Transfer of Thermal Energy

Question Paper

Course	CIE IGCSE Physics
Section	2. Thermal Physics
Topic	Transfer of Thermal Energy
Difficulty	Hard

Time Allowed 80

Score /61

Percentage /100

Question 1a

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]

Question 1b

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

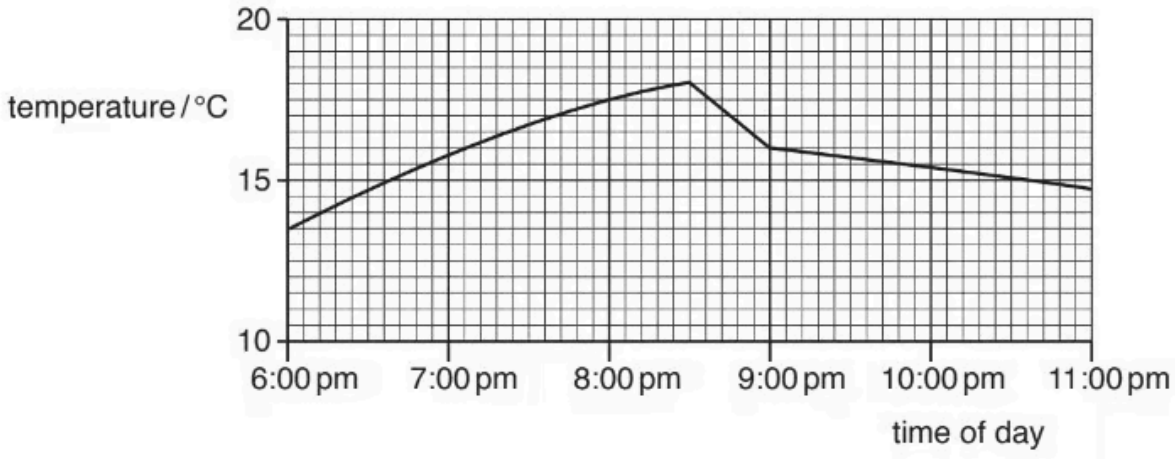

Fig. 6.1

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]

Question 1c

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.

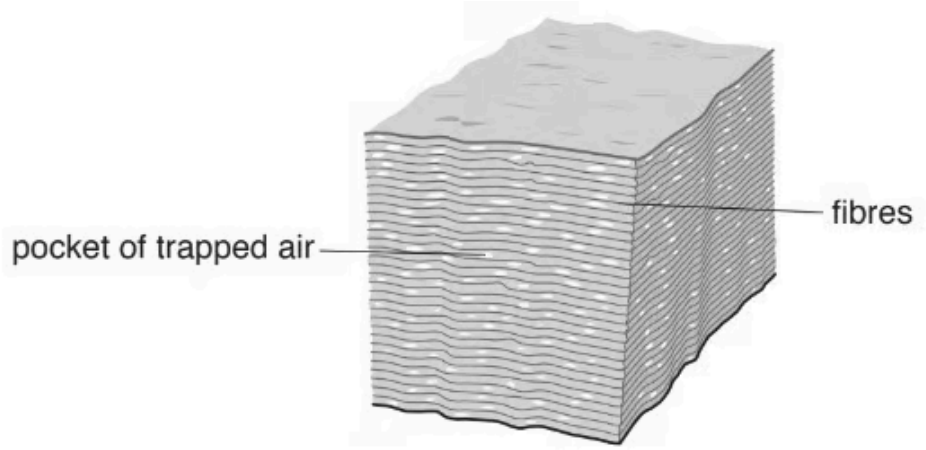

Fig. 6.2

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]

Question 2

Extended

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.

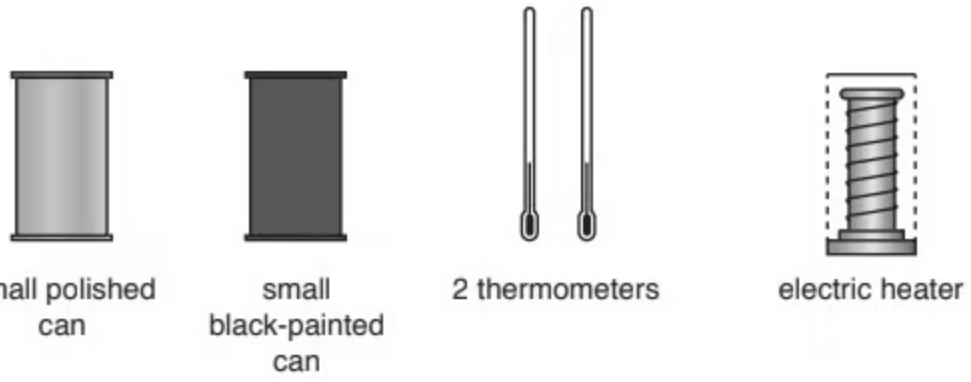

Fig. 5.1

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]

Question 3a

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

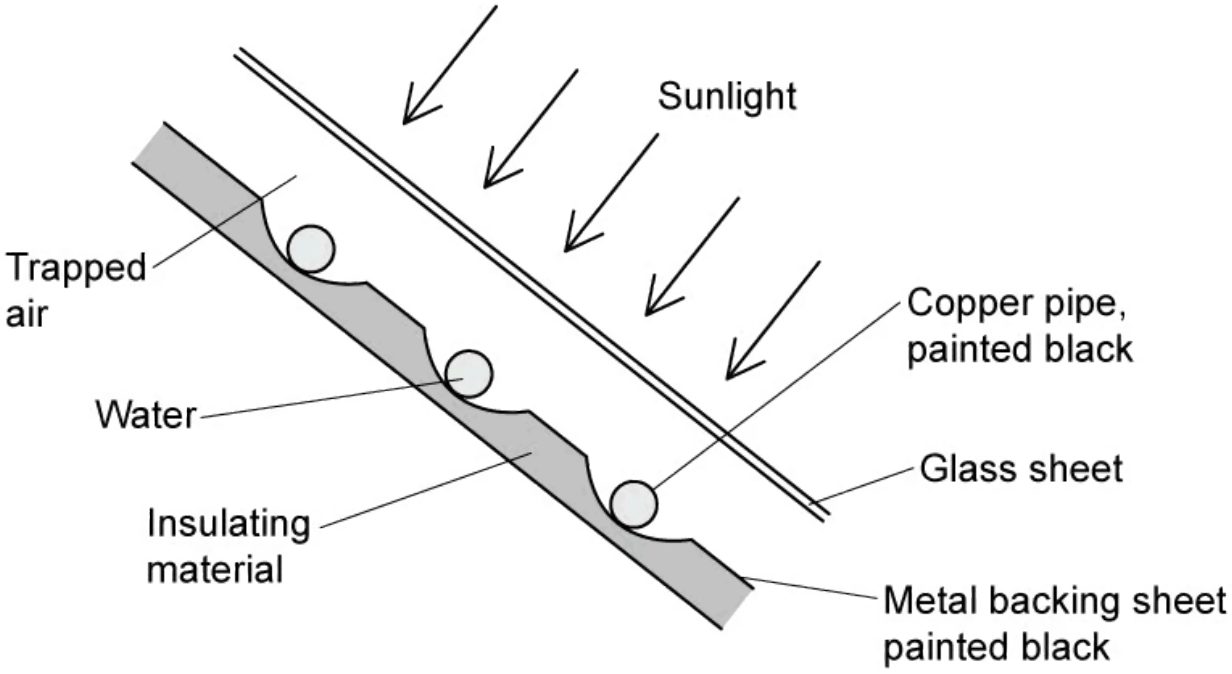

Fig. 1.1

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]

Question 3b

Extended

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]

Question 3c

Extended

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]

Question 3d

Extended

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]

Question 4a

Extended

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

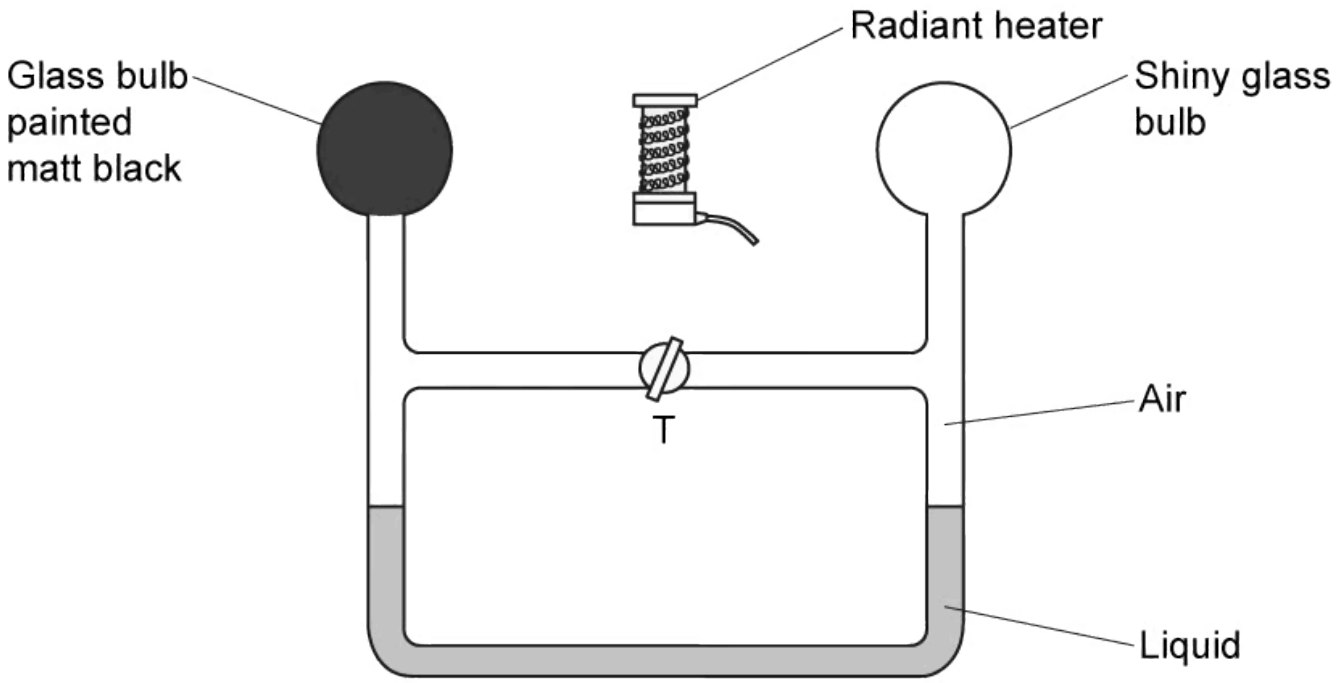

Fig. 1.1

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]

Question 4b

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]

Question 4c

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]

Question 4d

Extended

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.

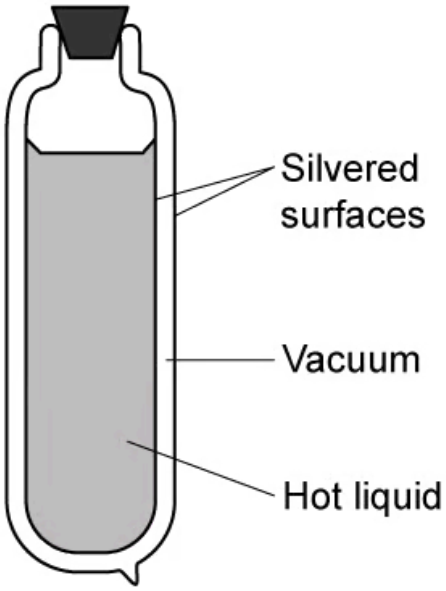

Fig. 1.2

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

[4 marks]

Question 5a

Extended

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]

Question 5b

Extended

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 that the Earth is.

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

[4 marks]

Question 5c

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.

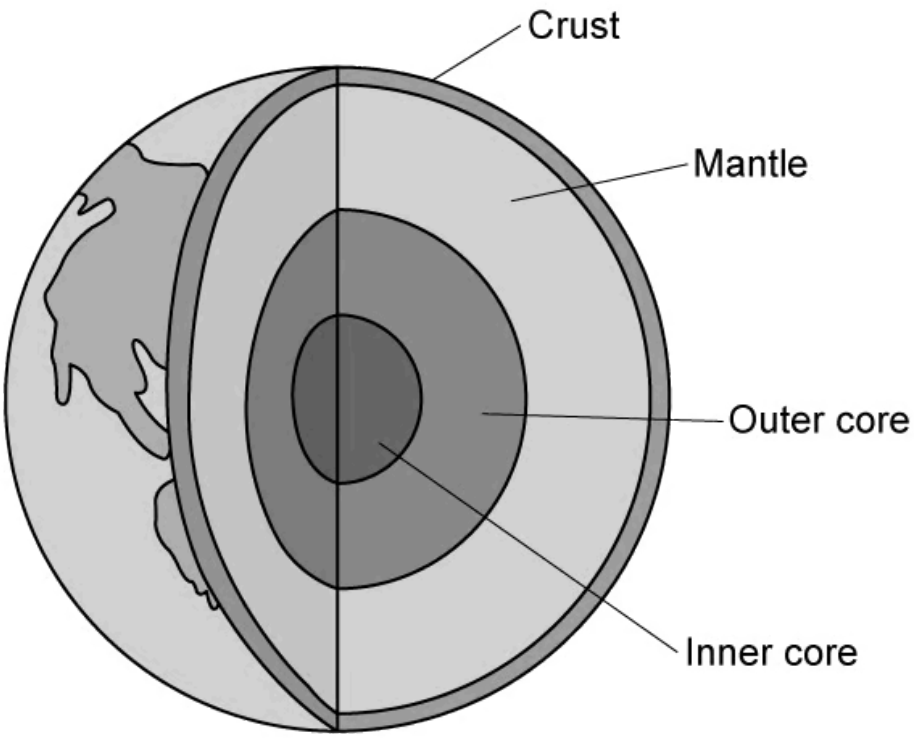

Fig. 1.2

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

[4 marks]

Question 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.

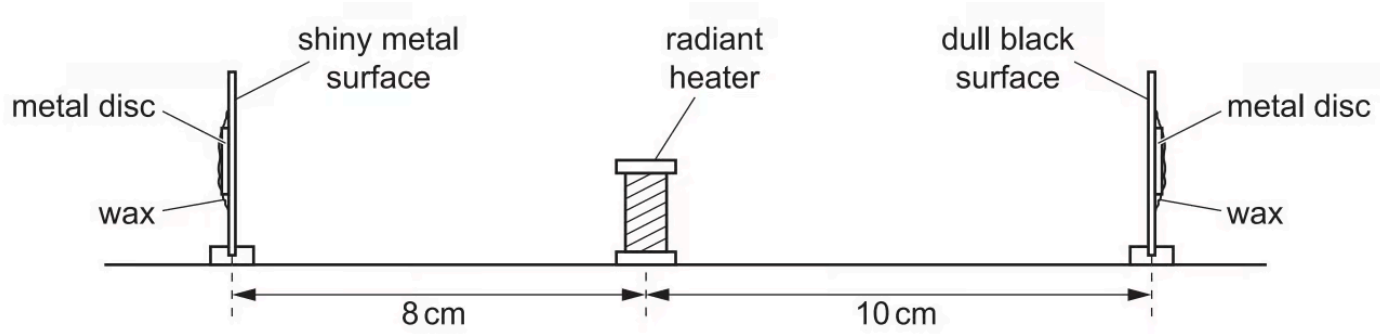

Fig. 6.2

(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]