

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.3.2.1 INTERNAL ENERGY (PACK 2)

SCORE

/121

PERCENTAGE

%

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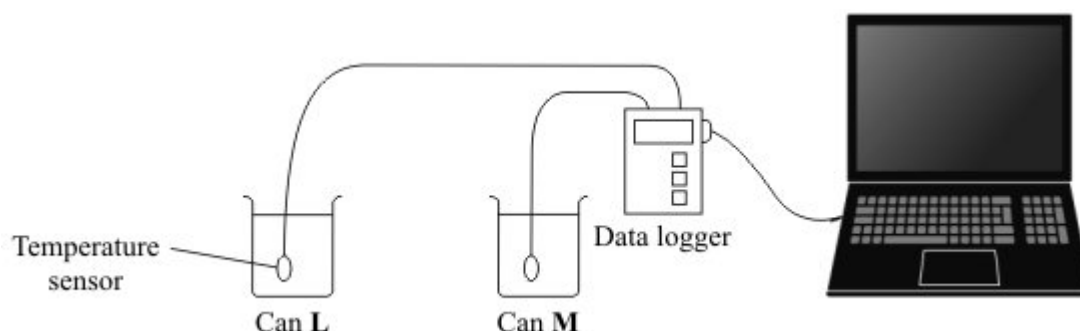
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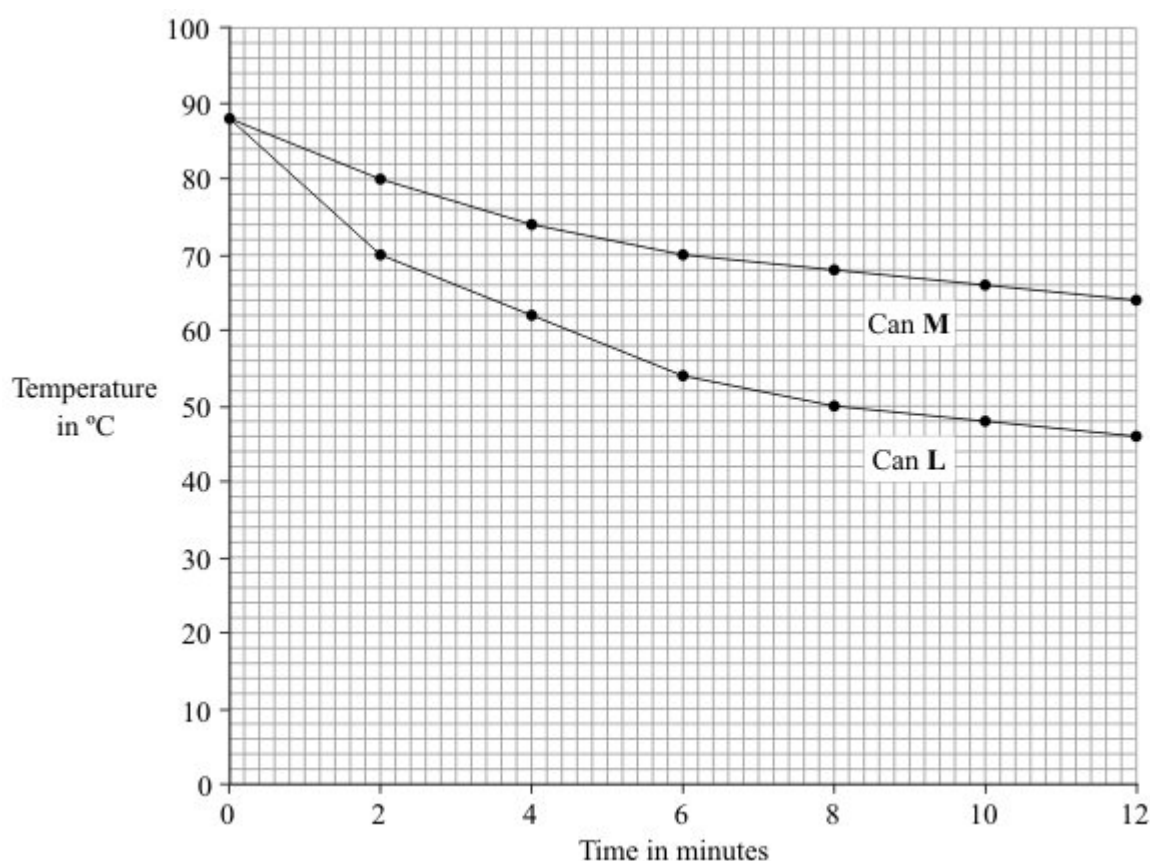
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Q1.

A student was asked to investigate the heat loss from two metal cans, L and M. The cans were identical except for the outside colour.



The student filled the two cans with equal volumes of hot water. He then placed the temperature sensors in the water and started the data logger. The computer used the data to draw the graph below.



(a) Which **one** of the following is a categoric variable?

Put a tick (✓) in the box next to your answer.

the outside colour of the cans

☐

the starting temperature of the hot water

☐

the time

the volume of hot water

(1)

(b) For can **L**, state the temperature drop of the water:

(i) in the **first** two-minute interval

(1)

(ii) in the **second** two-minute interval.

(1)

(c) In both cans the water cooled faster at the start of the investigation than at the end of the investigation. Why?

(1)

(d) One can was black on the outside and the other can was white on the outside.

What colour was can **L**? _____

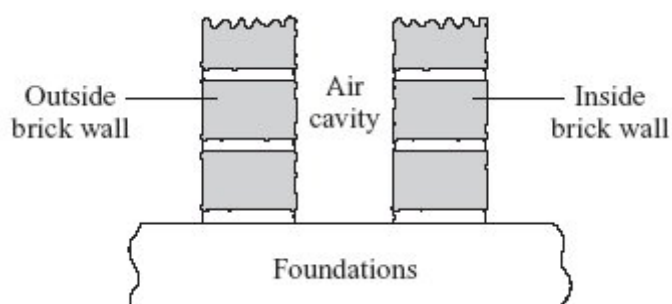
Explain the reason for your answer.

(3)

(Total 7 marks)

Q2.

(a) The diagram shows a section through the walls of a house built in 1930.



Explain how the air cavity between the two walls reduces the heat transfer from the house.

(2)

- (b) The table shows the installation costs and yearly savings on energy bills for different methods of insulating a house.

Method of insulation	Installation cost in £	Yearly saving on energy bills in £
Double glazing	4000	65
Loft insulation	240	60
Cavity wall insulation	600	80

- (i) Give **one** reason why loft insulation is often fitted to an old house before double glazing or cavity wall insulation.

(1)

- (ii) The time it takes for the saving on energy bills to equal the cost of installing the insulation is called the pay-back time.

Calculate the pay-back time for loft insulation.

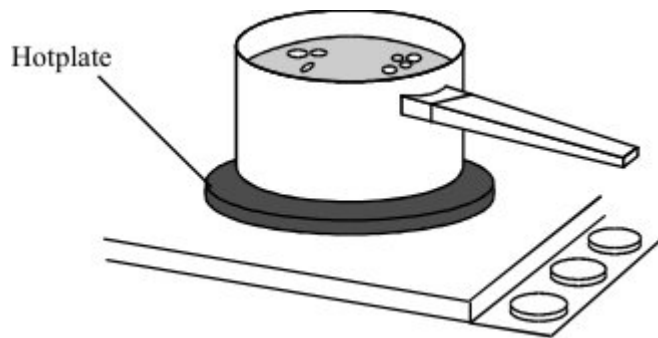
Pay-back time = _____ years

(1)

(Total 4 marks)

Q3.

The drawing shows water being heated in a metal saucepan.



- (a) Explain, in terms of the particles in the metal, how heat energy is transferred through the base of the saucepan.

(2)

- (b) Energy is transferred through the water by convection currents. Explain what happens to cause a convection current in the water. The answer has been started for you.

As heat energy is transferred through the saucepan, the water particles at the bottom

(3)

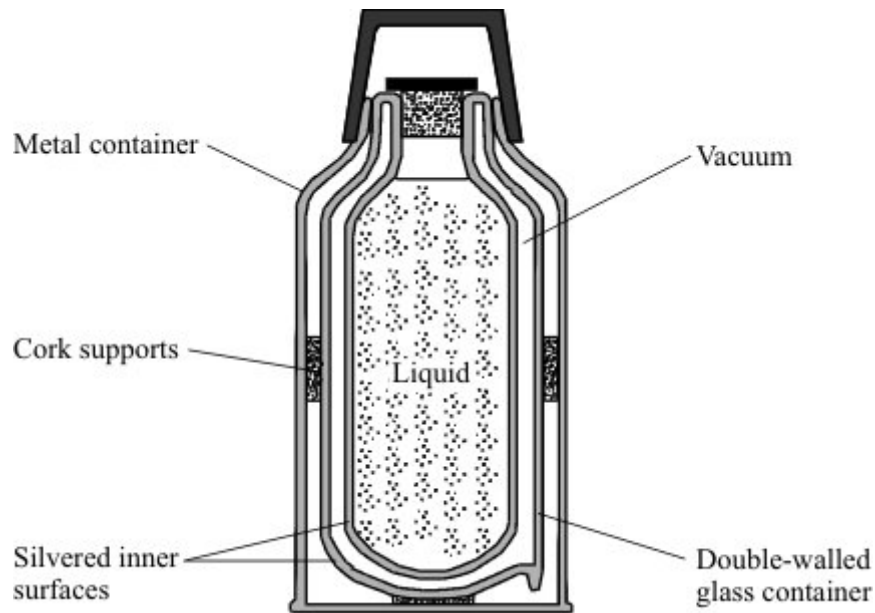
- (c) Some energy is transferred from the hotplate to the air by *thermal radiation*. What is meant by *thermal radiation*?

(1)

(Total 6 marks)

Q4.

The vacuum flask shown has five features labelled, each one designed to reduce heat transfer.



- (a) (i) Which labelled feature of the vacuum flask reduces heat transfer by both conduction and convection?

(1)

- (ii) Explain how this feature reduces heat transfer by **both** conduction and convection.

(2)

- (b) (i) Which labelled feature of the vacuum flask reduces heat transfer by radiation?

(1)

- (ii) Explain how this feature reduces heat transfer by radiation.

(2)
(Total 6 marks)

Q5.

Many people use a sleeping bag when they sleep in a tent. Sleeping bags, designed to keep a person warm, have a fibre filling.



- (i) Complete the sentence by choosing the correct words from the box.

conduction	convection	radiation
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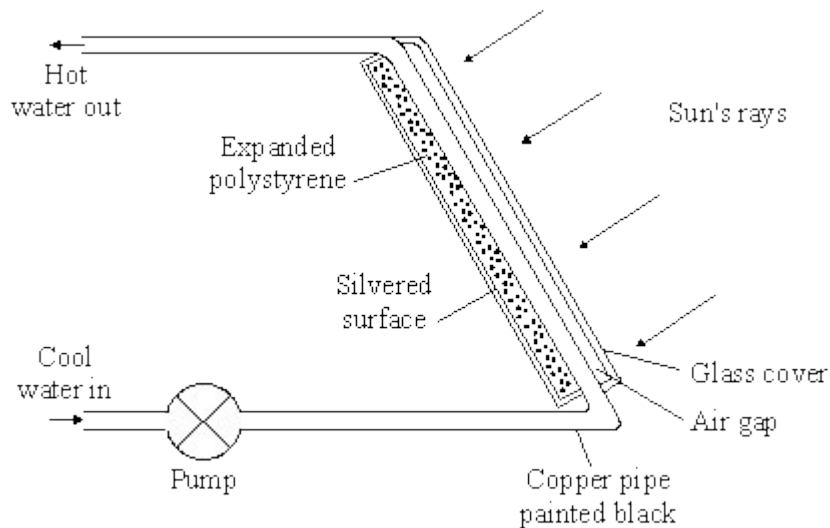
The fibre is designed to reduce heat transfer by _____ and

- (ii) Explain why the fibre is good at reducing heat loss from a person sleeping in the bag.

(Total 3 marks)

Q6.

The diagram shows part of a solar water heater. Water circulating through the solar panel is heated by the Sun.



- (i) Complete the following sentence.

Heat energy is transferred from the Sun to the solar panel by

_____.

(1)

- (ii) The pipe inside the solar panel is black. Why?

(1)

- (iii) There is a layer of expanded polystyrene behind the black pipe. Why?

(1)

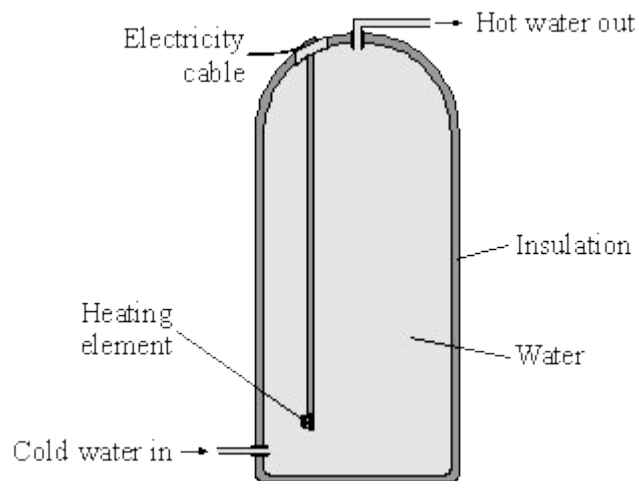
- (iv) A silvered surface is used at the back of the solar panel. Explain why.

(2)

(Total 5 marks)

Q7.

- (a) The diagram shows an immersion heater used to heat water inside a tank. Heat is transferred through the water by convection.



- (i) Draw arrows on the diagram to show the movement of the water in the tank when the heating element is switched on.
- (ii) Explain how a convection current is set up in the water. The explanation has been started for you.

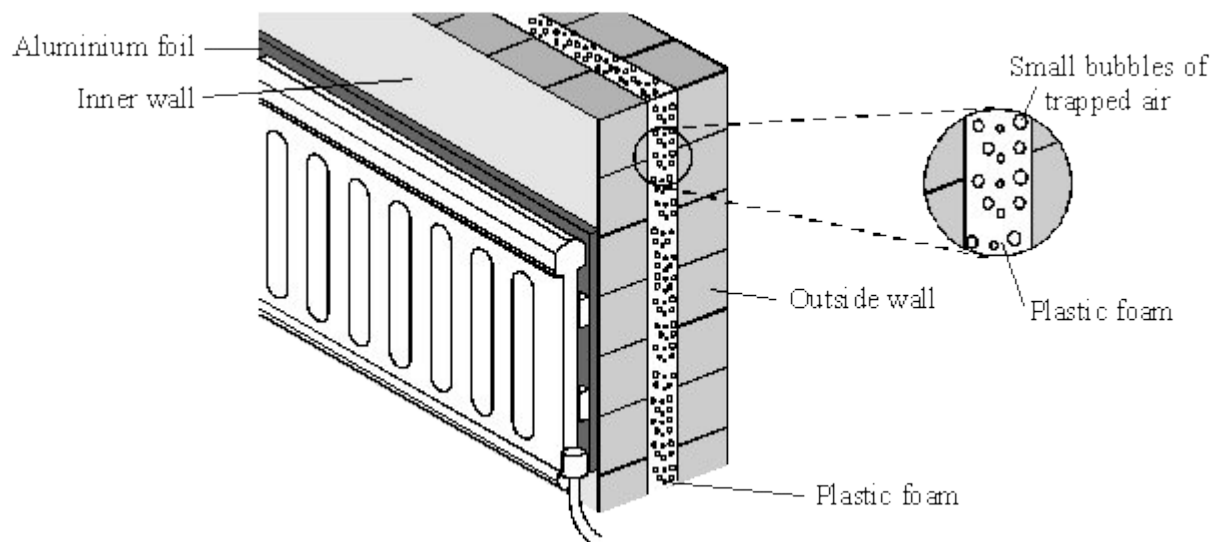
(2)

When the heating element is switched on, the hot water nearest the element rises

because _____

(2)

- (b) The diagram shows **two** ways to reduce heat loss through the walls of a house.



- (i) How is the aluminium foil able to reduce heat loss?

(1)

- (ii) The plastic foam is good at reducing heat loss through the walls. Explain why.

(3)

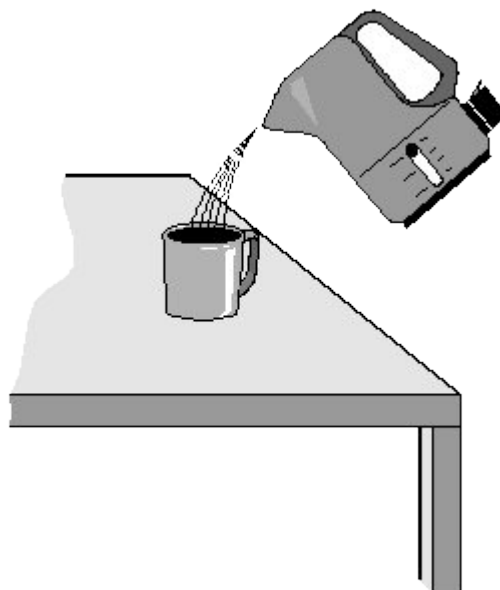
- (c) Evaporation is an important heat transfer process. When sweat evaporates, it takes heat energy from your body. As humidity increases, you are more likely to feel hot and uncomfortable. Explain why.

(2)

(Total 10 marks)

Q8.

- (a) The diagram shows hot water being poured into a mug.



- (i) Complete the sentence by choosing the correct words from the box. Each word may be used once or not at all.

air	mug	table	water
-----	-----	-------	-------

Heat energy is being transferred from the _____ to
the _____.

(1)

- (ii) When will this transfer of heat energy stop?

(1)

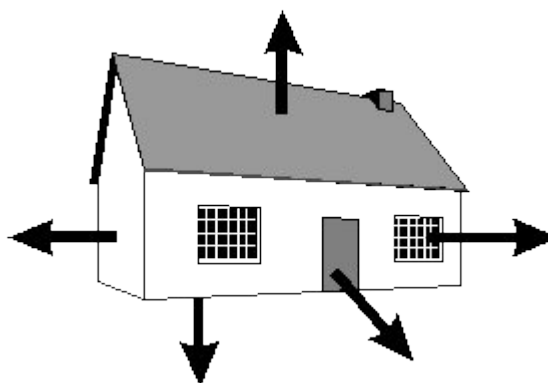
- (b) In the box are the names of four types of fuel used to heat homes.

coal	gas	oil	wood
------	-----	-----	------

Which **one** of these types of fuel is renewable?

(1)

- (c) The diagram shows where heat energy is lost from a house.



- (i) Complete the sentences by choosing the correct words from the box. Each word may be used once or not at all.

conduction	conductor	electric	evaporation	insulator
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The amount of heat energy lost through the windows by

_____ can be reduced by using thick curtains. The curtains trap a layer of air and air is a good

_____.

(2)

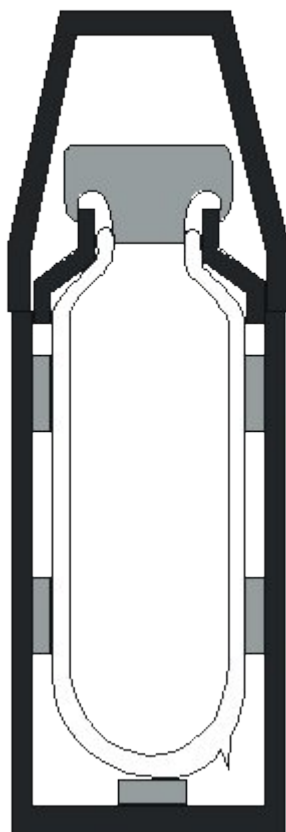
- (ii) Write down **one** other way of reducing heat loss from a house.

(1)

(Total 6 marks)

Q9.

The diagram below shows a vacuum flask.



- (a) Give **two** features of the flask which reduce heat loss by conduction.

1. _____

2. _____

(2)

- (b) Give **one** feature of the flask which reduces heat loss by radiation.

(1)

(Total 3 marks)

Q10.

- (a) When an electric kettle is switched on it will take a few minutes to boil the water. Once switched off it will gradually cool down.

- (i) When the kettle is switched on the water heats. Explain how all of the water is heated.

- (ii) The kettle is now switched off and begins to cool.

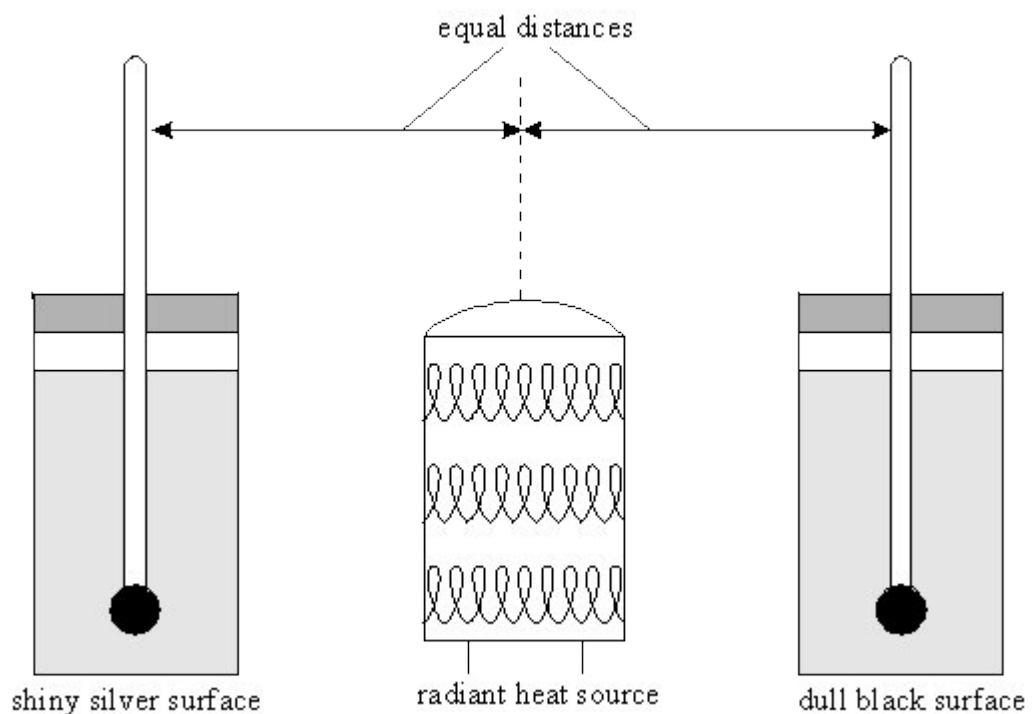
(1) Describe how heat energy is transferred **through** the walls of the kettle.

(2) Describe how the heat energy is transferred **from** the walls of the kettle.

(iii) Describe how heat losses from the surface of a metal kettle may be kept small.

(4)

- (b) A shiny metal can and a dull black can are filled with the same amounts of cold water.
A radiant heater is placed exactly half way between the cans as shown in the diagram below.



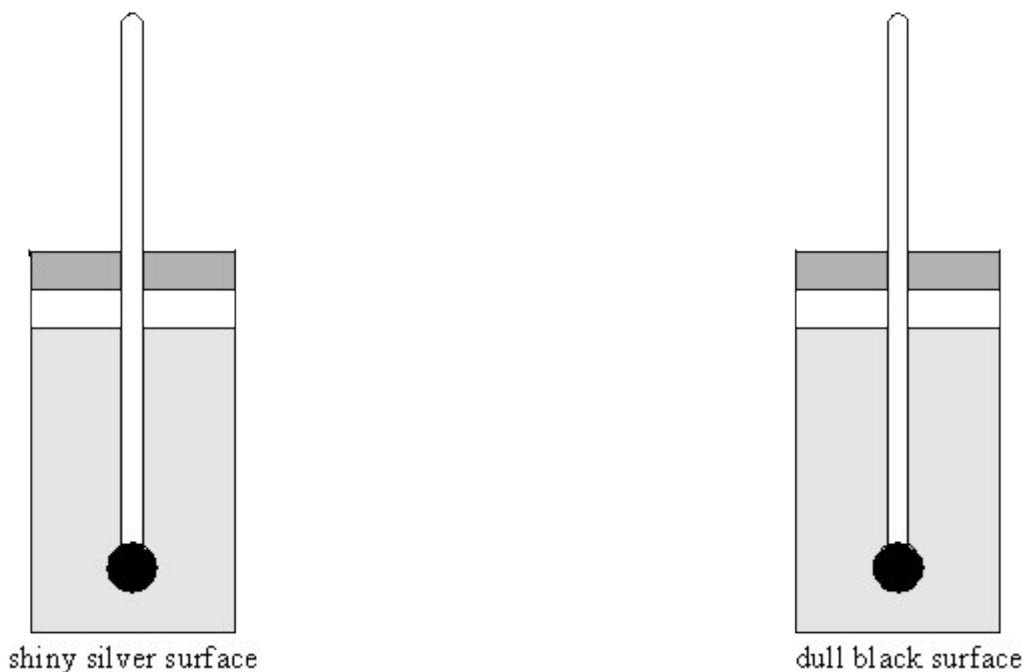
Two thermometers are used to measure the temperature of the water in each can every minute.

- (i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

(ii) Explain your answer to part (i).

(3)

(c) The radiant heater was removed and both the cans were filled with the same amount of boiling water, as shown in the diagram below.



The temperature was recorded every minute for ten minutes.

(i) Suggest how the temperature of the water in the dull can would be different from the temperature of the water in the shiny can after ten minutes.

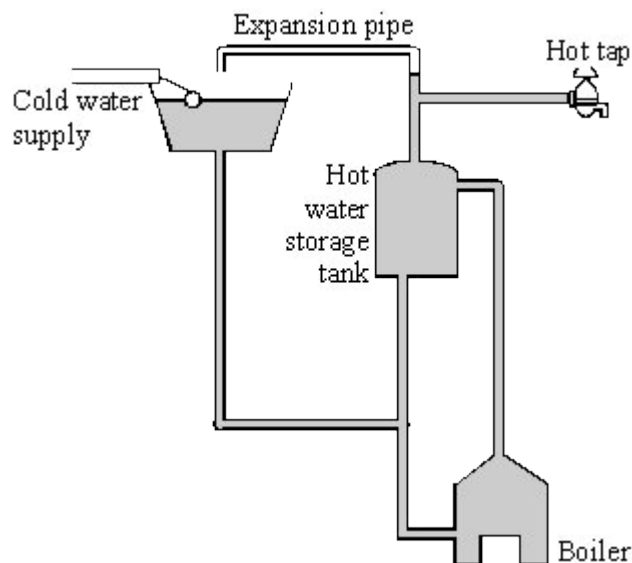
(ii) Explain your answer to part (i).

(3)

(Total 10 marks)

Q11.

- (a) The diagram shows a hot water system.



- (i) Explain why the boiler is below the hot water tank.

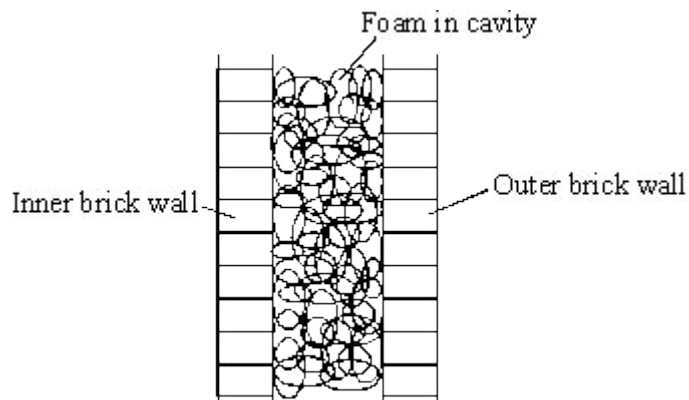
- (ii) Why is heat energy transferred from hot water in the tank to the surrounding air?

- (iii) Name the process by which energy is transferred through the sides of the tank.

- (iv) How may heat loss from the hot water tank be reduced?

(6)

- (b) One way of reducing heat loss from a house is by cavity wall insulation. Foam is pumped between the inner and outer brick walls as shown in the diagram.



How is heat loss from a house reduced by:

- (i) having a cavity wall?

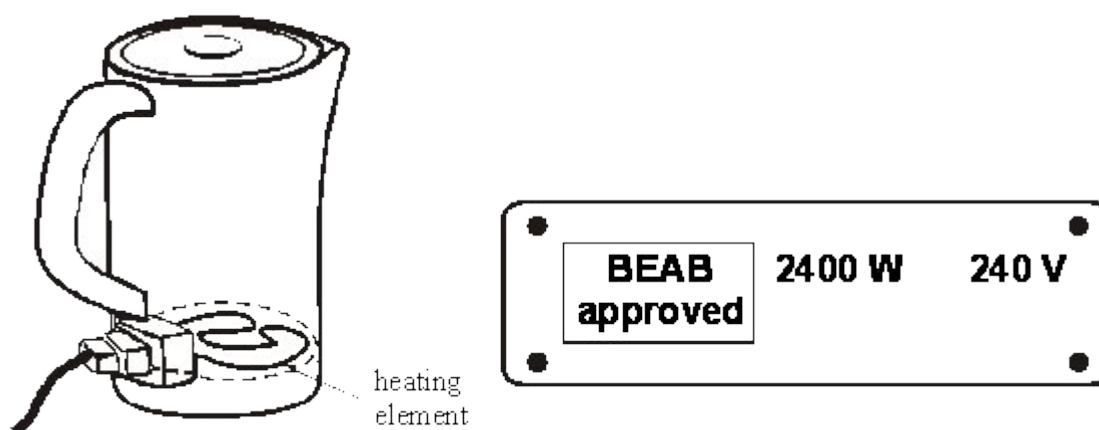
- (ii) filling the cavity with foam?

(3)

(Total 9 marks)

Q12.

The diagram below shows an electric kettle and the label on the bottom of the kettle.



The water at the bottom of the kettle will heat up first.
This is because the heating element is near the bottom of the kettle.
Convection currents will then cause the rest of the water in the kettle to be heated.

- (i) What are convection currents?

(1)

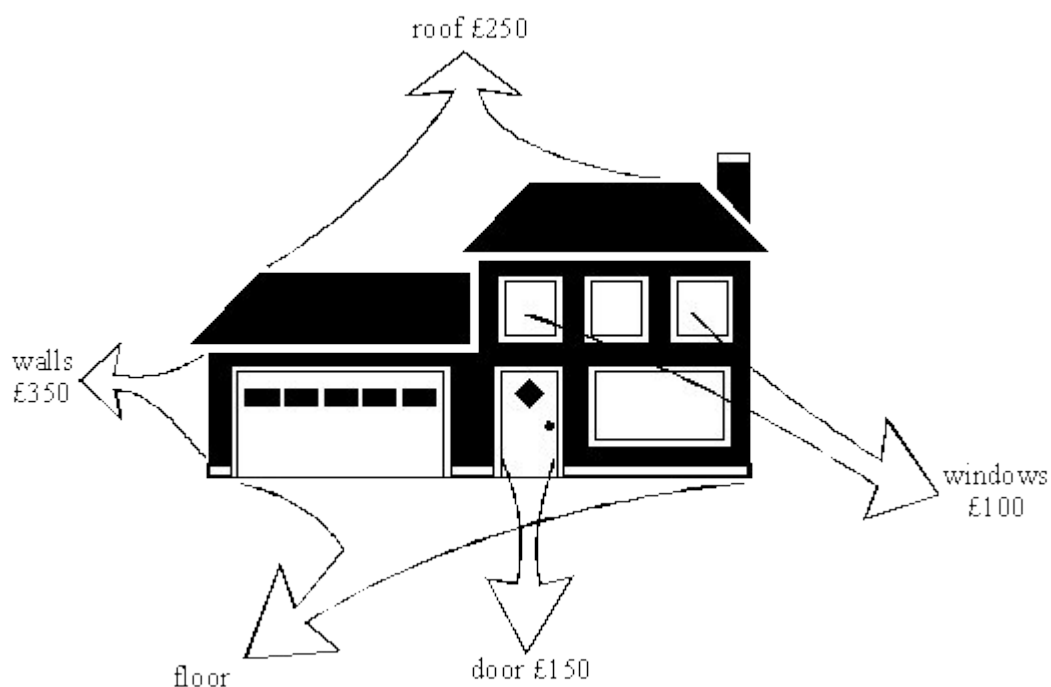
- (ii) Explain how convection currents are produced.
(Your answer should refer to **density** and **temperature**.)

(4)

(Total 5 marks)

Q13.

The diagram below shows a house which has **not** been insulated. The cost of the energy lost from different parts of the house during one year is shown on the diagram.



- (a) The total cost of the energy lost during one year is £1000.

- (i) What is the cost of the energy lost through the floor?

(2)

- (ii) Suggest one way of reducing this loss.

(1)

- (b) The table below shows how some parts of the house may be insulated to reduce energy losses. The cost of each method of insulation is also given.

WHERE LOST	COST OF ENERGY LOST PER YEAR (£)	METHOD OF INSULATION	COST OF INSULATION (£)
roof	250	fibre-glass in loft	300
walls	350	foam filled cavity	800
windows	100	double glazing	4500
doors	150	draught proofing	5

- (i) Which method of insulation would you install first? Explain why.

(3)

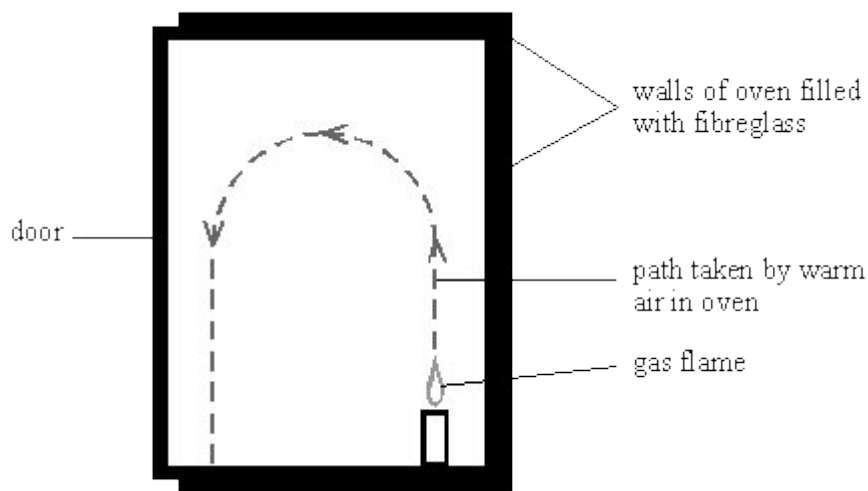
- (ii) Which method of insulation would you install last? Explain why.

(3)

(Total 9 marks)

Q14.

The diagram shows a section through a gas oven.



Use words from the list to complete the sentences.

conduction convection insulation radiation resistance

The outside of the door gets hot because energy is transferred through the door by _____

Energy is transferred from the gas flame to the rest of the oven by the movement of air.

This type of energy transfer is called _____

The walls of the oven are packed with fibreglass to reduce energy transfer. Energy transfer is reduced because fibreglass provides good _____

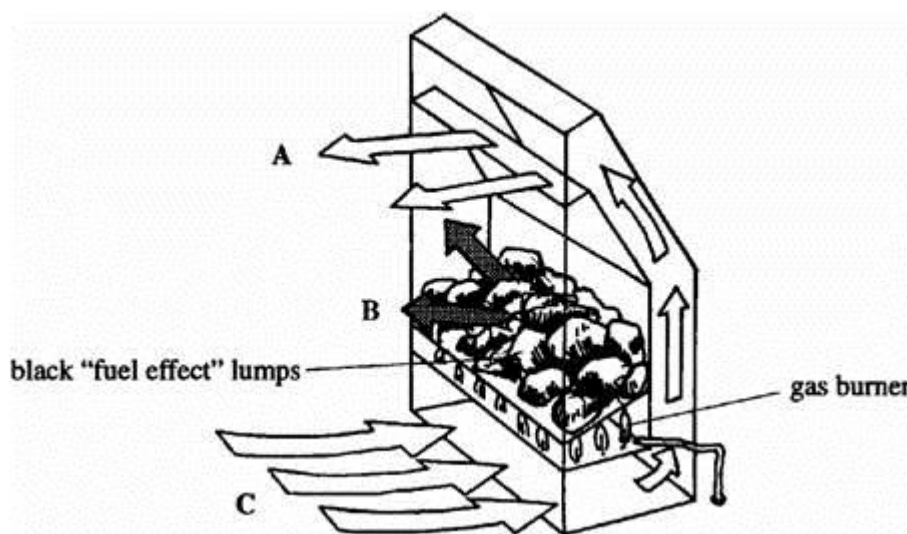
The outside of the cooker is white and shiny.

This reduces energy transfer by _____

(Total 4 marks)

Q15.

The diagram comes from a leaflet about a “coal effect” gas fire. It shows how air circulates through the fire.



(a) Explain in detail why the air travels from **C** to **A**.

(4)

(b) The black “fuel effect” lumps become very hot.

- (i) Name the process by which the lumps transfer thermal energy to the room as shown at **B**.

(1)

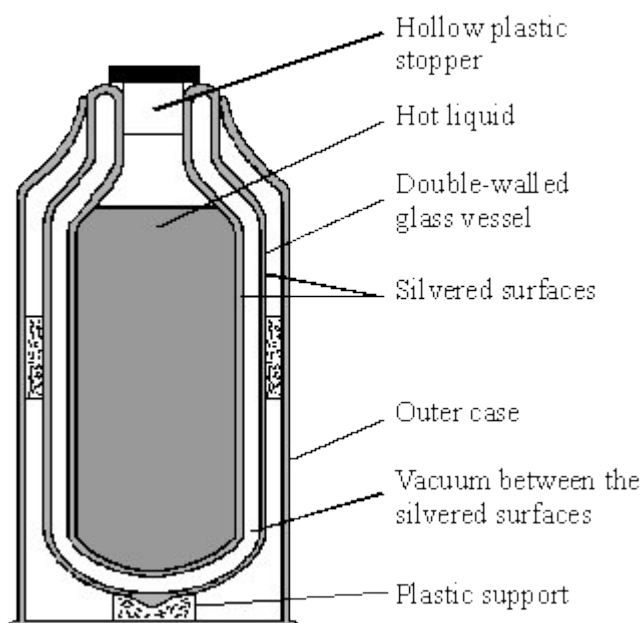
- (ii) Suggest **one** feature of the black “fuel effect” lumps which make them efficient at transferring energy.

(1)

(Total 6 marks)

Q16.

The drawing shows a section of a vacuum flask.



- (a) Heat is slowly “lost” from the hot liquid in the closed flask. It may be transferred by:

conduction	convection	evaporation	radiation
------------	------------	-------------	-----------

Choose from the words above to complete the following sentences. You may use a word once, more than once or not at all.

- (i) The vacuum between the glass walls reduces

_____ and _____

(2)

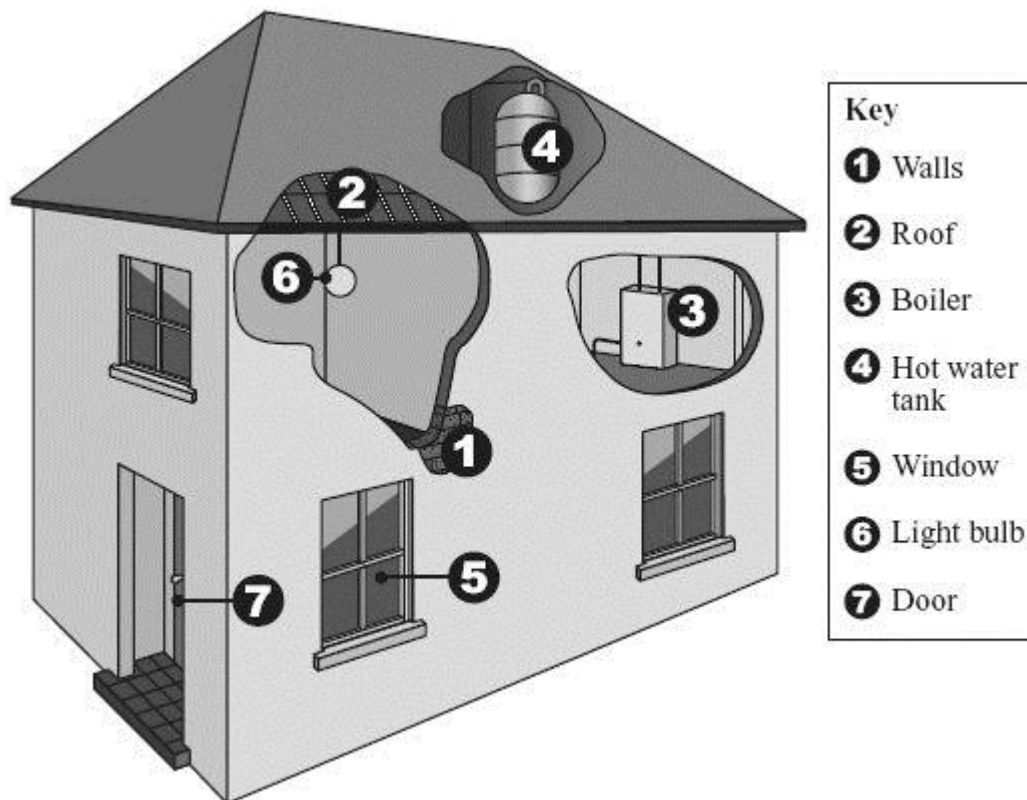
- (ii) The silvered surfaces of the glass walls reduce

- _____ (1)
- (iii) The stopper in the opening of the flask reduces
_____ and _____ (2)
- (iv) Heat is transferred by the air molecules, away from the vacuum flask, by
_____ (1)
- (v) The plastic of the plastic stopper is preferred to metal because it cuts down
_____ (1)
- (b) Mark **X** on the diagram of the vacuum flask where the liquid in the flask is hottest. (1)
- (c) Explain, in terms of particles, how heat is conducted through a glass wall of the vacuum flask.

_____ (2)
- (Total 10 marks)

Q17.

The drawing shows parts of a house where it is possible to reduce the amount of energy lost.



- (a) Give **one** way in which the amount of energy lost can be reduced from each of the following parts of the house.

1, 2 and 4 _____

5 _____

7 _____

(3)

- (b) Energy consumption can be reduced by using a more efficient boiler or more efficient light bulbs.

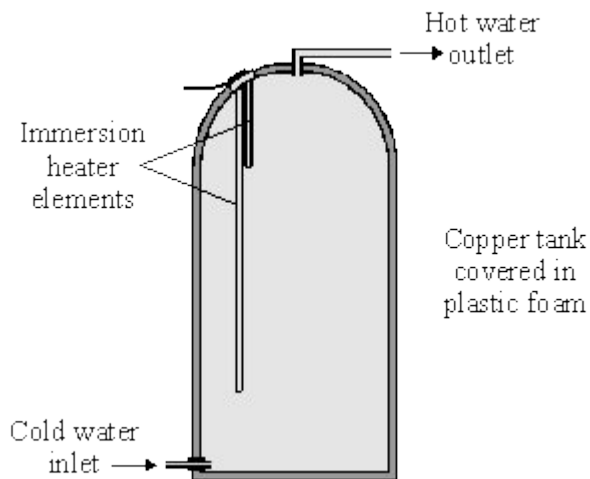
What is meant by a *more efficient* light bulb?

(1)

(Total 4 marks)

Q18.

The diagram shows a type of electric immersion heater in a hot water tank. These hot water tanks are normally found in airing cupboards.



Information on the immersion heater states:

230 V
10 A

- (a) Immersion heaters for hot water tanks often have a switch on them labelled *bath* or *sink*. The *bath* position of the switch has **both** parts of the immersion heater elements in the circuit. The *sink* position has only the short heater element in the circuit.

- (i) Explain why the hot water outlet is at the top of the tank, and the cold water inlet is at the bottom of the tank.

(2)

- (ii) Explain how the *sink* position for the immersion heater is able to save energy.

(2)

- (b) The copper tank is surrounded by plastic foam to minimise energy loss.

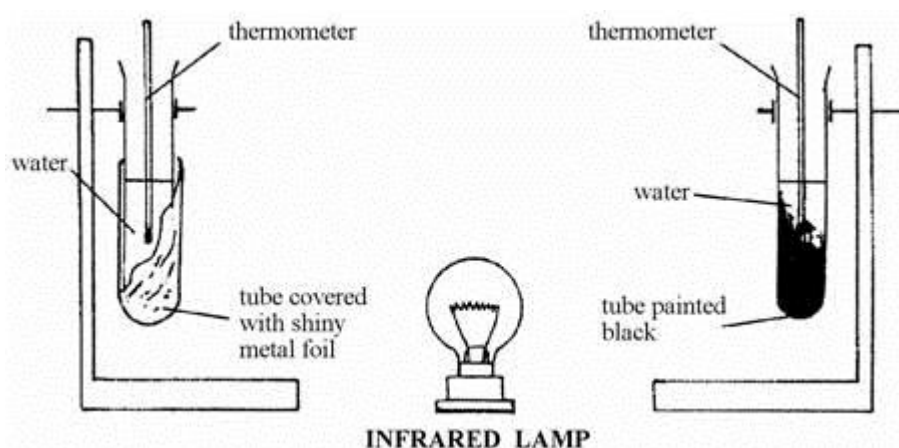
Explain why a pale, shiny surface to the foam also helps to minimise energy loss.

(2)

(Total 6 marks)

Q19.

The diagram shows an experiment to find out what happens to infrared waves when they strike different surfaces.



- (a) The water in the black tube gets hotter than the water in the shiny tube.
Choose words from the list to complete the sentences below.

absorbs conducts convects radiates reflects

The infrared lamp _____ energy to the tubes of water.

The black surface _____ most of the energy that reaches it.

The shiny surface _____ most of the energy that reaches it.

(3)

- (b) Put the sentences A- E below into the correct boxes on the flow diagram so that they tell you how to do the experiment

(You may use just the letters if you want to.)

A Switch off the lamp



B Switch on the lamp

Read the thermometers



C Make sure the lamp is the same distance from both tubes



D Read the thermometers

Wait for 5 minutes



E Wait for the temperature to stop rising



Stir the water in the tubes



(5)

(Total 8 marks)

Mark schemes

Q1.

- (a) the outside colour of the cans 1
- (b) (i) 18 (°C) **or** 88 to 70
ignore negative sign 1
- (ii) 8 (°C) **or** 70 to 62
ignore negative sign 1
- (c) greater temperature difference between water and surroundings (at start)
must mention temperature difference
ignore just water hotter
accept energy used to heat cans initially 1
- (d) black 1
- temperature falls the fastest (in L)
accept (can L) loses more heat / cools quicker
accept heat for temperature 1
- black is a good / the best / better emitter (of heat / radiation)
accept converse
ignore black is best absorber 1

[7]

Q2.

- (a) air is (a good) insulator 1
- or** air is a poor conductor
accept air cavity / 'it' for air
- reducing heat transfer by conduction
accept stops for reduces
ignore convection
*do **not** accept radiation*
*do **not** accept answers in terms of heat being trapped* 1
- (b) (i) most cost effective
accept it is cheaper or lowest cost
accept shortest payback time
accept in terms of reducing heat loss by the largest amount

do **not** accept it is easier
ignore most heat is lost through the roof

1

(ii) 4

1

[4]

Q3.

(a) ions / electrons gain (kinetic) energy

accept atom / particles / molecules for ion
accept ions vibrate faster
accept ions vibrate with a bigger amplitude
accept ions vibrate more
do not accept ions move faster

1

(free) electrons transfer energy by collision with ions
or energy transferred by collisions between vibrating ions

1

(b) move faster or take up more space

do **not** accept start to move / vibrate

1

(warmer) water expands or becomes less dense (than cooler water)

do **not** accept answers in terms of particles expanding

1

warm water rises (through colder water) or colder water falls to take its place

1

(c) transfer of energy by waves / infrared (radiation)

accept rays for waves

do **not** accept transfer of energy by electromagnetic waves

ignore reference to heat

1

[6]

Q4.

(a) (i) vacuum

do not allow stopper

1

(ii) (absence of particles) means no (transfer of energy between)
particles for conduction

accept particles or atoms or molecules or electrons

1

no movement of molecules for (transfer of energy by) convection

accept particles/atoms/electrons

if answer to (a)(i) is correct: then in (a)(ii) have stated
'conduction and convection both need a
medium/particles/materials' = 2 marks

*(If medium is specified, it must be correct, conduction can be solid, liquid or gas, convection must be liquid or gas)
if answer to (a)(i) is incorrect then in (a)(ii) have stated
'conduction and convection both need a medium...' = 1 mark,
unless further qualified by stating about absence of particles,
in which case get a second mark.*

1

- (b) (i) silvered surface
accept silver surface

1

- (ii) silvered is a bad emitter/radiator

1

surface reflects heat/energy/radiation (at inner and outer surface)
or is a bad absorber (of energy)
accept bounces off

1

[6]

Q5.

- (i) conduction, convection
answer can be in either order

1

- (ii) traps (lots of) air
*do **not** accept heat is trapped in the fibre*

1

air is a (good) insulator **or** poor conductor

1

[3]

Q6.

- (i) radiation **or** infra red
*do **not** accept rays
do **not** accept waves
accept electromagnetic waves*

1

- (ii) good absorber (of heat) to absorb heat (**or** infrared)
*do **not** accept 'attract' **or** 'capture' **or** soak*

1

- (iii) reduce heat loss (from the panel)
*accept (good) (heat) insulator
accept stop **or** reduce conduction
accept stop **or** reduce convection
accept traps heat
accept keeps water hot*

1

- (iv) to reflect (back into the panel) heat **or** infrared **or** Sun's energy
do not accept 'bouncing'
do not accept reflect Sun
*do not accept reflect sunlight **or** sun's rays*

1

radiated **or** given out by the (black) pipe
accept back to pipe
accept reduce heat loss for 1 mark
accept reduce heat loss by radiation for 2 marks
accept stop heat loss by radiation for 1 mark

1

[5]

Q7.

- (a) (i) convection current correctly shown
 with arrows extending to above
 insulation label line
circulation must show water rising in the left half of the tank
*accept continuous **or** broken arrows **must** be at least **one***
*arrow up and **one** arrow down*
*allow **1** mark for correct diagram which does not extend high*
enough

2

- (ii) it expands or it gets less dense
do not allow hot water rises
do not accept explanation in terms of molecules expanding
***or** changing density*
*do not accept lighter **or** heavier*

1

more dense water falls
allow cold water falls if qualified with a suitable reason

1

- (b) (i) reflects heat back into the room **or** where it came from
accept infrared or radiation or energy for heat
accept bounce for reflect if in correct context

1

- (ii) air is a (good) insulator or poor conductor **or** air stops conduction
*do not accept plastic foam is a good insulator **or** bad*
conductor

1

air is trapped

1

convection loss reduced or stopped

1

- (c) **two** out of the following three:
any answer which gains credit must contain a comparison

rate of evaporation decreases

accept less sweat can evaporate or evaporation is more difficult

less heat energy removed from the body

higher *humidity* the less water vapour can be absorbed (into the air)

accept sweat for water vapour

do not credit description of high humidity

accept a correct answer in terms of dynamic equilibrium

2

[10]

Q8.

(a) (i) any **one** from:

water to the mug

water to the air

mug to the air

mug to the table

***both** required*

direction of transfer must be correct

1

(ii) when temperatures are the same

accept a specific example eg when the temperature of the water and mug are the same

accept radiant heat transfer will never stop

1

(b) wood

1

(c) (i) conduction

accept convection if not given as 3rd answer

1

insulator

1

(ii) any **one** from:

do not accept any rebuilding of house

double glazing

loft insulation

accept roof for loft

1

carpets

(cavity) wall insulation

do not accept closing doors and windows

draft excluders

foil behind radiators
accept blocking chimney
 paint inside walls white

[6]

Q9.

- (a) plastic/glass walls; vacuum; insulating top
any two for 1 mark each

2

- (b) silvering/shiny on either wall
for 1 mark

1

[3]

Q10.

- (a) (i) Carries heat up (as convection current)

1

- (ii) (1) By conduction or from molecule to molecule
 (2) By radiation or as IR

2

- (iii) Use shiny surface (inside or outside) or small area

1

- (b) (i) Rise more quickly

1

- (ii) Dull surface good absorber
 (accept "attract" = "absorb" if context correct,
 then penalise spg mark.

Shiny surface poor absorber

2

- (c) (i) Fall more quickly

1

- (ii) Dull surface good emitter
 Shiny surface poor emitter

2

[10]

Q11.

- (a) (i) hot water rises (not heat)
for 1 mark

due to convection currents
or water expands/becomes less dense on heating
or less dense water rises
any for 1 mark

2

- (ii) inside hotter (than outside)
for 1 mark 1
- (iii) (heat transfer by) conduction
for 1 mark 1
- (iv) surround/cover/insulate tank with poor conductor **or** named insulator
for 1 mark each 2
- (b) (i) air is an insulator/poor conductor
for 1 mark 1
- (ii) convection stopped foam is an insulator/poor conductor
for 1 mark each 2

[9]

Q12.

- (i) currents of moving liquids/gases/fluids carrying/transferring energy
(can name fluid) 1
- (ii) liquids/gases **expand** when their temperature rises/when they are heated

the **density** of the heated liquid/gas is then **less** than that of the
colder liquid/gas which has not been heated

the warmer/less dense liquid/gas **then rises** through the colder/denser liquid/gas

the **colder/denser liquid/gas falls** to replace the liquid/gas which has risen,
and in turn becomes heated
for 1 mark each 4

[5]

Q13.

- (a) (i) £150
gets 2
- Else $1000 - (250 + 350 + 100 + 150)$ or $1000 - 850$
gets 1 2
- (ii) (Named) floor covering
OR Insulation under floor
for 1 mark 1
- (b) (i) Draught proof doors or fibre glass in loft or in cavity
For draught proofing

gains 1 mark

Very low cost/easy to install
Repays for itself quickly/cost recuperated quickly
Reasonable energy saving

any 2 for 1 mark each

For loft insulation

Second lowest installation cost/easy to install
Reasonable large energy savings for this cost
Reasonable payback time

gains 1 mark

For foam filled cavity

Biggest energy/cash saving
Cost effective

any 2 for 1 mark each

3

(ii) **Double glazing**

gains 1 mark

Costs most
Saves least energy
Least cost effective

any 2 for 1 mark each

3

[9]

Q14.

..... conduction
..... convection
..... insulation
..... radiation

for 1 mark each

[4]

Q15.

- (a) convection
air is heated by the burner / particles gain energy
air expands / particles move about more / particles move faster
air becomes less dense / particles are more spread out
air rises / particles rise - *not* heat rises
air from C moves into the heater / particles from C move into the heater to replace it / them

any four for 1 mark each

4

- (b) (i) radiation

for one mark

1

- (ii) black surface radiates / emits well
 (allow absorbs and emits well) (allow comparison with shiny / white surfaces)
- large surface area needed
 high temperature (of the lumps)
any one for 1 mark

1

[6]

Q16.

- (a) (i) conduction

1

convection

they may be in either order

1

- (ii) radiation

1

- (iii) evaporation

1

convection

they may be in either order

1

- (iv) convection

1

- (v) conduction

1

- (b) in the middle above halfway up (above line joining top of spacers)
below the surface of the liquid

1

- (c) by particles vibrating more
particles shake more or move more
do not credit they start vibrating

1

they pass on the energy **or** vibrations
do not credit heat

1

[10]

Q17.

- (a) insulation

allow example e.g fibreglass

1

double glazing

allow curtains

1

draught excluder

allow double glazing / close fitting door

allow turning down thermostat once only / turn down the heating

1

- (b) transfers more useful energy

allow converts more energy into light / less into heat / less energy wasted

1

[4]

Q18.

- (a) (i) the outlet mark

hot water rises **or** floats up

do not accept heat rises

the inlet mark

1

cold water replacing any drawn off comes in at the bottom and does not mix with hot **or** cool the hot water

do not accept descriptions of a convection current

1

- (ii) only heats top (of tank) **or** a small volume

credit heats less water

1

no mixing occurs with cold because hot water is less dense **or** water is a poor conductor

no mixing because cold water is more dense

1

- (b) radiation (losses from tank)

do not accept reflection of heat

1

lower from light **or** white **or** shiny surfaces

credit they are poor radiators for both marks

1

[6]

Q19.

- (a) radiates
absorbs / conducts
reflects

for 1 mark each

3

- (b) C make sure the lamp is the same distance from both tubes
B switch on the lamp
A switch off the lamp

- E wait for the temperature to stop rising
- D read the thermometers
for 1 mark each

5

[8]