GCSE PHYSICS **HEAT TRANSFER**

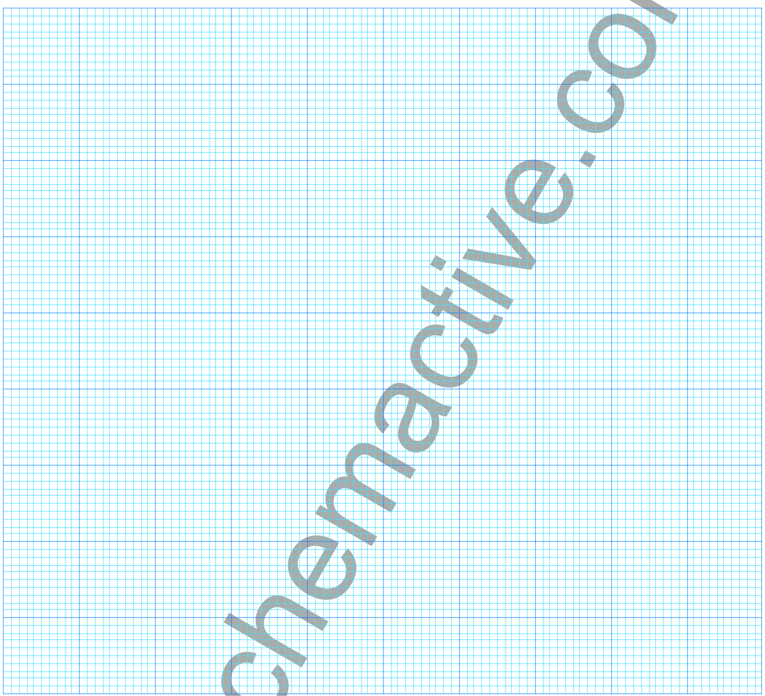
High Demand Questions QUESTIONSHEET 1

The specific heat capacity of a material is defined as the energy needed to raise the temperature of 1 kg of the material by 1^{o}C.

material	iron	aluminium	copper	lead	concrete
specific heat capacity (J/kg/^{o}C)	390	900	490	130	850

The table shows a range of materials and their specific heat capacities.
Hassan wants to design a container in which he can heat water. He has containers made out of the materials shown in the table.

(a)(i) Draw a bar graph to display the specific heat capacities for these materials.



[2]

(ii) If each container has a mass of 1 kg, which material would need the least energy to heat it through 1^{o}C?

.... [1]

(iii) Hassan decides not to choose a container made out of this material.
Why not?

.... [1]

(*Continued…*)

QUESTIONSHEET 1 CONTINUED

(b) (i) A copper container of mass 500g is used to heat water. Using the equation:

Energy supplied = mass × specific heat capacity × rise in temperature
(J) (kg) (J/kg/^{o}C) (^{o}C)

calculate the amount of energy needed to raise its temperature from 20^{o}C to 100^{o}C.

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.... [2]

(ii) Calculate the amount of energy saved by using the copper container rather than an aluminium container of mass 500g.

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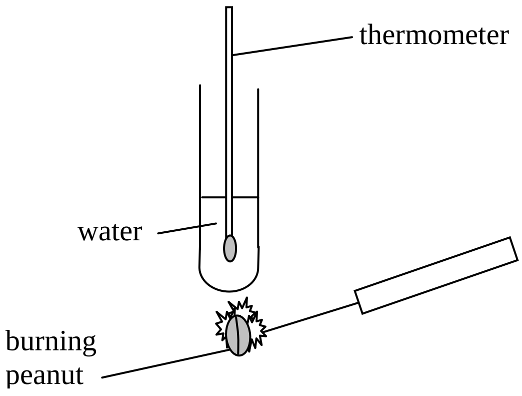
.... [3]

TOTAL / 9

Debbie and Asha are using a burning peanut to heat water in a boiling tube.



(a) What can they find out about the peanut by doing this experiment?

.... [1]

(b) (i) The equation:

Energy supplied = mass x specific heat capacity x temperature rise
(J) (kg) (J/kg/^{o}C) (^{o}C)

can be used to calculate the energy supplied to the water in the boiling tube.

The temperature of the water rose from 20^{o}C to 70^{o}C. If there were 20g of water in the tube, and the specific heat capacity of water is 4200 J/kg/^{o}C, calculate the energy supplied to the water.

(ii) The amount of energy stored in a peanut is much greater than this. Give two reasons why all the energy from the peanut did not go into heating the water.

....

.... [2]

(c) At the end of the experiment, the outside of the tube was covered in a black deposit.

(i) What was this?

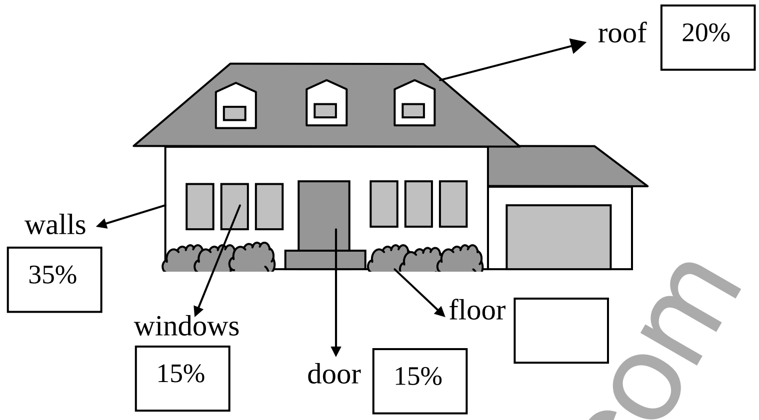
.... [1]

(ii) Where had it come from?

.... [1]

TOTAL / 7

The diagram shows a house without any insulation. The percentage of the energy lost from different parts of the house during the year is shown.



(a) The total cost of the energy lost during the year is £1000. This represents 35% of the total heating bill for the house.

(i) Calculate the cost of heating the house for one year.

....

.... [2]

(ii) Calculate the cost of the energy wasted through the floor.

....

.... [2]

(iii) Suggest one way of reducing the amount of heat energy escaping through the door other than draught proofing.

.... [1]

(b) The table shows some types of methods used to conserve energy, their installation costs and the amount of money that this method would save in a year. Assume each method reduces heat loss by 80%

Place of installation	**Method of insulation**	**Purchase cost (£)**	**Cost of energy wasted per year (£)**	**Cost of energy saved per year (£)**
Roof	Rock-wool or Fibre-glass in loft	250	200	
Walls	Cavity wall filling	1000	350	
Windows	Double glazing	3500	150	120
Doors	Draught-proofing	5	150	

(i) Complete the table by calculating the cost of the energy saved in one year for each method of insulation (The double-glazing has been done for you).

[3]

(Continued...)

QUESTIONSHEET 3 CONTINUED

(ii) Calculate the length of time needed to payback the initial purchase cost of Double-glazing. (Assume the cost of the energy does not change).

....

.... [1]

(iii) Which type of insulation would you install first? Explain why.

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.... [3]

TOTAL / 12

(a) Architects calculate heat loss from houses using a factor called the U-value.
They use the following formula:

Heat loss per second (W) = area (m^2) x temperature difference (^oC) x U-value

What are the units of the U-value?

.... [1]

(b) Below are some U-values for different parts of the house.

Part of house	**U-value**
Single-glazed window	5.5
Double-glazed window	3.0
Roof	2.0
Insulated roof	0.5
Cavity wall	1.5
Insulated cavity wall	0.5

An insulated roof measures 10 m by 8 m. The temperature inside is 20^oC and outside is 2^oC.
Calculate the heat loss per second through the roof.

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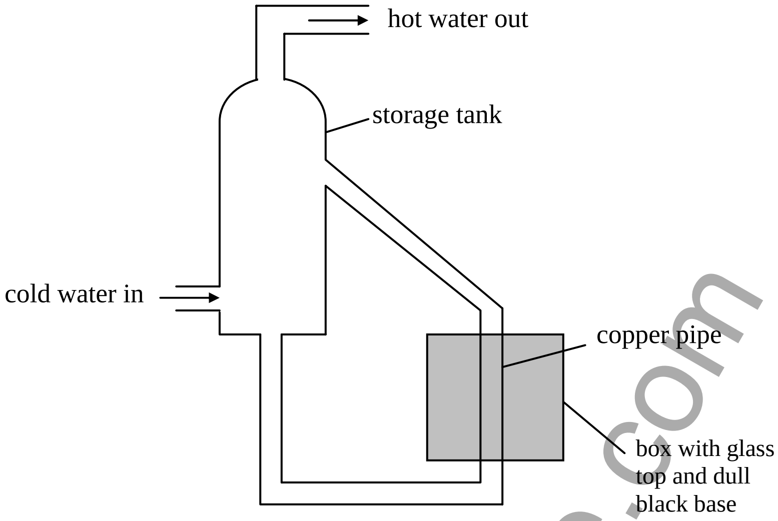
.... [3]

TOTAL / 4

Some people have solar panels to heat their water mounted on their roofs.
The diagram below shows the set up of a solar panel



(a) Explain why the surface is a dull black.

....

.... [2]

(b) Why is it covered with glass?

.... [1]

(c) (i) Why are the pipes arranged in a zig-zag pattern?

....

.... [2]

(ii) Why should the pipe linking the solar panel to the hot water tank be as short as possible?

.... [1]

(d) (i) What makes the water move through the pipes?

.... [1]

(ii) Why is the storage tank usually fitted higher than the panel?

.... [1]

(e) The house would normally have an alternative method of heating the water. Explain why.

.... [1]

TOTAL / 9

(a) Explain why birds fluff up their feathers in cold weather.

....

.... [2]

(b) Tramps will often wrap themselves in newspaper at night.
Why does this help them to keep warm?

.... [1]

(c) Design an experiment or series of experiments to compare the insulating properties of feathers and of newspaper. Mention the controls you would use to ensure that the experiments were fair.

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.... [8]

TOTAL / 11

The energy needed to change the temperature of a substance depends on the mass of the substance, the temperature and the specific heat capacity of the substance.

(a) Calculate the amount of energy needed to change the temperature of:

(i) 500 g of water by 5°C (specific heat capacity of water is 4200 J/kg °C)

....

....

.... [3]

(ii) 100 g of aluminium from 10°C to 30°C (specific heat capacity of aluminium is 880 J/kg °C)

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.... [3]

(b) A 4 kg lump of iron is given 20 kJ of energy. It rises in temperature by 10°C.
Calculate the specific heat capacity of iron.

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.... [3]

(c) At the seaside on a hot day, the sand feels warm, but the sea is cold. Explain this.

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.... [2]

TOTAL / 11

High Demand Questions QUESTIONSHEET 8

(a) A kettle has a power rating of 3 kW. 1.5 kg of water at 5°C are put in the kettle.

Assuming no heat is lost:

(i) how much energy is needed to boil the kettle?

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.... [3]

(ii) how long will the kettle take to boil?

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.... [3]

(the specific heat capacity for water is 4200 J/kg ^{0}C)

(b) How long would the kettle take to boil if 2 kg of ice at 0°C was put in it?
(latent heat of fusion of ice is 334 000 J/kg)

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.... [4]

TOTAL / 10

Medium Demand Questions QUESTIONSHEET 9

(a) All metals expand when they are heated, but by differing amounts.
Aluminium expands more than copper, which expands more than iron.

Draw labelled diagrams to show what you would expect to see when the following bimetal strips are heated to 300 ^{o}C:

(i) Copper and iron

[2]

(ii) copper and aluminium

[2]

(b)(i) Explain how bimetallic strips can be used to make a thermostat.

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.... [4]

TOTAL / 8

Medium Demand Questions QUESTIONSHEET 10

(a) Explain how the following methods of insulating a house help to reduce heat loss.

(i) double glazing.

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.... [2]

(ii) lining the loft with fibre glass.

....

.... [2]

(iii) the use of thick carpets.

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.... [2]

(b) Air is a very poor conductor of heat. Why is air replaced by foam in cavity wall insulation?

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.... [2]

(c) Explain why a string vest keeps a person warm, even though it is only a collection of holes.

....

.... [2]

TOTAL / 10

(a) The linear expansivity of a substance is the amount by which one metre length will increase for every one degree Celsius rise in temperature. Engineers can use this to work out how much their materials will expand over the range of temperature in which they are to be used.

(i) Why is it important to know this when building a bridge?

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.... [2]

(ii) The linear expansivity of steel is 0.000 012 m per ^{o}C.
What will be the length of a 500 m steel bridge if the temperature rises by 50 ^{o}C?

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.... [3]

(b) The linear expansivity of copper is 0.000 02 m per ^{o}C and that of aluminium 0.000 03 m per ^{o}C.
Which of the will expand most, 50 m of copper heated by 40 ^{o}C or 50 m of aluminium heated by 30 ^{o}C?
Justify your answers by calculations.

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.... [4]

(c) How was the idea of expansivity used in fitting metal tyres to wooden cart wheels?

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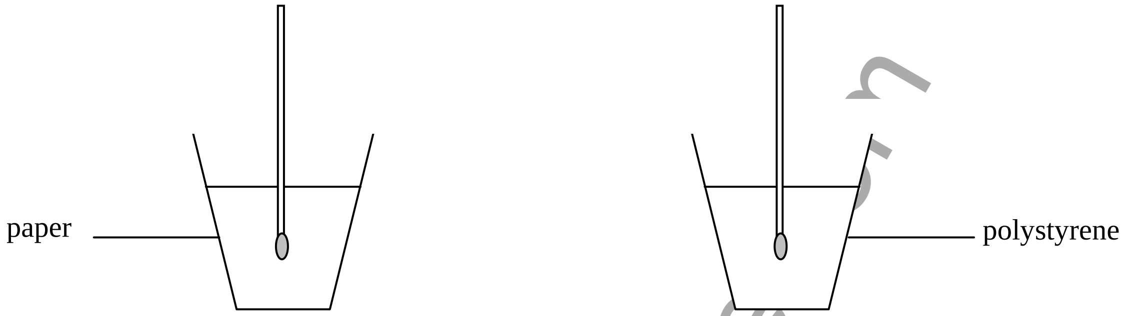
.... [2]

TOTAL / 11

(a)Carol is testing 2 cups to see which has the best insulating properties. The table shows the data when the same volume of hot water is placed in each cup, and the temperature monitored for 10 minutes.

time (min)	0	1	2	3	4	5	6	7	8	9	10
paper cup	80	66	57	53	49	47	45	43	42	41	40
polystyrene cup	80	74	68	65	63	61	60	59	58	57	56



(i) Plot graphs of temperature and time for each cup on the same axes. [5]

(Continued...)

QUESTIONSHEET 12 CONTINUED

(ii) How long did each cup take to cool from 80°C to 70°C?

paper cup:

.... [1]

polystyrene cup:

.... [1]

(iii) Which cup was the best insulator?

.... [1]

(iv) Explain your answer in (a)(iii).

.... [1]

(b) Carol put lids on the containers and repeated the experiment.

(i) What effect would you expect to see on her results?

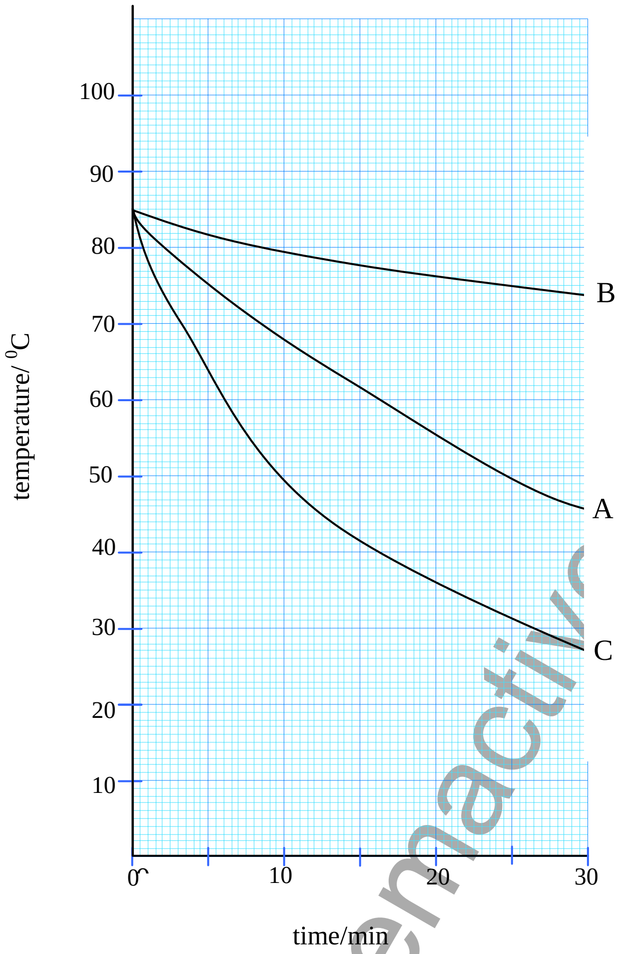
.... [1]

(ii) Explain your answer in (b)(ii)

.... [1]

TOTAL / 11

Mark sets up an experiment to investigate the heat loss from containers covered with different materials.



The graph shows cooling curves for 3 containers.
A is a pyrex beaker
B is a pyrex beaker covered with aluminium foil
C is a pyrex beaker painted black.
Each beaker has a lid.

(a) (i) After what time is the temperature 80^{o}C for each beaker?

A: .... [1]

B: .... [1]

C: .... [1]

(ii) What is the temperature of each beaker after 10 minutes?

A: .... [1]

B: .... [1]

C: .... [1]

(Continued...)

QUESTIONSHEET 13 CONTINUED

(b)(i) Which beaker is the best emitter of heat?

.... [1]

(ii) How is the heat being lost?

.... [1]

(iii) Name two other ways that heat can be lost when a body is hotter than its surroundings.

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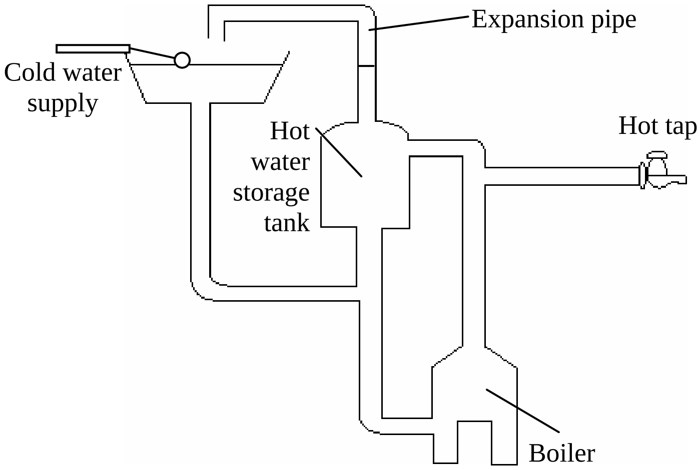
.... [2]

TOTAL / 10

The diagram shows the important parts of a hot water system in a home.



(a) (i) Name the **main** process whereby heat is transferred through the sides of the hot water tank to the surroundings.

.... [1]

(ii) Name the **main** heat transfer process whereby heat is transferred from the flames to the bottom of the boiler.

.... [1]

(b) State why an expansion pipe is needed.

....

.... [2]

For the following question use the theory of the arrangement of particles in solids, liquids and gasses to help you to answer the question.

(c) Explain the difference between the conduction and convection in solids liquids and gases.

....

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.... [4]

TOTAL / 8

Explain each of the following:

(a) a chimney and fire help to ventilate a room.

....

.... [2]

(b) a glider is able to stay in the air.

....

.... [2]

(c) it is best to crawl along the floor in a smoke-filled room.

....

.... [2]

(d) people wear light coloured clothing in Summer.

....

.... [2]

(e) frost is more likely to form on a clear night than on one which is cloudy.

....

.... [2]

TOTAL / 10

Medium Demand Questions QUESTIONSHEET 16

(a) Explain how perspiration helps to keep you cool.

....

....

.... [3]

(b) When walking on a mountain in wet weather a person's clothing became soaked.
Explain why this could be dangerous to the person's health.

....

....

.... [3]

(c) For each of the list of conditions needed to dry clothes on a washing line as quickly as possible, explain the science behind them.

(i) the air should be dry

....

.... [2]

(ii) the day should be windy

....

.... [2]

(iii) large items such as sheets should be well spread out.

....

.... [2]

TOTAL / 12

Mary has just received her gas bill for the winter quarter. She is amazed at how high it is.
Her friend Rita suggests that she should insulate her house.

(a) Why would insulation reduce her gas bill?

.... [1]

where heat lost	walls	roof	windows	floors
% loss	40	35	15	10

(b) The table shows the percentage heat loss through parts of a house.

(i) Draw a bar graph to display the results.

[2]

(ii) Where is most energy lost from the house?

.... [1]

(iii) Name the types of insulation she should consider for each area:

walls: .... [1]

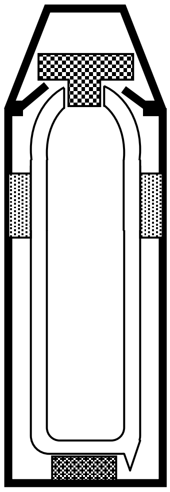
roof: .... [1]

windows: .... [1]

floor: .... [1]

TOTAL / 8

The diagram shows a vacuum flask. It is designed to keep heat from entering or leaving the flask.



The table below shows a design feature to help to stop heat being transferred and a type of heat transfer.

Design feature	Heat transfer process
Silvered inner walls	Conduction
Plastic stopper	Convection
Vacuum within inner cavity	Radiation

(a) Link the design feature to the type of heat transfer that it is designed to reduce.

....

.... [2]

(Continued...)

Below is a paragraph of text describing heat transfer. Insert a keyword into the blank spaces. The keywords are:-

CONDUCTION CONVECTION RADIATION.

The keywords may be used once, more than once or not at all.

(b) The main type of heat energy transfer in solids is ________________.

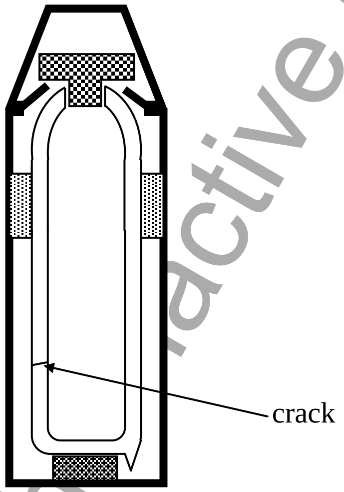
The main type of energy transfer process in liquids is __________________ .

The main type of heat energy transfer process in gases is ____________________.

The Sun's heat rays pass through outer space towards Earth by a process called _______________.

[4]

(c) The diagram shows a flask that has a crack in one of the inner walls.



Explain why the flask did not work as efficiently.

....

.... [2]

TOTAL / 8

0 °C   20 °C   37 °C   50 °C   100 °C   176 °C   1530 °C

(a) From the list of temperatures given above, select the most likely value for each of the following:

(i) the boiling point of pure water at normal pressure .... [1]

(ii) the body temperature of a healthy person .... [1]

(iii) the melting point of iron .... [1]

(iv) normal room temperature .... [1]

(v) the melting point of pure ice .... [1]

(b) State **two** ways in which a clinical thermometer differs from a laboratory thermometer.

....

.... [2]

(c) What are the **two** most common liquids used in a laboratory thermometer?

....

.... [2]

TOTAL / 9

Complete the following sentences.

______________________ currents form when liquids are heated.

The hot liquid _____________ and the cold liquid ________________.

Energy travels through space by ______________, which can be reflected by _________________.

Shiny surfaces are _______________ and dull black ones are _________________.

The unit of energy is the _______________.

Energy travels through the bottom of a saucepan by _________________.

Metals are good _______________ whereas plastics are good ______________.

TOTAL / 11