

TOPIC 9

Transfer of Thermal Energy

- 1 How may heat be transferred through a vacuum?
- A by convection only
 B by radiation only
 C by conduction only
 D by convection and radiation only
 E by conduction, convection and radiation

J90/I/18

- 2 If heat energy is removed from an object, its temperature will normally

- A fall.
 B fall then rise.
 C stay the same.
 D rise.
 E rise then fall.

N90/I/12

- 3 The air in a large paper bag is heated. The bag is then found to rise through the surrounding cold air. This is because

- A the air in the bag has become less dense.
 B the mass of the paper bag has decreased.
 C heat always rises.
 D the mass of air in the bag has increased.
 E the chemical composition of the air in the bag has changed.

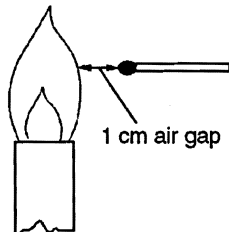
N90/I/17

- 4 Which of the following is the poorest conductor of heat energy?

- A air
 B brass
 C a vacuum
 D water
 E wool

J91/I/18

- 5 An unlit match is held near to an extremely hot bunsen flame.



The match does **not** get hot enough to light because

- A the flame is not hot enough
 B air is a bad conductor of heat.
 C the match head reflects radiation.
 D the flame does not radiate any heat sideways.
 E a match can only be lit by striking it on a rough surface.

N91/I/17

- 6 How is heat transferred through the walls of a steel radiator?

- A conduction only
 B convection only
 C radiation only
 D conduction and convection
 E convection and radiation

N91/I/18

- 7 In the process of convection, heat energy is transferred

- A by electromagnetic radiation.
 B because of temperature differences in a solid.
 C because of density differences in a fluid.
 D by the vibration of molecules about a mean position.
 E by the diffusion of molecules through a fluid.

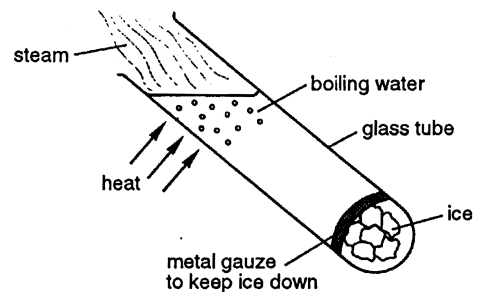
J92/I/16; J95/I/15

- 8 Which of the following will be the best absorber of infra-red radiation?

- A dark animal fur
 B shiny metal tray
 C white plastic bag
 D window glass
 E writing paper

J92/I/17

- 9 Boiling water and ice can exist at the same time in a test tube.



What does this experiment show?

- A Ice convects heat well.
 B Metal gauze conducts heat badly.
 C Water conducts heat well.
 D Water conducts heat badly.
 E Water convects heat badly.

N92/I/17

- 10 A solar heater uses energy from the Sun to heat water. The panels of the heater are painted black.

Why is this?

- A to improve absorption of infra-red radiation
 B to improve emission of infra-red radiation
 C to improve the conducting properties of the panel
 D to make the panels less noticeable
 E to reduce convection currents

J93/I/15

- 11 A copper plate is heated to 100 °C. It cools by emitting

- A electrons.
 B γ -radiation.
 C infra-red radiation.
 D ultraviolet radiation.
 E visible light.

J93/I/16 ; N96/I/16

- 12 A vacuum will prevent heat transfer by

- A conduction only.
 B convection only.
 C radiation only.
 D conduction and convection only.
 E conduction, convection and radiation.

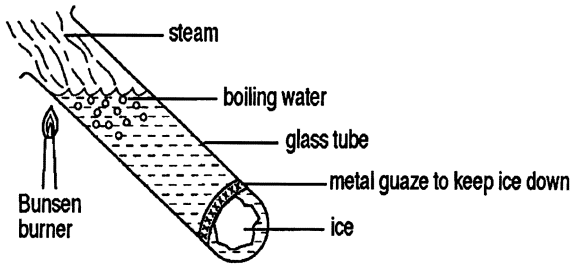
N93/I/16

- 13 Which types of surface are the best absorbers and the best emitters of infra-red radiation? ✓

	best absorber	best emitter
A	black and dull	black and dull
B	black and shiny	white and dull
C	white and dull	black and shiny
D	white and shiny	white and shiny

J94/I/17

- 14 An experiment is carried out as shown in the diagram.



Why does the ice take a long time to melt, even though the water at the top of the tube is boiling?

- A Water is a poor conductor of heat.
 B Convection cannot occur in water.
 C The gauze prevents the energy reaching the ice.
 D Ice is a poor conductor of heat.

J94/I/18; J00/I/16

- 15 By what processes does a beaker of hot water lose energy?

- A conduction, convection and evaporation only
 B conduction, convection and radiation only
 C conduction, convection, evaporation and radiation
 D evaporation and radiation only

N94/I/16

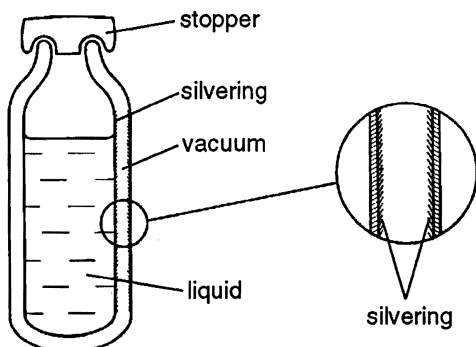
- 16 A black plastic bag is filled with cold water and hung up in a sunny place.

What causes the water temperature to rise?

- A convection inside the black bag
 B the black bag absorbing radiation
 C the black bag acting as an insulator
 D the black bag emitting radiation

N94/I/17

- 17 The diagram shows a vacuum flask and an enlarged view of a section through the flask wall.

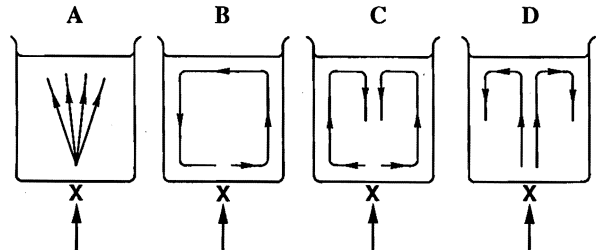


The main reason for the silvering is to reduce heat transfer by

- A conduction only.
 B radiation only.
 C conduction and convection.
 D convection and radiation.

J95/I/16

- 18 Water in a beaker is heated at X.



Which diagram best shows the convection currents?

N95/I/17

- 19 For infra-red radiation, shiny surfaces are

- A good absorbers and good emitters.
 B good absorbers but poor emitters.
 C poor absorbers but good emitters.
 D poor absorbers and poor emitters.

N95/I/18; J99/I/6

- 20 When metal hot-water pipes are used to heat air in a room, how is most of the energy transferred through the metal and through the air?

through metal *through air*

- A conduction convection
 B conduction radiation
 C convection convection
 D convection radiation

J96/I/17

- 21 When you stand in bare feet with one foot on a stone floor and the other on a carpet, the stone floor feels colder than the carpet.

The most likely explanation is that

- A air is unable to circulate through the carpet fibres.
 B more energy flows from the carpet to your foot than from the stone floor to your foot.
 C more energy flows from your foot to the stone floor than to the carpet.
 D the stone floor is at a lower temperature than the carpet.

J96/I/18

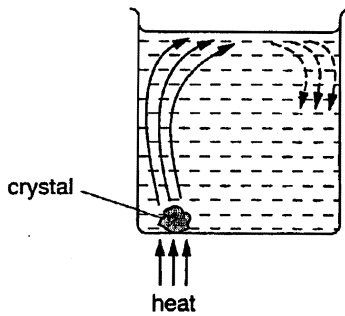
- 22 The hot water for a house can be produced by absorbing solar energy, using copper panels through which the water circulates.

What is the best finish for the top surface of the copper panels?

- A clear plastic C highly polished
 B dull black paint D white paint

N96/I/17

- 23 The diagram shows a crystal being heated in a beaker of water. The crystal releases a dye which shows how the water circulates around the beaker.



What is happening to cause the water above the crystal to rise?

- A The water contracts and its density decreases.
- B The water contracts and its density increases.
- C The water expands and its density decreases.
- D The water expands and its density increases.

J97/I/15

- 24 The tubes inside solar heating panels allow the Sun's radiation to warm water.

Why are these tubes blackened?

- A Dark surfaces absorb radiation well.
- B Dark surfaces conduct heat well.
- C Dark surfaces emit radiation well.
- D Dark surfaces reflect radiation well.

J97/I/16

- 25 The rate at which thermal (heat) energy is conducted through a substance depends on its state.

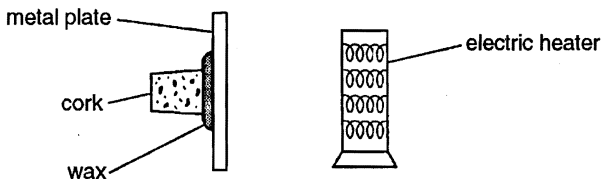
What is the order of conduction?

best \longrightarrow worst

- A gas liquid solid
- B liquid gas solid
- C solid gas liquid
- D solid liquid gas

N97/I/17

- 26 A small cork is fixed with wax to a metal plate. An electric heater is placed close to the plate. After a time, the wax melts and the cork drops off.

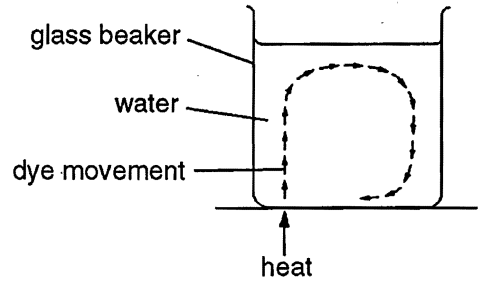


How does heat reach the wax?

- A by conduction only
- B by conduction and convection
- C radiation and conduction
- D radiation and convection

N97/I/18

- 27 The diagram shows an experiment that demonstrates convection taking place in water.

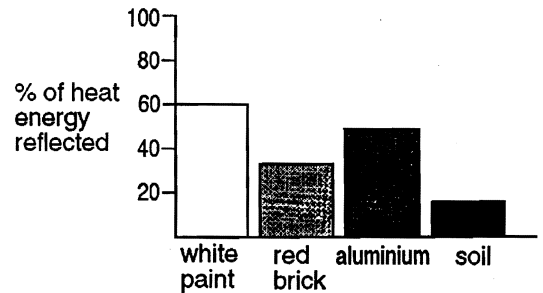


Why does the hot water rise?

- A Heat always rises.
- B The density of the water is reduced.
- C The density of the water is increased.
- D Water is a bad conductor of heat.

J98/I/15

- 28 The chart shows the percentage of heat energy reflected by different materials.

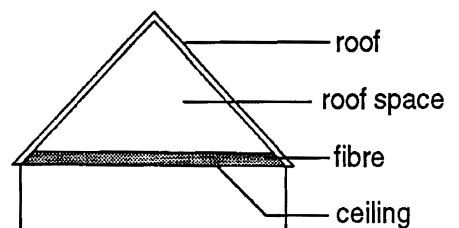


What is the best way to help keep a house cool in a hot climate?

- A cover the roof with a layer of aluminium
- B cover the roof with a layer of red brick
- C cover the roof with a layer of soil
- D cover the roof with a layer of white paint

J98/I/16

- 29 Fibre is used for home insulation as shown.



How does fibre prevent heat passing easily through the ceiling?

- A Fibre allows air to pass through easily.
- B Fibre is tightly packed.
- C Fibre is warm.
- D Fibre traps air.

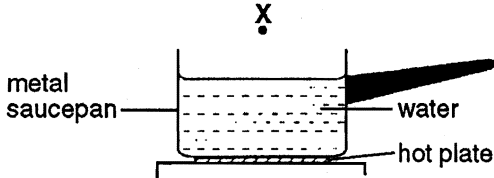
N98/I/16

30 Which material is the best absorber of infra-red radiation?

- A dark animal fur
- B shiny metal
- C window glass
- D white paper

N99/I/15

31 The diagram shows a metal saucepan containing water and placed on a hot plate. After some time, the air at point X also becomes hot.



What are the main ways by which heat travels from the hot plate through the base of the metal saucepan, through the water and through the air to point X?

	through the base of the saucepan	through the water	through the air
A	conduction	convection	convection
B	conduction	radiation	convection
C	convection	convection	conduction
D	radiation	convection	conduction

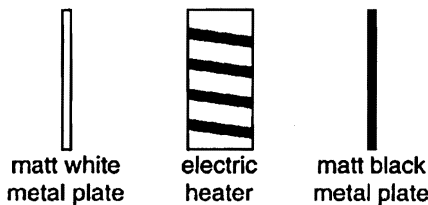
N99/I/16

32 Density changes are responsible for which methods of thermal energy transfer?

- A conduction only
- B convection only
- C radiation only
- D conduction, convection and radiation

N2000/I/14

33 Two identical metal plates are painted, one matt white and the other matt black. These are placed at equal distances from a radiant heater as shown. The heater is turned on for five minutes.



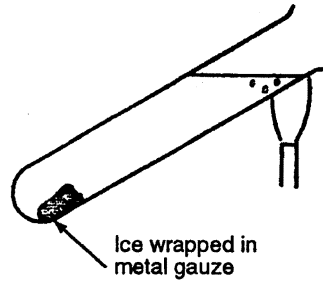
Which metal plate absorbs more energy and which plate emits more energy in this time?

	absorbs more	emits more
A	black	black
B	black	white
C	white	black
D	white	white

N2000/I/15

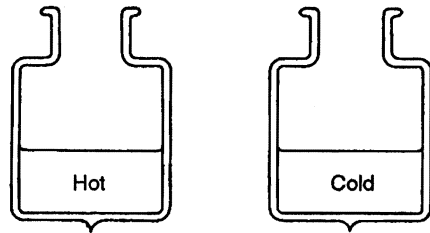
34 Water in a test-tube can be heated near the top until it boils without melting a piece of ice held at the bottom by wrapping it in metal gauze, as shown in the diagram.

Suggest reasons why this is possible.



N79/I/7

35 The diagrams show the inner vessels of two vacuum flasks, one containing a liquid whose temperature is well above room temperature, and the other containing a liquid whose temperature is well below room temperature.

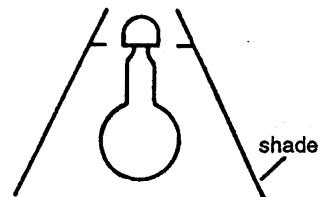


(a) In the case of the hot liquid draw in the likely path of a convection current in the air in the flask. Mark the direction of this current with arrows.

(b) Explain why placing a stopper in the vacuum flask containing the cold liquid would do little to help keep the liquid cold.

J80/I/6

36 The diagram shows the metal shade and bulb of an electric reading lamp.



Draw on the diagram arrows to indicate the convection currents in the air inside the shade when the lamp is in use.

State the processes by which heat is transferred from the bulb filament to the shade.

Why does the shade eventually reach a steady temperature?

N81/I/5

37 On a sunny day, the surface of the sea is much slower to warm up than the surface of the land. Suggest an explanation.

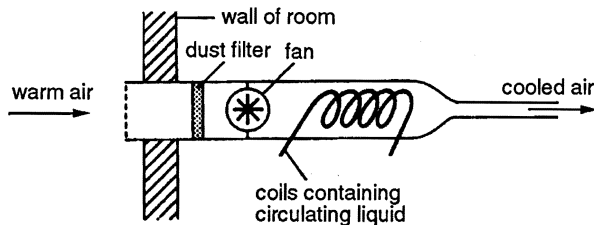
How can you account for the fact that a breeze blowing from the sea on to the land may develop during a sunny day which is otherwise calm?

J82/I/8

38 In an air-conditioning unit, air is cooled by being blown past coils in which a liquid is continuously evaporated, as illustrated in the diagram.

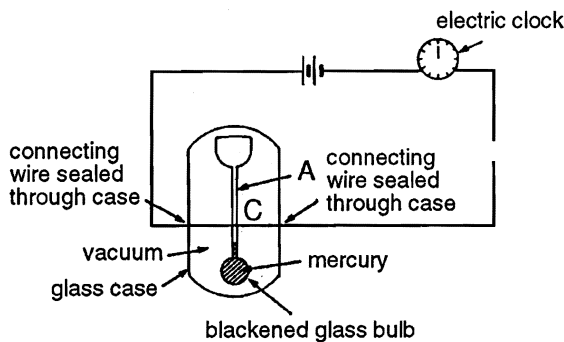
- (a) Why does evaporation of the liquid cause the air flowing past the coils to be cooled?
 (b) What effect will increasing the surface area of the coils have on the cooling achieved?

Give a reason for your answer.

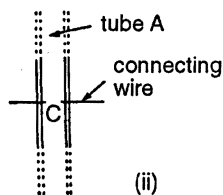


- (c) The rate at which the liquid is evaporating is increased. State and explain the effect of this change on the fall in temperature of the air.
 (d) At a constant rate of evaporation of the liquid, the fall in temperature of the air is found to depend on the rate at which the air flows past the coils. Why is this?
 (e) Why should the unit be placed high up in the room it is to cool? N82/II/2

39 Diagram (i) illustrates an instrument used to measure the time that the Sun shines during a day. The blackened glass bulb contains mercury and is supported inside an evacuated glass case. Diagram (ii) shows how the connecting wires are arranged inside tube A.



(i)



(ii)

- (a) How does heat from the Sun reach the mercury? Give a reason for your answer.
 (b) Explain why the clock starts when the Sun shines.

- (c) Why is tube A made to be of small cross-sectional area?
 (d) Explain why blackening the bulb ensures that the mercury level falls rapidly when the Sun ceases to shine. J83/II/2

40 Indicate, with a reason, whether you would expect it would take less time to bring water in a saucepan to the boil if the outside curved surface of the saucepan were polished chrome rather than dull black. N83/II/6

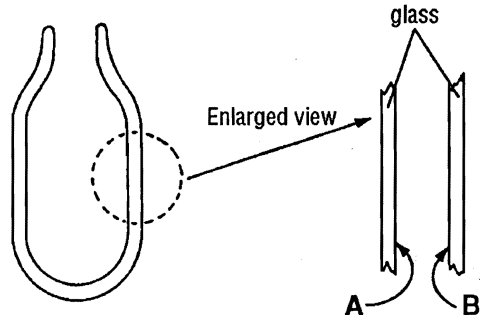
41 On a clear calm night, the temperature of the surface of the sea fell less rapidly than the temperature of the nearby land. Explain this observation.

Hence explain with the aid of a diagram how a breeze blowing from the land to the sea may be set during a clear calm night. N84/II/4

42 A tall "deep freeze" unit has the freezing compartment at the top. What advantage is there in placing the freezing compartment in this position?

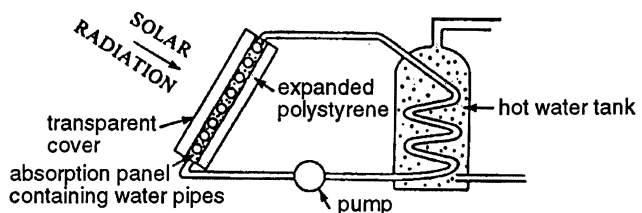
When the door of such a unit is opened for a short time, the cold air inside is replaced by warmer air. Why does this exchange of air have little effect on the temperature of the contents of the unit? N84/II/7

43 The diagram shows a vacuum flask used for keeping cold liquids cool. The glass surfaces A and B are silvered. Explain the purpose of this silvering.



What is the purpose of evacuating the air from between the glass surfaces? N85/II/5

44 The diagram illustrates the structure of a solar heating system.



- (a) State the energy change which occurs in this system.
 (b) What is the advantage of having a black absorption panel?

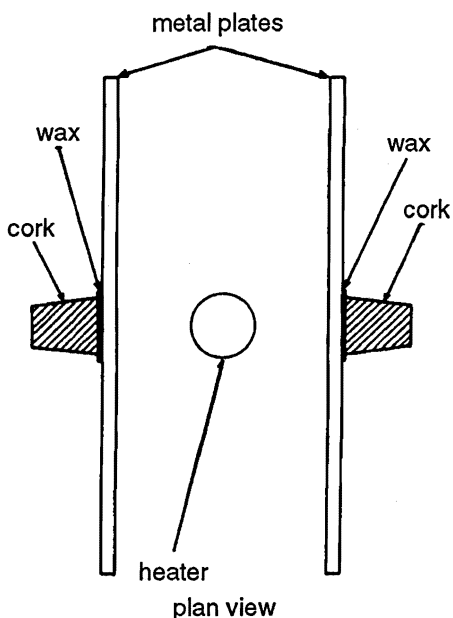
- (c) What is the purpose of the polystyrene backing board?
- (d) On a summer day the average energy falling on 1 m^2 of such a panel in one second in Britain is 200 J . If radiation is incident at this rate on a panel of area 5 m^2 and 30% of the energy is absorbed by the water, calculate the energy absorbed by the water in 8 hours.
- *(e) Calculate the cost of using an electrical immersion heater to provide this amount of energy at a cost of 5p per kWh. J86/11/6

45 A saucepan with a thick copper base contains water and is placed on a flat electric hot plate.

- (a) State the process by which energy is
- transferred from the hot plate to the water,
 - spread through the water.
- (b) State one reason why the water would reach boiling point more rapidly with a lid on the pan.
- (c) The sides of saucepans are often polished. How does this reduce heat loss? N86/11/7

46 State the three ways in which heat may be transferred.

The diagram shows two metal plates placed vertically at equal distances from an electric heater. The plates are identical except for the surfaces facing the heater. Identical corks are attached by thin equal layers of wax to the surfaces of the plates facing away from the heater as shown.



After the heater has been switched on for a few minutes, the wax holding one cork melts and the cork falls to the bench; the wax on the other plate does not melt.

Suggest a possible explanation of this occurrence. N87/11/5

47 In an attempt to make use of waste heat, the water supply to the steam generator in a factory is pumped through a heat exchanger inside the factory chimney before it enters the steam generator.

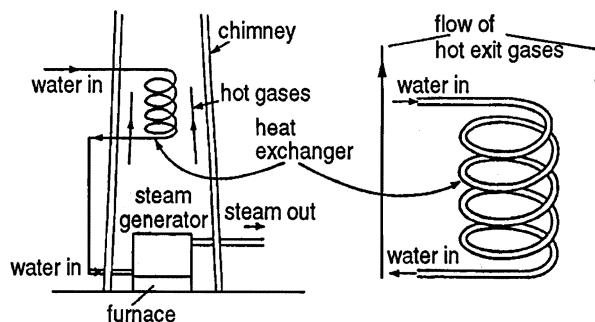
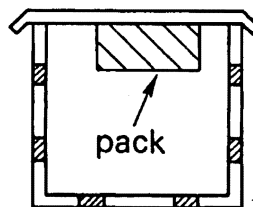


Fig. 1

As indicated, the heat exchanger consists of a coiled metal tube arranged so that the rising hot exit gases flow around the coiled tube.

- (a) What property of metals makes them suitable for use as the material of the tube in the heat exchanger? Indicate how the property makes the exchanger more effective. [2]
- (b) By what process do the hot gases rise up the chimney? Explain why this process occurs. [2]
- J88/11/5

48 A pack which contains a frozen liquid is placed in a holder under the lid of a box as shown in the diagram. The box is then used to keep food cold.



- (a) Suggest why the frozen pack is placed at the top of the box rather than at the bottom. [2]
- (b) Why does the food keep cold longer if the walls are made
- of rigid plastic rather than of metal.
 - with a double skin? [2]
- N88/11/7

- 49 (a) (i) Describe how water, initially at room temperature, could be used to demonstrate the expansion which takes place when water is heated.
- (ii) Describe another experiment, also using water initially at room temperature, to demonstrate convection currents in water.
- (iii) Explain how the expansion of water leads to convection currents in the water. [12]

- (b) A piece of paper is pinned along its top edge to a notice board situated directly above a desk lamp as shown in Fig. 2.1.

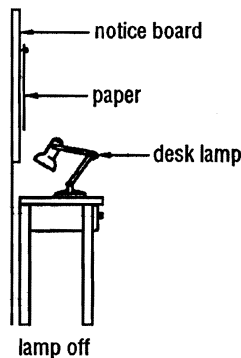


Fig. 2.1



Fig. 2.2

When the lamp is switched on, it is observed that the paper rises to the position shown in Fig. 2.2 and remains almost stationary, falling back to the board only when the lamp is switched off. Explain these observations. [3]

- (c) Describe how you could produce a downwards convection current in air. [2]

J89/II/7

- 50 State briefly how energy is transferred in the processes of (a) conduction, (b) convection, and (c) radiation. [6]

J90/II/3

- 51 A bunsen burner is used to heat a beaker full of water.

- (a) Explain how energy is transferred through the bottom of the beaker. [2]
 (b) Explain how energy is transferred through the water. [3]
 (c) A student's hand, several centimetres to one side of the bunsen burner, starts to feel hot. Name the process by which energy is transferred from the burner to the student's hand. [1]

N92/II/2

- 52 Figure 3 shows a filament lamp standing upright in air.

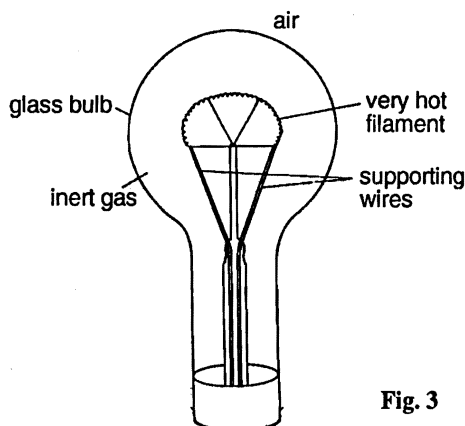


Fig. 3

The connections to the lamp are not shown.

- (a) On Fig. 3 draw arrows to represent radiation from the filament. [1]
 (b) State two places where thermal conduction takes place. [2]
 (c) Describe briefly two convection currents which are set up. [3]

J93/II/4

- 53 (a) Fig. 4 shows a tall cylinder filled with water. The bottom of the cylinder rests on a block of ice.

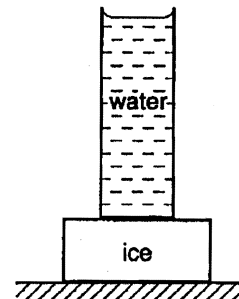


Fig. 4

Explain, with reasons, whether the temperature of the water in the cylinder is higher at the top, constant all the way up or higher at the bottom. Assume that the cylinder has been in place for a long time, that room temperature is steady at about 30 °C and that there are no draughts. [3]

- * (b) The mercury in a school thermometer has a mass of 8.0 g; the glass of the thermometer has a mass of 20.0 g. The specific heat capacity of mercury is 140 J/(kg K) and that of the glass is 670 J/(kg K). Calculate the energy required to raise the temperature of the whole thermometer from 20 °C to 100 °C. [5]

- (d) A mercury-in-glass thermometer is used to determine the temperature of a hot environment. Explain, in terms of changes involving the atoms and molecules of the glass in the bulb of the thermometer, how energy is transferred from a hot environment to the cooler mercury. [3]

J96/II/11(a, b, d)

- 54 Fig. 5 shows a solar panel used to heat water.

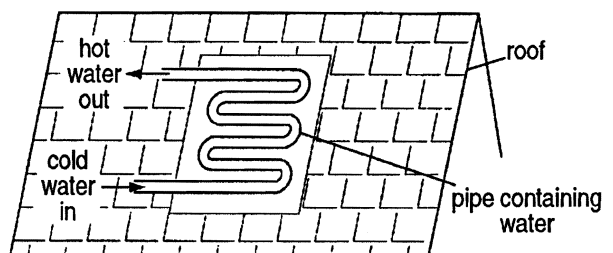


Fig. 5

- (a) State the name of the process by which energy is transferred
- (i) from the Sun to the outside of the pipe in the solar panel,
 - (ii) from the outside of the pipe to the water inside it.
- [2]
- (b) State which of the following materials would be the most suitable for the pipe that contains the water.
 black plastic; white plastic; glass; black-painted copper; polished steel.
- Give two reasons for your choice of material. [3]
- N98/II/4

ANSWERS

- | | | | | |
|---------|------------------------------|----------------------|------------|-------|
| 1. B | 2. A | 3. A | 4. C | 5. B |
| 6. A | 7. C | 8. A | 9. D | 10. A |
| 11. C | 12. D | 13. A | 14. A | 15. C |
| 16. B | 17. B | 18. D | 19. D | 20. A |
| 21. C | 22. B | 23. C | 24. A | 25. D |
| 26. C | 27. B | 28. D | 29. D | 30. A |
| 31. A | 32. B | 33. A | | |
| 44. (d) | $8.64 \times 10^6 \text{ J}$ | (e) | 12 p | |
| 51. (c) | Radiation | | | |
| 53. (b) | 1160 J | | | |
| 54. (a) | (i) Radiation | (ii) | Conduction | |
| | (b) | Black painted copper | | |