezer

- reduces power consumption of fridge-freezer

  *do **not** accept it is a bad conductor / good insulator*

2

[4]

32 (a) (i) makes it warmer / raises the temperature

accept produces convection (current)

accept makes it less dense

1

(ii) reduced **or** slows down

1

(b) (i) electrical energy (to run the pump) must be paid for

accept electricity for electrical energy

accept electricity is needed for the pump

accept it uses electricity

accept because of the pump

1

(ii) more useful (heat) energy is transferred into the house than the energy used to operate the pump

or reduced cost of heating the house is greater than the cost of running the (electrical) pump

or costs little to run compared to the savings made

*accept for **1** mark*

reduces energy bills

***or** reduced fuel costs / heating costs owtte*

*do **not** accept it's cheap*

2

[5]

33 (a) (i) as a source of thermal <u>radiation</u>

accept heat for thermal radiation

accept to act as the Sun

*do **not** accept sunlight alone*

1

(ii) any **one** from:

- volume of water

  accept amount for volume

- distance between lamp and boiling tube
- initial / starting temperature of water
- same room temperature

  *do **not** accept time or same insulation material*

1

(iii) any **one** from:

- greater sensitivity / precision

  *do **not** accept more reliable (negates mark)*

- could link to a computer for (automatic) data analysis
- could take more frequent readings
- reduces instrument reading error

  accept more accurate

  *do **not** accept easier to use on its own*

1

(b) (i) acts as a control

accept to be able to make a comparison

accept to see the difference

*do **not** accept 'to make it a fair test' OWTTE on its own*

1

(ii) (plastic) foam and aluminium foil

1

(iii) (aluminium) foil is a poor absorber of thermal radiation

accept heat / infra red for thermal radiation

1

or (aluminium) foil is a (good) reflector of thermal radiation

*do **not** accept 'reflects sunlight' on its own*

(plastic) foam traps air which is a (good) insulator

accept (plastic) foam is a poor conductor / (good) insulator

*do **not** accept 'the material' is a good insulator / poor conductor*

1

(c) particles vibrate with a bigger / stronger amplitude / faster / with more (kinetic) energy

accept particles vibrate more

*do **not** accept start to vibrate only*

1

energy transferred by collisions with other particles

*do **not** accept answers in terms of free/mobile electrons*

1

[9]

34 (a) (i) 7pm

accept 19.00 / 1900

1

(ii) 8pm

accept 20.00 / 2000

1

temperature drops more slowly

accept heat for temperature accept line is less steep

1

(b) insulator

1

conduction *

1

convection *

** answers can be either way around*

1

(c) (i) 4 (years)

1

(ii) it is the cheapest / cheaper / cheap

*do **not** accept answers in terms of heat rising or DIY*

1

has the shortest / shorter payback time

*do **not** accept short payback time*

1

[9]

35 (a) the outside colour of the cans

1

(b) (i) 18 (°C) **or** 88 to 70

ignore negative sign

1

(ii) 8 (°C) **or** 70 to 62

ignore negative sign

1

(c) greater temperature difference between water and surroundings (at start)

must mention temperature difference

ignore just water hotter

accept energy used to heat cans initially

1

(d) black

1

temperature falls the fastest (in L)

accept (can L) loses more heat / cools quicker

accept heat for temperature

1

black is a good / the best / better emitter (of heat / radiation)

accept converse

ignore black is best absorber

1

[7]

36 (a) ions / electrons gain (kinetic) energy

accept atom / particles / molecules for ion
accept ions vibrate faster
accept ions vibrate with a bigger amplitude
accept ions vibrate more
do not accept ions move faster

1

(free) electrons transfer energy by collision with ions
or energy transferred by collisions between vibrating ions

1

(b) move faster or take up more space

*do **not** accept start to move / vibrate*

1

(warmer) water expands **or** becomes less dense (than cooler water)

*do **not** accept answers in terms of particles expanding*

1

warm water rises (through colder water) **or** colder water falls to take its place

1

(c) transfer of energy by waves / infrared (radiation)

accept rays for waves

*do **not** accept transfer of energy by electromagnetic waves*

ignore reference to heat

1

[6]

37 (a) (i) 20

1

(ii) convection

1

(iii) fit draughtproof strips

1

accept lay carpet
accept fit curtains
accept close doors / windows / curtains
accept any reasonable suggestion for reducing a draught
'double glazing' alone is insufficient

(b) air is (a good) insulator

1

or air is a poor conductor

accept air cavity / 'it' for air

reducing heat transfer by <u>conduction</u>

accept stops for reduces
ignore convection
*do **not** accept radiation*
*do **not** accept answers in terms of heat being trapped*

1

(c) (i) most cost effective

accept it is cheaper or low<u>est</u> cost
accept shortest payback time
accept in terms of reducing heat loss by the largest amount
*do **not** accept it is easier*
ignore most heat is lost through the roof

1

(ii) 4

1

[7]

38 (a) (i) vacuum

do not allow stopper

1

(ii) (absence of particles) means no (transfer of energy between) particles for conduction

*accept particles **or** atoms **or** molecules **or** electrons*

1

no movement of molecules for (transfer of energy by) convection

accept particles/atoms/electrons

if answer to (a)(i) is correct: then in (a)(ii) have stated 'conduction and convection both need a medium/particles/materials' = 2 marks

(If medium is specified, it must be correct, conduction can be solid, liquid or gas, convection must be liquid or gas)

if answer to (a)(i) is incorrect then in (a)(ii) have stated 'conduction and convection both need a medium...'= 1 mark, unless further qualified by stating about absence of particles, in which case get a second mark.

1

(b) (i) silvered surface

accept silver surface

1

(ii) silvered is a bad emitter/radiator

1

surface reflects heat/energy/radiation (at inner and outer surface) **or** is a bad absorber (of energy)

accept bounces off

1

[6]

39 (i) conduction, convection

answer can be in either order

1

(ii) traps (lots of) air

*do **not** accept heat is trapped in the fibre*

1

air is a (good) insulator **or** poor conductor

1

[3]

40 (i) radiation **or** infra red

*do **not** accept rays*

*do **not** accept waves*

accept electromagnetic waves

1

(ii) good absorber (of heat) to absorb heat (**or** infrared)

*do **not** accept 'attract' **or** 'capture' **or** soak*

1

(iii) reduce heat loss (from the panel)

accept (good) (heat) insulator

*accept stop **or** reduce conduction*

*accept stop **or** reduce convection*

accept traps heat

accept keeps water hot

1

(iv) to reflect (back into the panel) heat **or** infrared **or** Sun's energy

*do **not** accept 'bouncing'*

*do **not** accept reflect Sun*

*do **not** accept reflect sunlight **or** sun's rays*

1

radiated **or** given out by the (black) pipe

accept back to pipe
accept reduce heat loss for 1 mark
accept reduce heat loss by radiation for 2 marks
accept stop heat loss by radiation for I mark

1

[5]

41 (a) (i) convection current correctly shown with arrows extending to above insulation label line

*circulation must show water rising in the left half of the tank accept continuous **or** broken arrows **must** be at least **one** arrow up and **one** arrow down*

*allow **1** mark for correct diagram which does not extend high enough*

2

(ii) it expands or it gets less dense

*do **not** allow hot water rises*

*do **not** accept explanation in terms of molecules expanding **or** changing density*

*do **not** accept lighter **or** heavier*

1

more dense water falls

allow cold water falls if qualified with a suitable reason

1

(b) (i) reflects heat back into the room **or** where it came from

accept infrared or radiation or energy for heat

accept bounce for reflect if in correct context

1

(ii) air is a (good) insulator or poor conductor **or** air stops conduction

*do **not** accept plastic foam is a good insulator **or** bad conductor*

1

air is trapped

1

convection loss reduced or stopped

1

(c) **two** out of the following three:

any answer which gains credit must contain a comparison

rate of evaporation decreases

*accept less sweat can evaporate **or** evaporation is more difficult*

less heat energy removed from the body

higher *humidity* the less water vapour can be absorbed (into the air)

accept sweat for water vapour

*do **not** credit description of high humidity*

accept a correct answer in terms of dynamic equilibrium

2

[10]

42 (a) (i) any **one** from:

water to the mug
water to the air
mug to the air
mug to the table

***both** required*

direction of transfer must be correct

1

(ii) when <u>temperatures</u> are the same

accept a specific example eg when the <u>temperature</u> of the water and mug are the same

accept radiant heat transfer will never stop

1

(b) wood

1

(c) (i) conduction

accept convection if not given as 3rd answer

1

insulator

1

convection

1

(ii) any **one** from:

*do **not** accept any rebuilding of house*

double glazing

loft insulation

accept roof for loft

1

carpets

(cavity) wall insulation

*do **not** accept closing doors and windows*

draft excluders

foil behind radiators

accept blocking chimney

paint inside walls white

[7]

43 (a) plastic/glass walls; vacuum; insulating top

any two for 1 mark each

2

(b) silvering/shiny on either wall

for 1 mark

1

[3]

44 (a) (i) Carries heat up (as convection current)

1

(ii) (1) By conduction or from molecule to molecule
(2) By radiation or as IR

2

(iii) Use shiny surface (inside or outside) or small area

1

(b) (i) Rise more quickly

1

(ii) Dull surface good absorber
(accept "attract" = "absorb" if context correct,
then penalise spg mark.

Shiny surface poor absorber

2

(c) (i) Fall more quickly

1

(ii) Dull surface good emitter
Shiny surface poor emitter

2

[10]

45 (a) (i) hot water rises (not heat)
for 1 mark

due to convection currents
or water expands/becomes less dense on heating
or less dense water rises
any for 1 mark

2

(ii) inside hotter (than outside)
for 1 mark

1

(iii) (heat transfer by) conduction
for 1 mark

1

(iv) surround/cover/insulate tank with poor conductor **or** named insulator
for 1 mark each

2

(b) (i) air is an insulator/poor conductor

for 1 mark

1

(ii) convection stopped foam is an insulator/poor conductor

for 1 mark each

2

[9]

46 (a) (i) £150

gets 2

Else 1000 – (250 + 350 + 100 + 150) or 1000 – 850

gets 1

2

(ii) (Named) floor covering
OR Insulation under floor

for 1 mark

1

(b) (i) Draught proof doors or fibre glass in loft or in cavity
For draught proofing

gains 1 mark

Very low cost/easy to install
Repays for itself quickly/cost recuperated quickly
Reasonable energy saving

any 2 for 1 mark each

For loft insulation

Second lowest installation cost/easy to install
Reasonable large energy savings for this cost
Reasonable payback time

gains 1 mark

For foam filled cavity
Biggest energy/cash saving
Cost effective

any 2 for 1 mark each

3

(ii) **Double glazing**

gains 1 mark

Costs most
Saves least energy
Least cost effective

any 2 for 1 mark each

3

[9]

47 (i) currents of moving liquids/gases/fluids carrying/transferring energy
(can name fluid)

1

(ii) liquids/gases **expand** when their temperature rises/when they are heated

the **density** of the heated liquid/gas is then **less** than that of the colder liquid/gas which has not been heated

the warmer/less dense liquid/gas **then rises** through the colder/denser liquid/gas

the **colder/denser liquid/gas falls** to replace the liquid/gas which has risen, and in turn becomes heated

for 1 mark each

4

[5]

48 ..... conductio
..... convectio
..... insulatio
..... radiatio

for 1 mark each

[4]

49 (a) convection
air is heated by the burner / particles gain energy
air expands / particles move about more / particles move faster
air becomes less dense / particles are more spread out
air rises / particles rise - *not* heat rises
air from C moves into the heater / particles from C move into the heater to replace it / them

any four *for 1 mark each*

4

(b) (i) radiation

for one mark

1

(ii) black surface <u>radiates / emits</u> well
(*allow* absorbs and emits well) (*allow* comparison with shiny / white surfaces)

large surface area needed
high temperature (of the lumps)

any one for 1 mark

1

[6]

50 (a) insulation

allow example e.g fibreglass

1

double glazing

allow curtains

1

draught excluder

allow double glazing / close fitting door

allow turning down thermostat once only / turn down the heating

1

(b) transfers more useful energy

allow converts more energy into light / less into heat / less energy wasted

1

[4]

51 (a) (i) conduction

1

convection

they may be in either order

1

(ii) radiation

1

(iii) evaporation

1

convection

they may be in either order

1

(iv) convection

1

(v) conduction

1

(b) in the middle above halfway up (above line joining top of spacers)

below the surface of the liquid

1

(c) by particles vibrating more

*particles shake more **or** move more*

do not credit they start vibrating

1

they pass on the energy **or** vibrations

do not credit heat

1

[10]

52 (a) (i) the outlet mark

hot water rises **or** floats up

do not accept heat rises

the inlet mark

1

cold water replacing any drawn off comes in at the bottom and does not mix with hot **or** cool the hot water

do not accept descriptions of a convection current

1

(ii) only heats top (of tank) **or** a small volume

credit heats less water

1

no mixing occurs with cold because hot water is less dense **or** water is a poor conductor

no mixing because cold water is more dense

1

(b) radiation (losses from tank)

do not accept reflection of heat

1

lower from light **or** white **or** shiny surfaces

credit they are poor radiators for both marks

1

[6]

53 (a) radiates
absorbs / conducts
reflects

for 1 mark each

3

(b) C make sure the lamp is the same distance from both tubes
B switch on the lamp
A switch off the lamp
E wait for the temperature to stop rising
D read the thermometers

for 1 mark each

5

[8]