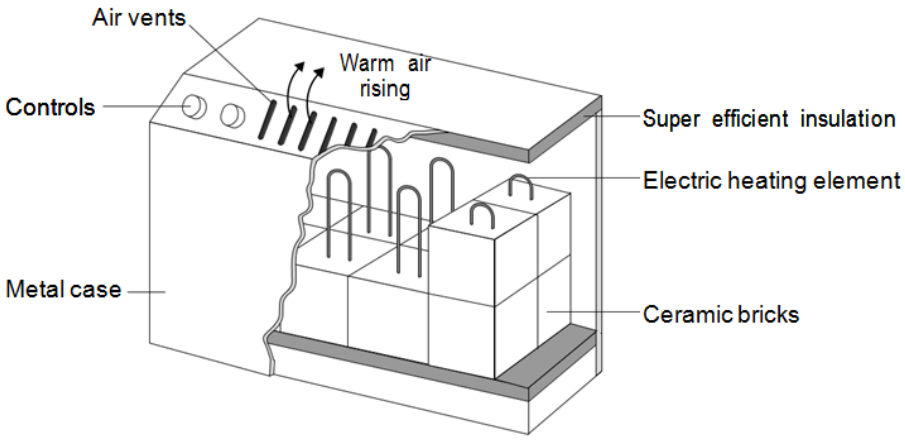
Conduction and Convection 2

Q:1 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) (i) Complete the following sentences using words from the box.

conduction	convection	evaporation

Energy is transferred through the metal casing by _____

The warm air rising from the heater transfers energy to the room by _____

(2 marks)

(a) (ii) The inside of the metal case is insulated.Which one of the following gives the reason why?

Tick (☐) one box.

To transfer energy from the ceramic bricks to the room faster ☐

To stop energy from the room transferring into the heater ☐

To keep the ceramic bricks hot for a longer time ☐

(1 mark)

(b) In winter, the electricity supply to a 2.6 kW storage heater is switched on for seven hours each day.

b) (i) Calculate the energy transferred, in kilowatt-hours, from the electricity supply to the heater in seven hours.Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

Energy transferred = _____ kWh

(2 marks)

(c) Between 7 am and 8 am, after the electricity supply is switched off, the temperature of the ceramic bricks falls by 25 °C.

Calculate the energy transferred from the ceramic bricks between 7 am and 8 am.

Total mass of ceramic bricks = 120 kg.

Specific heat capacity of the ceramic bricks = 750 J/kg °C.

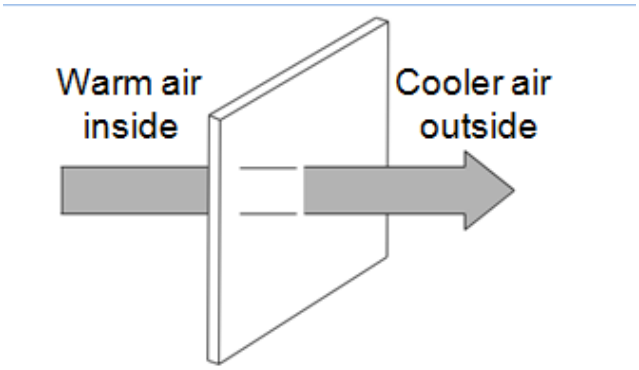
Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

Energy transferred = _____ J

(2 marks)

Q:2 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 mark)

(a) (ii) Explain how heat is transferred through the glass.

_____

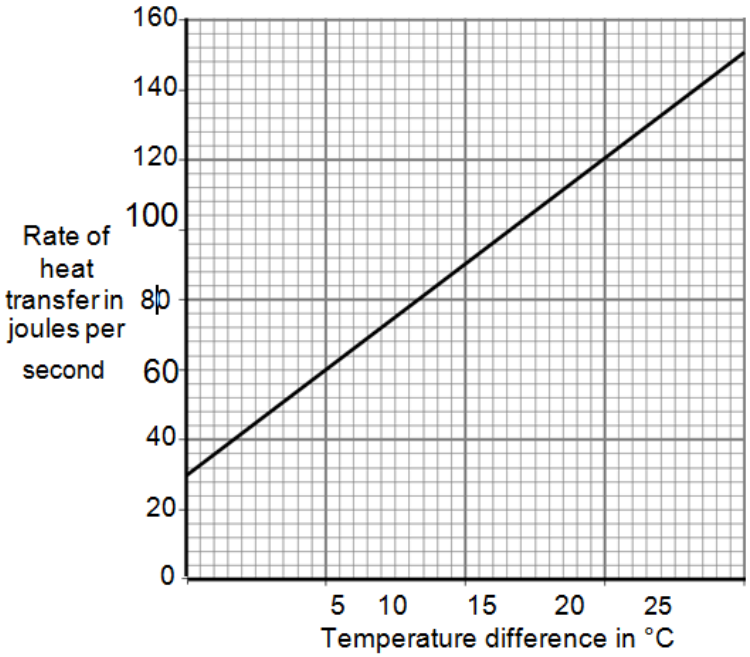
_____

_____

(2 marks)

(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 m2 single-glazed window for a range of temperature differences.



(b) (i) What is the range of temperature differences shown in the graph?

From _____ to _____

(1 mark)

(b) (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.

_____

_____

(2 marks)

(b) (iii) A house has single-glazed windows. The total area of the windows in the house is 15 m2.

On one particular day, the difference between the inside and outside temperatures is 20 oC.

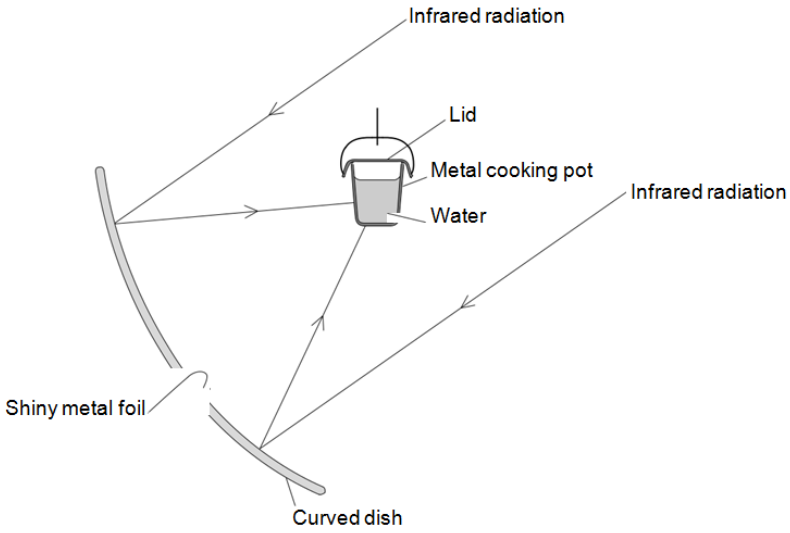
Use the graph to calculate the total rate of heat transfer through all of the windows on this particular day.

Show clearly how you work out your answer.

Rate of heat transfer = _____ J/s

(2 marks)

Q:3 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 mark)

(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 marks)

(c) Why does the cooking pot have a lid?

_____

_____

(1 mark)

(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.

Use the correct equation from the Physics Equations Sheet.

_____

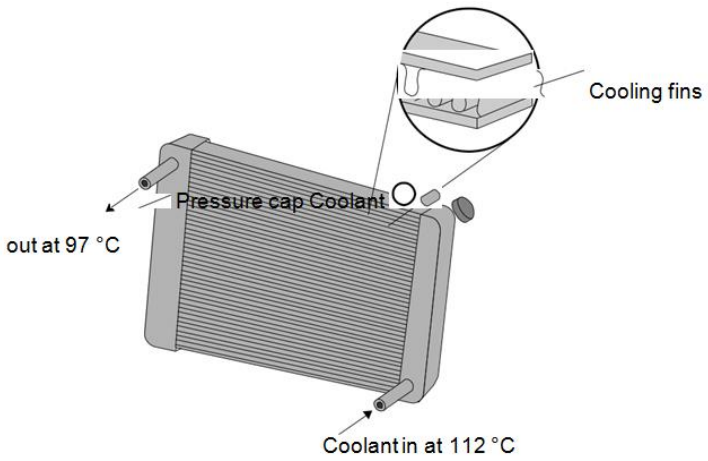
_____

_____

Energy = _____ J

(2 marks)

Q:4 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?

._____

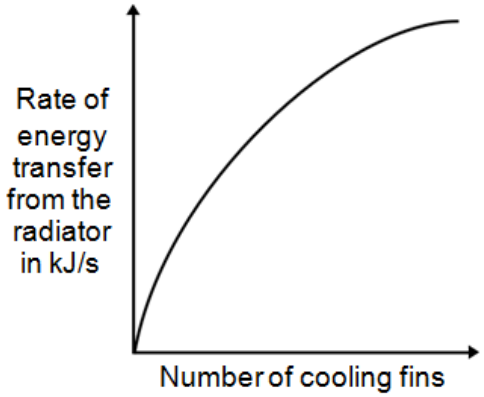
_____

_____

(2 marks)

(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.

_____

_____

_____

_____

(2 marks)

(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.

Use the correct equation from the Physics Equations Sheet.

Energy transferred each second = _____ J

(3 marks)

(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

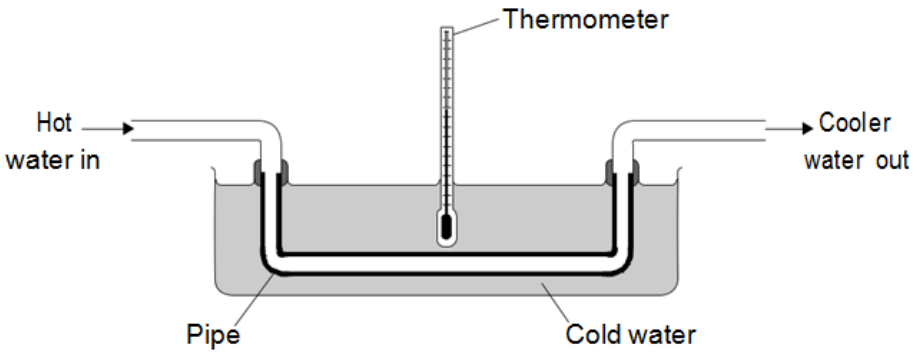
Give a reason for your answer.

(2 marks)

Q:5 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 mark)

(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

(b) (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 mark)

(b) (ii) Which one of the three materials made the best heat exchanger?

_____

Give a reason for your answer.

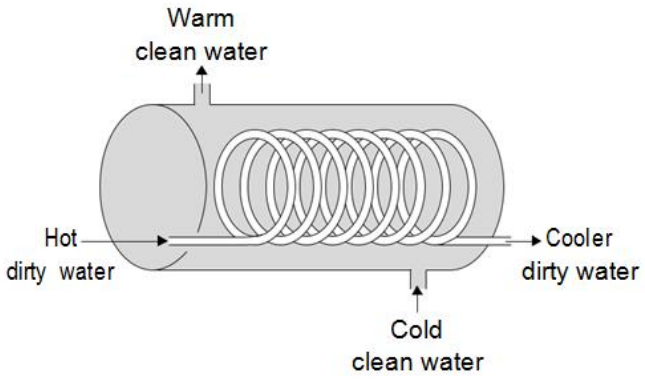
_____

_____

(2 marks)

(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.

_____

_____

_____

(2 marks)

TOTAL MARKS=35