

O Level Pure Physics Structured

Thermal Transfer Test 1.0

Q1

Electronics components are easily overheated and damaged. They are thus usually attached to heat sinks which will transfer thermal energy from the electronic components to the surroundings. Fig. 4.1 shows a heat sink attached to an electronic component in a computer.

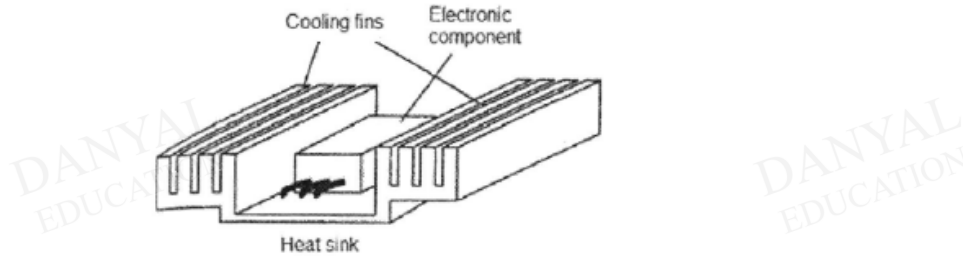


Fig. 4.1

(a) (i) Suggest a material for the heat sink and explain why.

.....
.....
..... [2]

(ii) Suggest a colour for the heat sink and explain why.

.....
.....
..... [2]

(b) Heat sinks are characterised by their *thermal resistances*. The heat sink shown in Fig. 4.1 has a thermal resistance of $2\text{ }^{\circ}\text{C}\text{W}^{-1}$. This means its temperature will rise by $2\text{ }^{\circ}\text{C}$ when the electronic component dissipates 1 J of thermal energy per second.

(i) Find the temperature rise of the heat sink when the electronic component dissipates a thermal power of 10 W .

temperature = [1]

(ii) The electronic component continues to dissipate heat. Suggest a reason why the temperature of the heat sink will be constant after some time.

.....
..... [1]

Q2

Fig. 3.1 shows a freezer for keeping food frozen.



Fig. 3.1

(a) The outside surface of the freezer is painted white.

Explain one advantage of having the outside surface of the freezer painted white.

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.....

.....[2]

Q3

Fig. 4.1 shows a solar heating system.

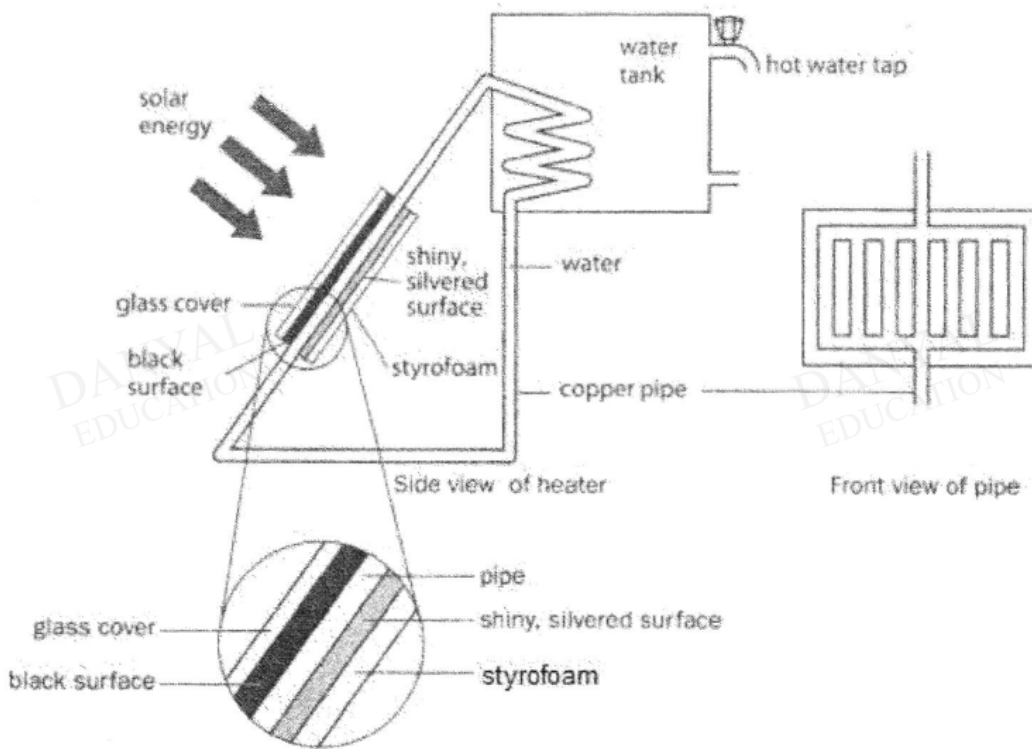


Fig. 4.1

(a) Explain how the sun causes the water in the tank to heat up.

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.....[4]

(b) Explain the purpose of the styrofoam.

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.....[1]

(c) Suggest one modification that can heat up the water at a greater rate and explain why.

.....
.....[2]

Q4

Induction cookers work on the principle of electromagnetic induction. Fig 9.1 shows an induction cooker which consists of a copper coil connected to an alternating current (a.c.) supply and a ceramic plate. When a pot made of soft magnetic material is placed on top of the cooker and the a.c. supply is turned on, electromagnetic induction leads to the pot being heated. The ceramic plate remains relatively cool.

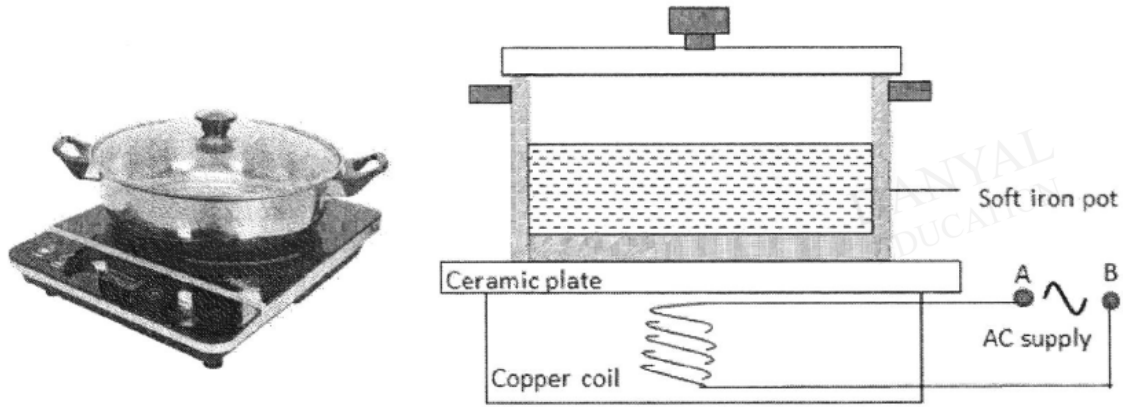


Fig. 9.1

Fig. 9.4 shows a gas stove used to heat up a pot.

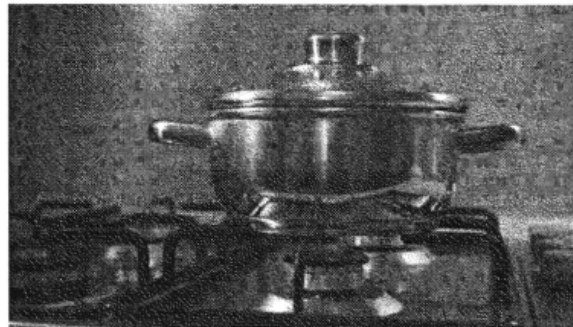


Fig. 9.4

Suggest why an induction cooker is more efficient than the gas stove using the same pot with the same energy input.

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.....[1]

Q5

In cold countries, people wear coats that are designed to reduce the rate at which thermal energy is lost from their bodies.
The material for some coats is made from a layer of thin strips of silver-coloured plastic between two layers of fabric, as shown in Fig. 5.1.

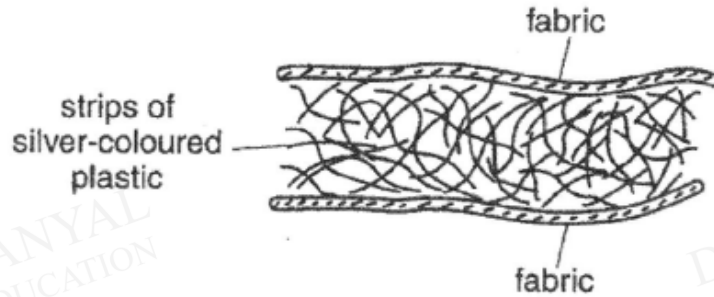


Fig. 5.1

The plastic strips trap small pockets of air between them.
Explain why the layer of silver-coloured plastic strips reduces loss of thermal energy by

(a) conduction,

.....
.....
.....
..... [2]

(b) convection,

.....
..... [1]

(c) radiation.

.....
..... [1]

Answers

Thermal Transfer Test 1.0

Q1

ai | Material: Any type of metal [A1]

	Explanation: Metals are better conductors of thermal energy than non-metals so it allows higher rate of heat transfer to be conducted from the component to the heat sink. [A1]
aii	Colour: Any dark colour [A1] Explanation: Dark colours are better emitters of radiation than light colours so it increases the rate of emission of thermal energy to the surroundings so that it can cool faster. [A1]
bi	Temperature rise = $(2)(10) = 20\text{ }^{\circ}\text{C}$ [A1]
bii	Rate of conduction of thermal energy from electronic component = rate of emission of thermal energy to surroundings. [A1]

Q2

poor absorber/ good reflector of (infra-red) radiation (not with poor emitter)	[1]
less thermal energy absorbed.	[1]

Q3

a	Pipes are heated up through radiation from sun. The pipes conduct heat to the water flowing in pipe. Water expands, becomes less dense and rises, flowing to the top of the water tank. Cool water at the tank (is denser) and sinks, flowing down the pipe to get heated, repeating the process/forming a convection current.	B1 B1 B1 B1
b	Poor conductor / good insulator of heat to reduce heat loss to surroundings	B1
c	Increase bends of pipes / use longer pipe to increase surface area / allow more time for water to heat up	B1 B1

Q4

For the same energy input, the gas stove loses more heat to the surroundings compared to the induction stove.

B1

Q5

(a)	<ul style="list-style-type: none">Fabric and plastic are good thermal insulators.Trapped air (between fabric) is a good thermal insulator.	[1] [1]
(b)	Trapped air prevents formation of convection currents	[1]
(c)	Silver-coloured plastic are good reflectors of radiant heat (reflects radiant heat back to the human body)	[1]

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