

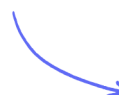
Theory Questions

Transfer of Thermal Energy

Demonstrating Conduction / Thermal Conduction / Convection / Radiation / The Greenhouse Effect / Investigating IR Radiation / Consequences of Thermal Energy Transfer

Easy (5 questions)	/40
Medium (8 questions)	/45
Hard (6 questions)	/61
Total Marks	/146

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Easy Questions

- 1 (a)** Fig. 6.1 shows a hot liquid in a vacuum flask. The vacuum flask keeps the temperature of the liquid in the flask constant for a long time.

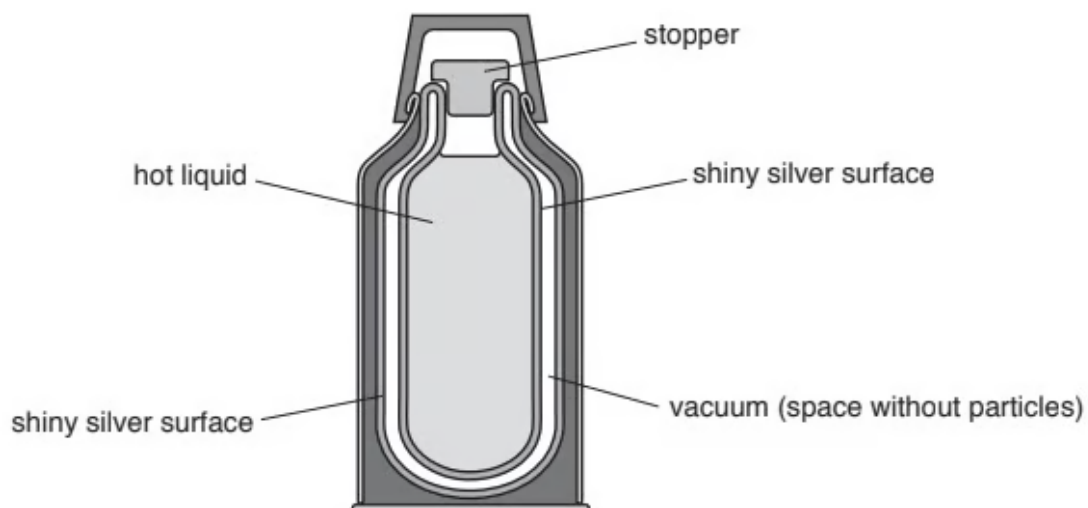


Fig. 6.1

Describe how each feature helps to keep the liquid hot for longer.

(i) shiny silver surface

[2]

(ii) the vacuum between the silvered surfaces

[3]

..... (5 marks)

(b) (i) Suggest a material for the stopper that will help to keep the liquid hot for longer.

[1]

(ii) Give a reason for your answer.

[1]

..... (2 marks)

2 (a) A Bunsen burner heats a beaker of water, as shown in Fig. 4.1.

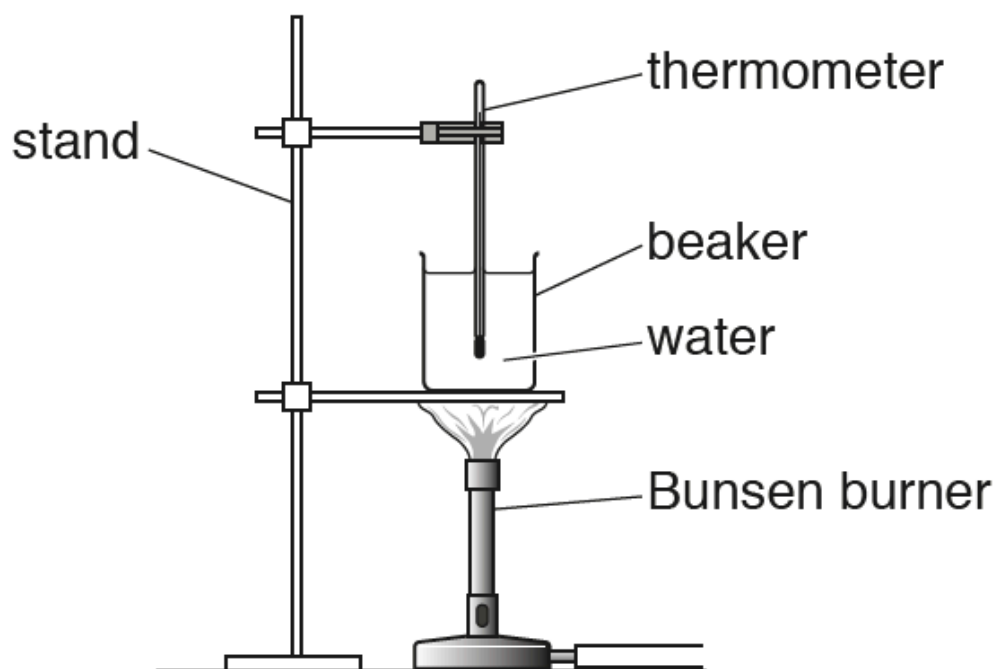


Fig. 4.1

(i) Fig. 4.2 shows the thermometer used in Fig. 4.1.

State the temperature shown on the thermometer.

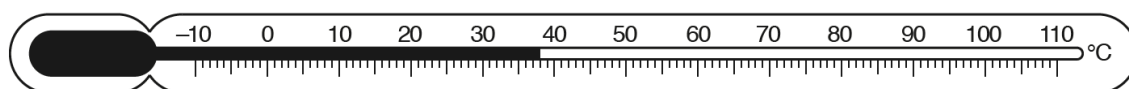


Fig. 4.2

temperature = ... °C [1]

(ii) The thermometer shown in Fig. 4.2 uses a physical property that changes with temperature.

Indicate the measurable property that changes with temperature. Tick **one** box.

- ☐ expansion of glass
- ☐ expansion of liquid
- ☐ colour of liquid
- ☐ colour of glass

[1]

.....
..... (2 marks)

(b) Thermal energy (heat) transfers through the bottom of the beaker to the water.

State the name given to this process.

..... (1 mark)

(c) Thermal energy transfers throughout the water in the beaker.

Describe and explain how this happens.

.....
.....
.....
..... (4 marks)

- 3 (a)** Complete the sentences with words that describe the main process of energy transfer by heating in each case.

A man goes for a walk on a cold day. He touches a metal gate, which removes energy from his hands by He holds the sides of a cup containing a hot drink. His hands gain energy by Some farm workers have lit a fire. The man warms his hands by the side of the fire. His hands gain energy by

(3 marks)

(b) Extended

Describe in terms of particles the transfer of energy from the thermal store of the man's hands through the metal of the gate.

.....

.....

.....

(3 marks)

- (c)** Fig. 5.1 shows a car on a sunny day in a hot country.

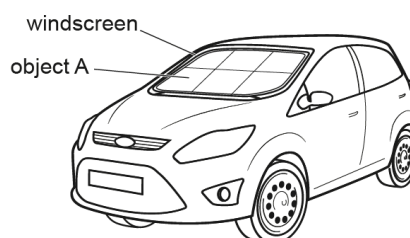


Fig. 5.1

The object labelled A is placed inside the windscreen. It is used by the owner of the car to reduce the temperature rise of the air in the car.

Select the most suitable material for the outer surface of object A. Explain your choice.

dull black	dull white	shiny black	shiny white
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(2 marks)

- 4 (a)** Fig. 6.1 is a diagram of the inside of an electric oven. The diagram shows a side view of the oven.

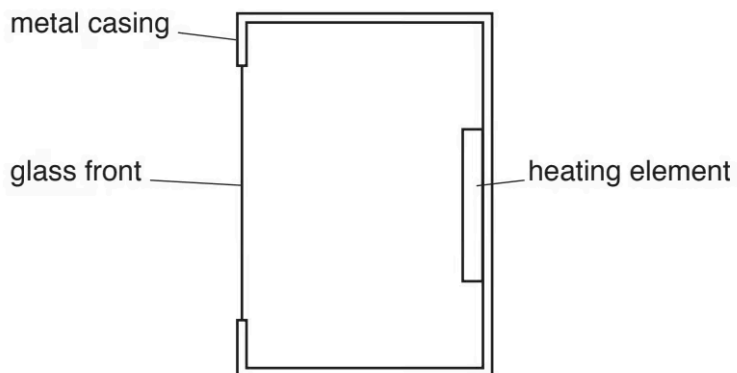


Fig. 6.1

The heater is switched on.

- (i) On Fig. 6.1, draw two arrows to show how thermal energy moves throughout the oven by convection.

[2]

- (ii) Explain how thermal energy moves throughout the oven by convection. Use your ideas about density and expansion.

[3]

- (iii) Use a word from the box to complete the sentence.

conduction expansion insulation radiation

Thermal energy travels at the speed of light by

(6 marks)

(b) The oven is in a kitchen that is fitted with a smoke detector.

Warm, moving air can carry smoke particles.

Suggest the best position for the smoke detector in the kitchen.

(1 mark)

5 (a) Extended

A student is performing an experiment to investigate how much infrared radiation is radiated by different coloured surfaces.

Four conical flasks are painted shiny grey, dull grey, black and white, see Fig. 1.1.

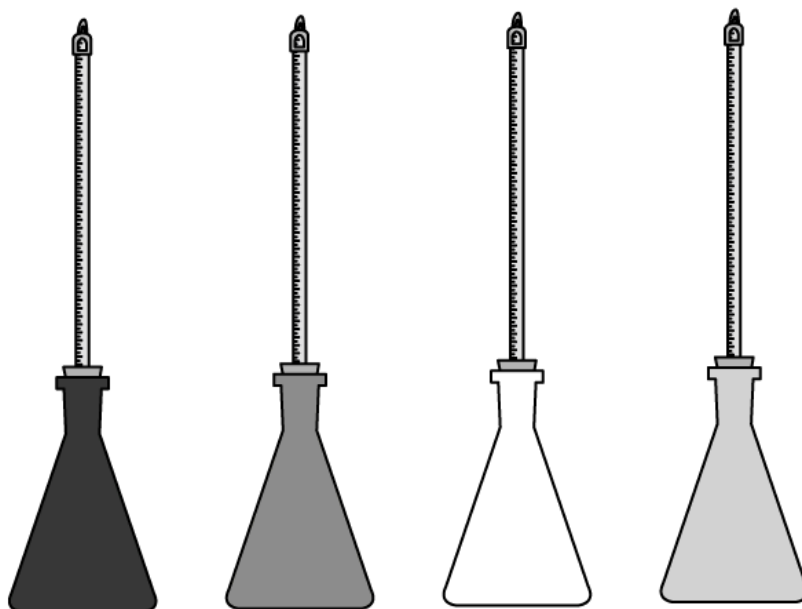


Fig. 1.1

They fill the four conical flasks with boiling water and record the subsequent temperature every 30 s.

State the dependent and independent variables in this experiment.

(2 marks)

(b) Extended

State two control variables in this investigation.

(2 marks)

(c) **Extended**

The results of the experiment are plotted in Fig. 1.2 below. Each line represents the temperature loss of a different flask.

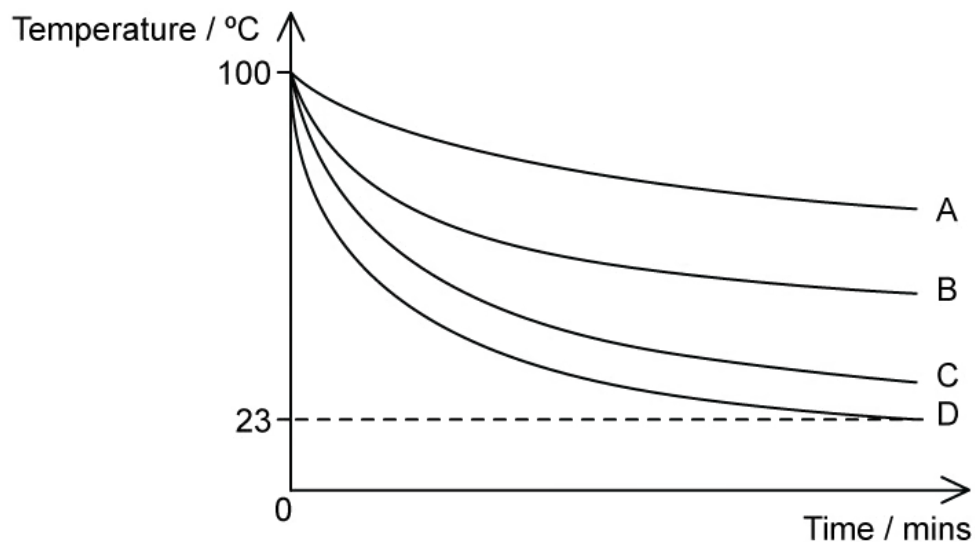


Fig. 1.2

Fig. 1.2

(i) State the letter of the curve with the lowest temperature change per second.

[1]

(ii) State the letter of the flask covered in the best conductor.

[1]

(2 marks)

(d) **Extended**

(i) Draw **four** lines between the labels from Fig. 1.2 and the different flask colours.

Dull grey	A
Shiny grey	B
White	C
Black	D

[4]

(ii) Suggest why the temperature of flask D does not drop below 23 °C.

[1]

.....

.....

.....

.....

.....

(5 marks)

Medium Questions

- 1 (a)** Some materials are poor conductors of thermal energy (heat energy).

State the term that describes materials that are poor conductors of thermal energy.

..... (1 mark)

- (b)** Some materials are good conductors of thermal energy.

Draw a ring around each material that is a good conductor of thermal energy.

air	aluminium	copper	glass	plastic	water
-----	-----------	--------	-------	---------	-------

(1 mark)

- (c)** A student has two rods made of different materials. The rods are the same size.

Describe an experiment to identify which material is the better conductor of thermal energy.

You may draw a diagram in the space below.

(3 marks)

2 (a) Extended

Fig. 4.1 shows a cold plastic spoon that has just been placed in hot liquid in a cup.

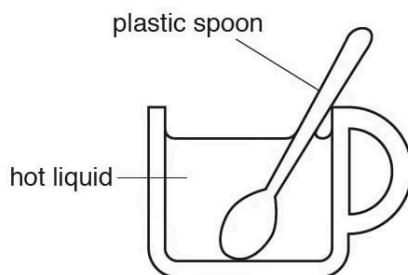


Fig. 4.1

Describe, in terms of molecules, why the temperature of the whole of the spoon increases.

.....

.....

..... (3 marks)

(b) Extended

The plastic spoon is replaced by a metal spoon.

Describe an additional process by which the temperature of the whole of this spoon increases.

.....

..... (2 marks)

(c) Extended

The cup contains 150 g of liquid of specific heat capacity $4.2 \text{ J / (g}^\circ\text{C)}$. When the cold spoon is placed into the hot liquid, the temperature of the liquid decreases from 80°C to 56°C .

Calculate the loss of thermal energy from the liquid.

energy loss = ...

.....

.....

.....

(3 marks)

- 3 (a)** A student constructs a device for absorbing thermal energy from the Sun. Fig. 6.1 shows the device.

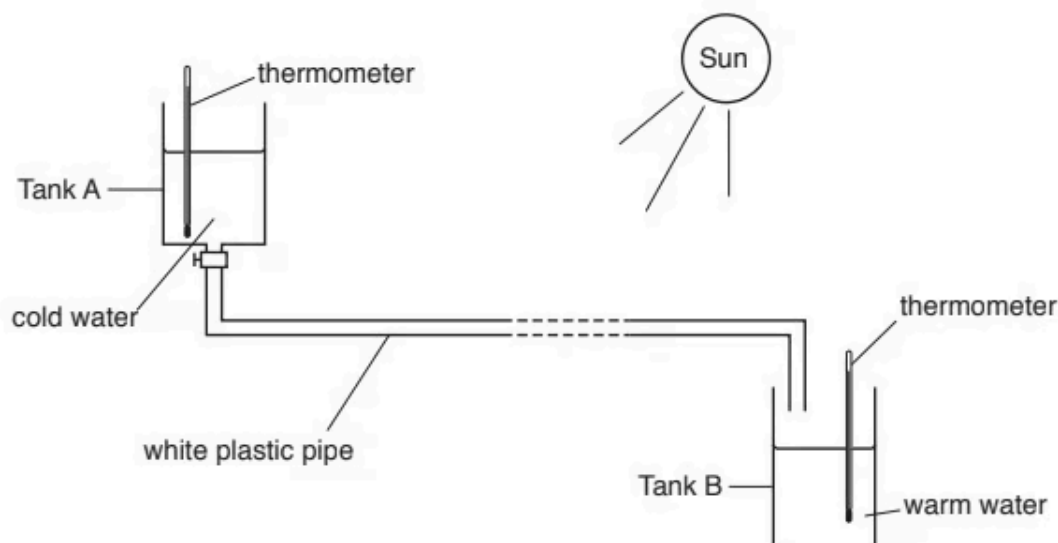
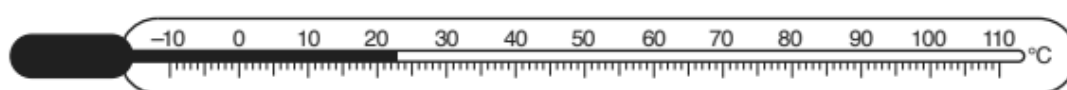


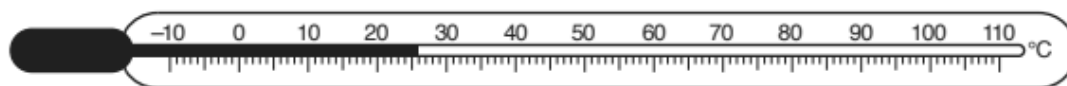
Fig. 6.1

The student places the white plastic pipe in sunlight. The cold water flows slowly from Tank A to Tank B. Energy from the Sun heats the water in the pipe.

Fig. 6.2 shows the temperatures in Tank A and Tank B.



Thermometer showing temperature in Tank A.



Thermometer showing temperature in Tank B.

Fig. 6.2

Determine the rise in temperature of the water.

temperature rise = ... °C

..... (1 mark)

- (b)** The student wants to increase the thermal energy absorbed by the water in the pipe. Suggest three improvements he can make to increase the thermal energy absorbed.

.....
.....
..... (3 marks)

- (c)** Describe how the thermal energy is transferred from the Sun to the water inside the pipe.

.....
..... (2 marks)

- 4 (a)** A student investigates the thermal energy lost from two metal cans, X and Y. The cans are identical apart from their outside colour.

The student pours the same volume of hot water into each can and seals each can. The student records the temperature of the water in each can at regular time intervals for a period of 35 minutes.

The equipment is shown in Fig. 6.1.

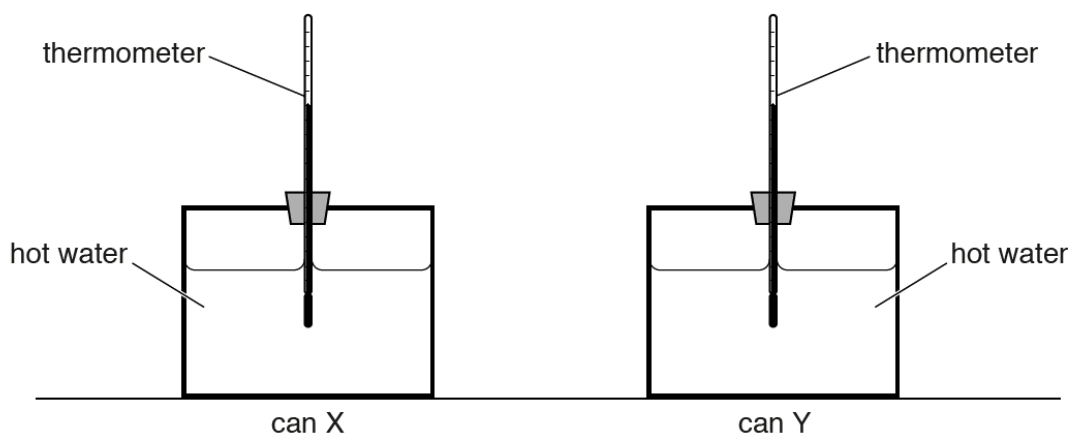


Fig. 6.1

Fig. 6.2 is a graph of the results from the investigation.

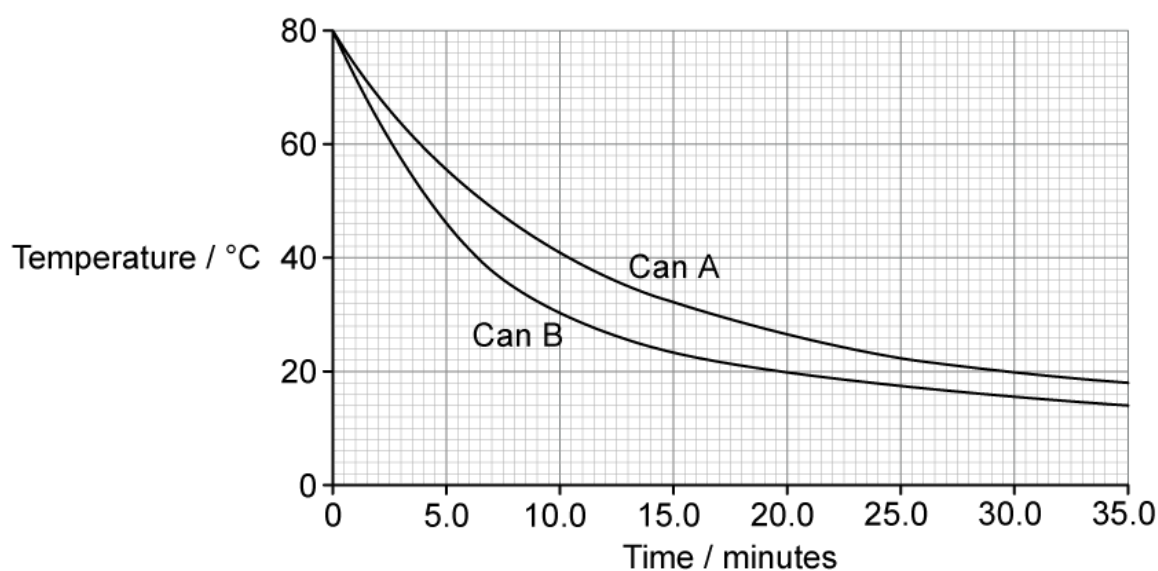


Fig. 6.2

For can X, use Fig. 6.2 to determine the drop in temperature of the water

(i) in the **first** five minutes

[1]

(ii) in the **last** five minutes

[1]

.....
.....
(2 marks)

(b) Explain why the water cools at a greater rate during the first five minutes of the experiment, compared with the last five minutes.

.....
.....
(2 marks)

(c) The outside of one can is dull black and the outside of the other is shiny white.

State the colour of can Y.

Explain your answer.

.....
.....
(2 marks)

5 (a) A student heats some water in a metal can, as shown in Fig. 6.2.

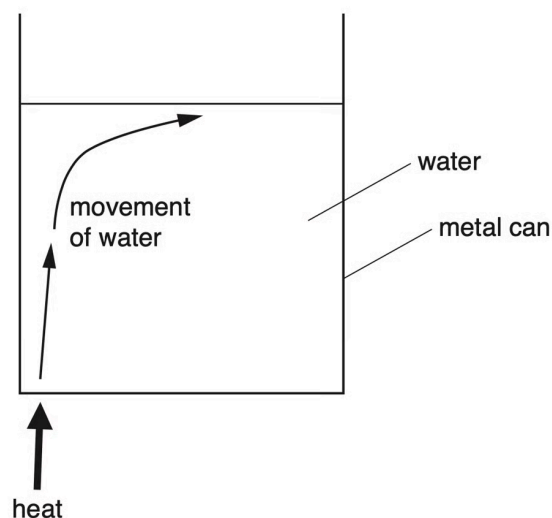


Fig. 6.2

Complete the sentence. Choose a word from the box.

conduction convection radiation

Thermal (heat) energy moves through the metal can by

(1 mark)

(b) Describe how thermal energy is transferred throughout the water. Include your ideas about density changes.

(3 marks)

6 A teacher fills a copper can with solid wax and heats the can. She measures the temperature of the wax every minute. She continues heating once the wax has melted and stops heating when the wax is boiling.

(i) State the term used for the process that transfers thermal energy through the copper.

[1]

(ii) Fig. 6.1 shows how the temperature of the wax changes as it is heated.

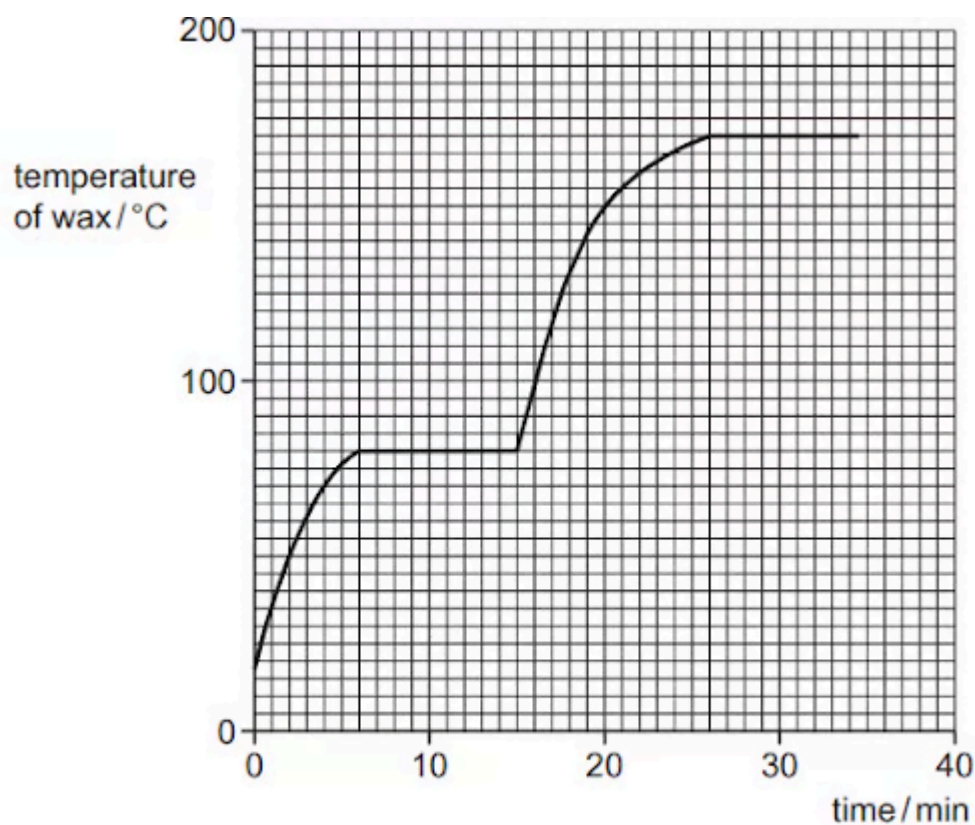


Fig. 6.1

Using the graph in Fig. 6.1, determine:

1. the melting point of the wax °C

[1]

2. the boiling point of the wax °C

[1]

3. the time at which the wax starts to boil. min

[1]

.....

.....

.....

.....

(4 marks)

7 Extended Tier Only

During a picnic on a warm, dry day, a metal can of lemonade is wrapped in a damp cloth.

Evaporation cools the water in the cloth.

As the water in the cloth cools, so does the lemonade.

Explain how electrons transfer thermal energy through the metal of the can.

.....

.....

.....

(3 marks)

8 (a) Fig. 6.1 shows a road next to the sea.



Fig. 6.1

On a sunny day, the Sun warms the road.

Describe how energy from the Sun reaches the Earth and warms the road.

.....

.....

.....

(3 marks)

(b) The temperature of the road is greater than the temperature of the sea.

The surface of the road is black.

Suggest **one** reason why the temperature of the road is greater than that of the sea.

.....

(1 mark)

(c) The air above the road is heated by the warm road.

(i) Describe how this affects the molecules of the air.

[2]

(ii) A cyclist travelling along the road notices that a cool breeze is blowing from the sea to the land.

Explain how convection produces this breeze. You may include a diagram if it helps your answer.

[3]

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.....

.....

.....

.....

(5 marks)

Hard Questions

- 1 (a) A thermometer is used to measure the temperature inside a room in a house.

State a physical property that varies with temperature and can be used in a thermometer.

..... (1 mark)

- (b) Fig. 6.1 shows how the temperature of the room changes between 6:00 pm and 11:00 pm.

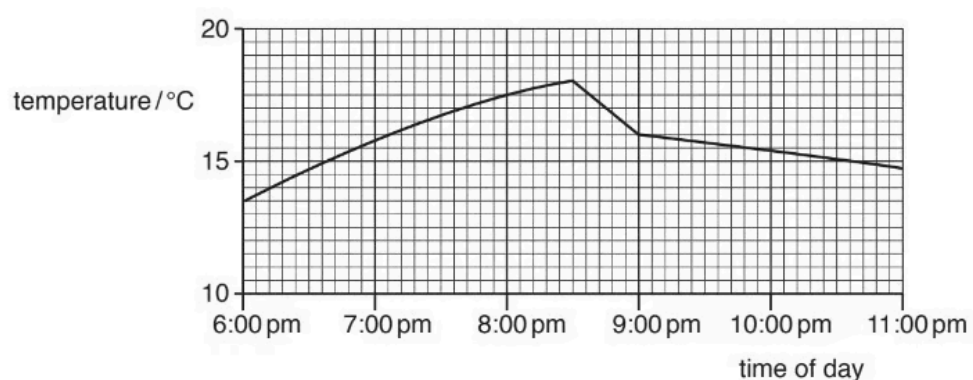


Fig. 6.1

A heater in the room is switched on at 6 pm. The room has a large window. A large amount of thermal energy is transferred through the window. The window in the room has thick curtains.

Closing the curtains reduces the loss of thermal energy from the room.

- (i) Suggest the time at which the heater is switched off.

[1]

- (ii) Suggest the time at which the curtains were closed and explain your answer. Use information from the graph.

[2]

.....

.....

(3 marks)

- (c) In cool climates, people use mineral wool to reduce heat loss from houses. Mineral wool is made of fibres and trapped air, as shown in Fig.6.2.

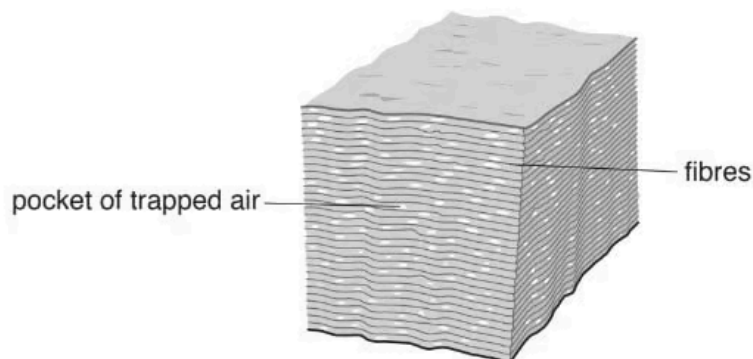


Fig.6.2

Use words from the box to complete the sentences. Each word may be used once, more than once, or not at all.

conductor	conduction	convection	emitter	insulator	radiation	radiator
-----------	------------	------------	---------	-----------	-----------	----------

Air is a good

When air is trapped between fibres, it reduces heat loss by and by

(3 marks)

2 Extended tier only

A student wants to investigate good and bad absorbers of thermal radiation. She has the apparatus shown in Fig. 5.1, a supply of cold water and a metre rule.

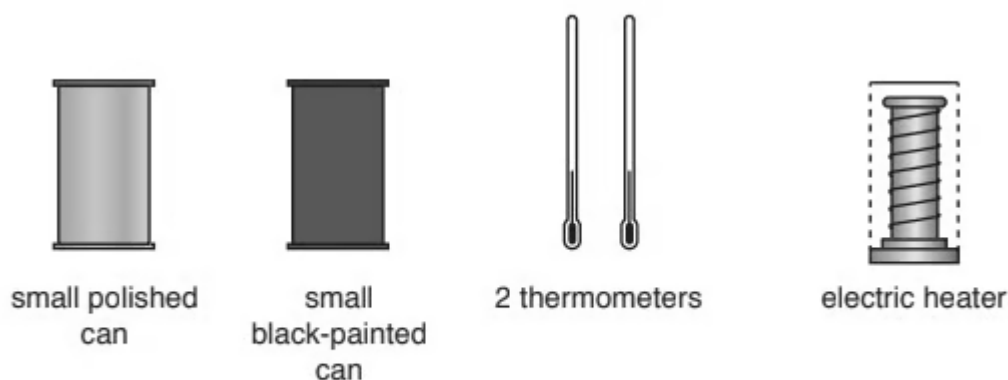


Fig. 5.1

Explain how the student could use the apparatus she has available to carry out her investigation.

Describe the results she would expect to obtain. Draw a diagram of the set-up.

(4 marks)

3 (a) A solar panel is mounted on the roof of a house. Fig. 1.1 shows a section through part of the

solar panel.

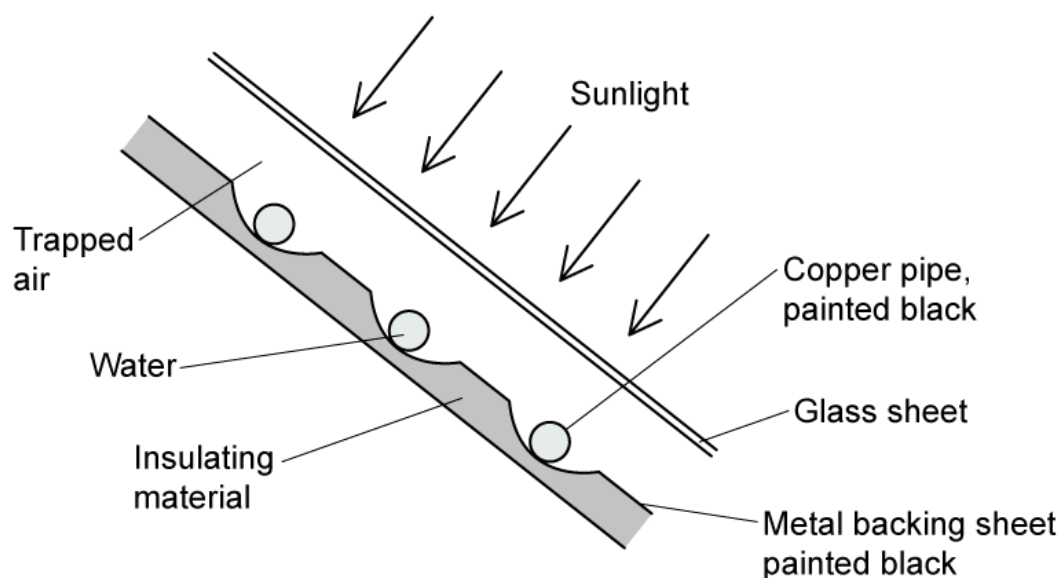


Fig. 1.1

A pump makes water flow through the copper pipes. The water is heated by passing through the solar panel.

Select and explain three features of the solar panel that maximise the final temperature of the water.

(3 marks)

(b) Extended tier only

During one day, 250 kg of water is pumped through the solar panel. The temperature of this water rises from 16 °C to 38 °C.

The water absorbs 25% of the energy incident on the solar panel. The specific heat capacity of water is 4200 J/(kg °C)

Calculate the energy incident on the solar panel during that day.

(5 marks)

(c) Extended tier only

The heated water is stored in a sealed copper hot-water tank. During the day, the water cools as thermal energy (heat) passes from the water to the air surrounding the tank.

Name and describe the process by which the thermal energy is transferred from the hot water to the air.

(4 marks)

(d) Extended tier only

The manufacturer of the hot-water tank says that when the outside surface is polished regularly and kept bright and shiny, the hot water will cool more slowly.

Describe an experiment that shows whether a container with a bright and shiny surface is better at keeping its contents warm than one with a dull and dark surface.

(5 marks)

4 (a) Extended tier only

The apparatus shown in Fig. 1.1 is known as Leslie's Differential Air Thermometer.

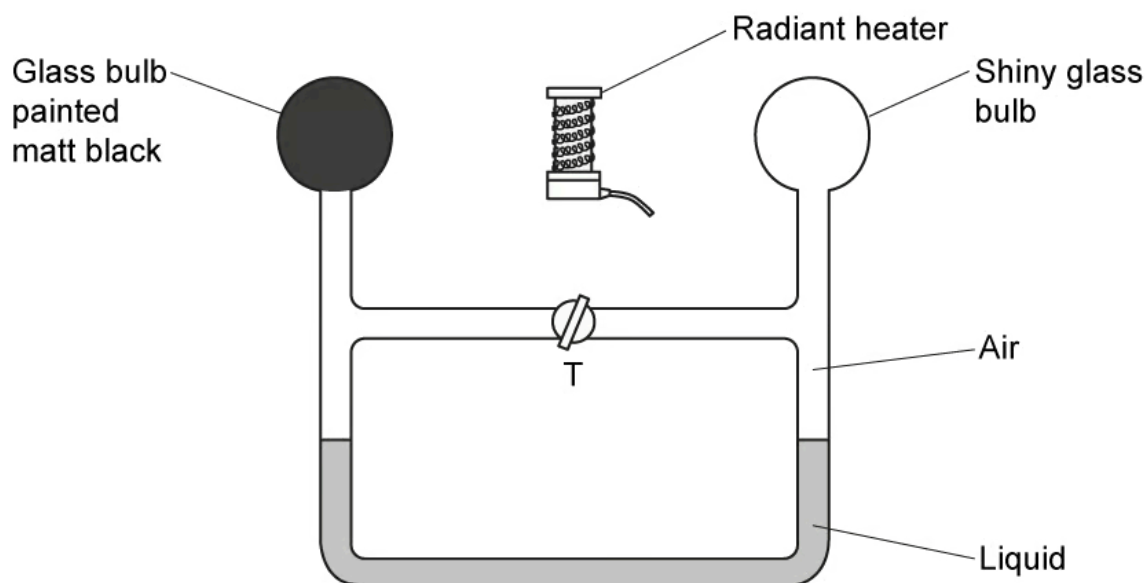


Fig. 1.1

The heater is switched off. Tap T is opened so that the air on the two sides of T has the same pressure. Tap T is then closed.

(i) The heater is switched on. On Fig. 1.1, mark clearly where the two liquid levels might be a short time later.

[1]

(ii) Explain your answer to **(a)(i)**.

[2]

.....

.....

.....

(3 marks)

- (b)** A gym has a low initial temperature. A larger radiant heater is placed on the floor in the centre of a gym to heat the room. The room has no open windows or ventilation.

Describe and explain the subsequent motion of air in the gym, naming any processes.

.....

.....

.....

.....

.....

..... (5 marks)

- (c)** After a marathon in winter, the athlete has sweated a large amount.

(i) Explain why this could be dangerous.

[3]

(ii) Some athletes choose to wear a shiny foil blanket immediately after a race. Explain why.

[3]

.....

.....

.....

.....

.....

.....

..... (6 marks)

- (d) Extended tier only**

For the end of the marathon, the athlete's coach has a double-walled vacuum flask (Fig. 1.2), which is designed to maintain the temperature of its contents. It is partially filled with a hot liquid.

The lid is made of black plastic and sealed tight. The walls are silvered metal.

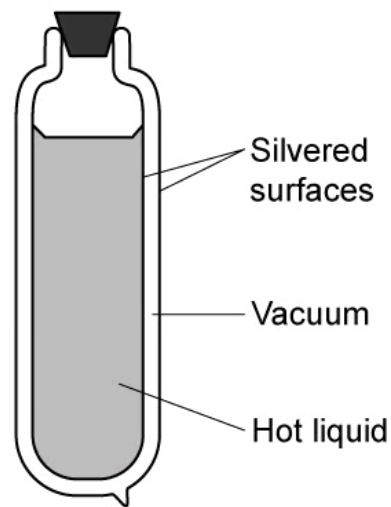


Fig. 1.2

Eventually the liquid cools. Explain how thermal energy is transferred from the hot liquid through the lid over time.

.....

.....

.....

..... (4 marks)

5 (a) Extended tier only

An object in the space between Earth and the Sun has an average temperature of 3 K.

(i) State how the intensity of radiation the object receives from the Sun at this point differs from the intensity at the Earth's surface.

[1]

(ii) Explain why the temperature of the object in space here is lower than if it was on Earth.

[2]

.....

.....

..... (3 marks)

(b) Extended tier only

The average surface temperature of Venus is 475 °C.

The average surface temperature of Earth is 13 °C.

If Venus had an atmosphere the same as Earth's, it would have a maximum surface temperature of 35 °C.

If Venus had an orbital radius the same as Earth's, it would have a surface temperature of 227 °C.

Venus is ~30% closer to the Sun than the Earth is.

Referring to these data, explain why the surface temperature of Venus is much higher than Earth's.

.....

.....

(4 marks)

(c) The Earth's magnetic field arises from its iron-rich molten core, shown in Fig. 1.2.

Molten iron must be **in motion** to generate a magnetic field.

The inner core is very hot and solid. The outer core is also iron-rich and liquid.

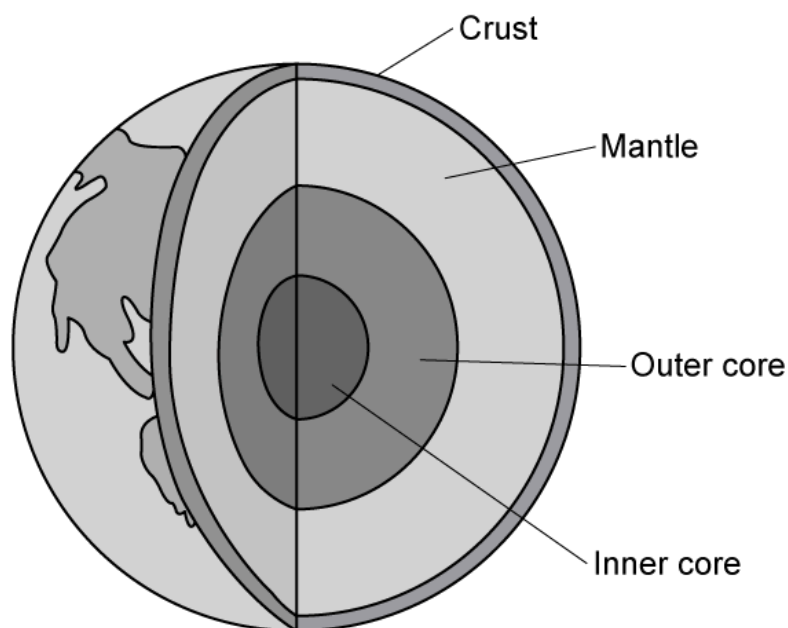


Fig. 1.2

Explain the origin of the Earth's magnetic field, referring to density in your answer.

(4 marks)

6 A student is testing how different surfaces absorb radiant heat.

The student puts two metal plates in holders and places them on either side of a radiant heater as shown in Fig. 6.2. One plate has a shiny metal side facing towards the heater and the other plate has a dull black side facing towards the heater.

A metal disc is attached to each plate using wax.

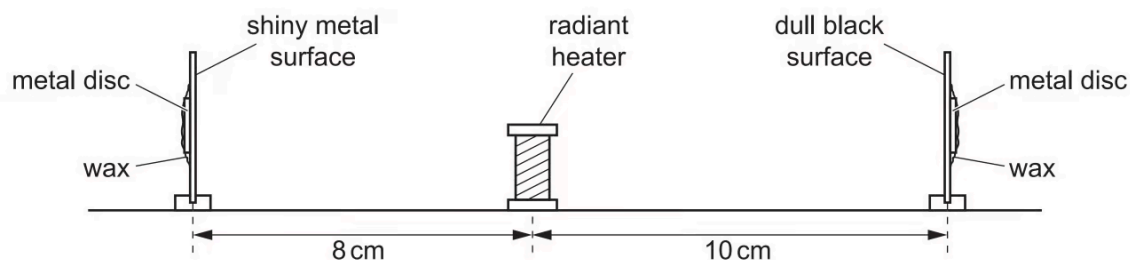


Fig. 6.2

(i) The student turns on the radiant heater and starts a stop-clock. The wax on the plate with a dull black side melts and the metal disc falls off the plate 53 seconds after the stop-clock is started.

The metal disc on the plate with a shiny metal side remains attached for another 32 seconds after the metal disc on the first plate falls.

Explain why the metal disc on the plate with a dull black side falls before the metal disc on the plate with a shiny metal side.

[2]

(ii) Another student observes the experiment shown in Fig. 6.2 and says that the comparison of the two plates is not fair.

Suggest why the experiment is not fair.

[2]

(4 marks)