

Mark schemes

1	(a) Student A's measurements had a higher resolution	1
	Student B was more likely to misread the temperature	1
	(b) a random error	1
	(c) 8.4 °C	1
	(d) 740 (seconds) <i>allow answers in the range 730 – 780</i>	1
	(e) $0.40 \times 199\,000$ 79 600 (J) <i>accept 79 600 (J) with no working shown for 2 marks</i>	1
	(f) stearic acid has a higher temperature than the surroundings <i>accept stearic acid is hotter than the surroundings</i>	1
	temperature will decrease until stearic acid is the same as the room temperature / surroundings	1
		[9]
2	(a) range of speeds	1
	moving in different directions <i>accept random motion</i>	1
	(b) internal energy	1
	(c) density = mass / volume	1
	(d) 0.00254 / 0.0141 0.18	1

kg / m³

1

[7]

3

Level 3 (5–6 marks):

Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.

Level 2 (3–4 marks):

Clear description of one method to measure density **or** partial description of both methods. Steps may not be logically ordered.

Level 1 (1–2 marks):

Basic description of measurements needed with no indication of how to use them.

0 marks:

No relevant content.

Indicative content

For both:

- measure mass using a balance
- calculate density using $\rho = m / V$

Metal cube:

- measure length of cube's sides using a ruler
- calculate volume

Small statue:

- immerse in water
- measure volume / mass of water displaced
- volume of water displaced = volume of small statue

[6]

4

(a) **solid**
particles vibrate about fixed positions

1

closely packed

accept regular

1

gas

particles move randomly

accept particles move faster

accept freely for randomly

1

far apart

1

- (b) amount of energy required to change the state of a substance from liquid to gas (vapour) 1
- unit mass / 1 kg
dependent on first marking point 1
- (c) 41000 **or** 4.1×10^4 (J)
accept
41400 or 4.14×10^4
correct substitution of
 $0.018 \times 2.3 \times 10^6$ gains 1 mark 2
- (d) **AB**
changing state from solid to liquid / melting 1
- at steady temperature
*dependent on first **AB** mark* 1
- BC**
temperature of liquid rises 1
- until it reaches boiling point
*dependent on first **BC** mark* 1
- [12]**
- 5** (a) (black) is a good absorber of (infrared) radiation 1
- (b) (i) amount of energy required to change (the state of a substance) from solid to liquid (with no change in temperature)
melt is insufficient 1
- unit mass / 1kg 1
- (ii) 5.1×10^6 (J)
accept 5×10^6
allow 1 mark for correct substitution ie $E = 15 \times 3.4 \times 10^5$ 2
- (c) (i) mass of ice
allow volume / weight / amount / quantity of ice 1

- (ii) to distribute the salt throughout the ice
to keep all the ice at the same temperature
- (iii) melting point decreases as the mass of salt is increased
allow concentration for mass
accept negative correlation
*do **not** accept inversely proportional*
- (d) 60 000 (J)
accept 60 KJ
*allow **2** marks for correct substitution ie $E = 500 \times 2.0 \times 60$*
*allow **2** marks for an answer of 1000 **or** 60*
*allow **1** mark for correct substitution ie*
 *$E = 500 \times 2.0$ **or** $0.50 \times 2.0 \times 60$*
*allow **1** mark for an answer of 1*

3

- (e) Marks awarded for this answer will be determined by the Quality of Communication (QC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant content

Level 1 (1–2 marks)

There is *an attempt at a description of some advantages or disadvantages.*

Level 2 (3–4 marks)

*There is a basic description of some advantages **and** / **or** disadvantages for some of the methods*

Level 3 (5–6 marks)

There is a clear description of the advantages and disadvantages of all the methods.

examples of the points made in the response

extra information

energy storage

advantages:

- no fuel costs
- no environmental effects

disadvantages:

- expensive to set up and maintain
- need to dig deep under road
- dependent on (summer) weather
- digging up earth and disrupting habitats

salt spreading

advantages:

- easily available
- cheap

disadvantages:

- can damage trees / plants / drinking water / cars
- needs to be cleaned away

undersoil heating

advantages:

- not dependent on weather
- can be switched on and off

disadvantages:

- costly
- bad for environment

6
[18]

6	(a) solid	1
	(b) decreased	
	<i>correct order only</i>	1
	decreased	1
	increased	1
	(c) (i) A	
	<i>reason only scores if A chosen</i>	1
	uses least / less energy (in 1 year)	
	<i>a comparison is required</i>	
	<i>accept uses least power</i>	
	<i>accept uses least kWh</i>	1
	(ii) greater the volume the greater the energy it uses (in 1 year)	1
	(iii) a very small number sampled	
	<i>accept only tested 3</i>	
	<i>accept insufficient evidence / data</i>	
	<i>allow not all fridges have the same efficiency or a correct description implying different efficiencies</i>	
	<i>only tested each fridge once is insufficient</i>	
	<i>there are lots of different makes is insufficient</i>	1

[8]

7

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

- mass (of block)
accept weight for mass
- starting temperature
- final / increase in temperature
temperature is insufficient
- voltage / p.d.
same power supply insufficient
- power (supplied to each block)
- type / thickness of insulation
same insulation insufficient

2

(ii) one of variables is categoric

or

(type of) material is categoric

- accept the data is categoric*
- accept a description of categoric*
- do **not** accept temp rise is categoric*

1

(iii) concrete

reason only scores if concrete chosen

1

(heater on for) longest / longer time

- a long time or quoting a time is insufficient*
- do **not** accept it is the highest bar*

1

(iv) 4500 (J)

- allow **1** mark for correct substitution ie*
- 2 × 450 × 5 provided no subsequent step shown*

2

(b) (i) point at 10 minutes identified

1

(ii) line through all points except anomalous

line must go from at least first to last point

1

(iii) 20 (°C)

- if 20°C is given, award the mark.*
- If an answer other than 20°C is given, look at the graph. If the graph shows a correct extrapolation of the candidate's best-fit line and the intercept value has been correctly stated, allow 1 mark.*

1

(iv) 2 (minutes)

1
[11]

8

(a) infrared / IR

correct answer only

1

(b) any **two** from:

- increase the power / watts
allow increase the temperature of the oven or make the oven hotter
- decrease the speed
allow leave the biscuits in for longer
- put biscuits through again
increase radiation is insufficient
ignore changes to the design of the oven

2

(c) (inside) surface is a (good) reflector or poor absorber (of IR)

*Ignore bounce for reflect**surface is a (good) reflector of light does not score**surface is a (good) reflector of light and infrared / heat does score*

1

(and) outside surface is poor emitter (of IR)

1

(so) increases the energy reaching the biscuits

*allow reduces energy loss or makes oven more efficient**do **not** accept no energy losses**keeps oven hotter is insufficient*

1

[6]

9 Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks

No relevant content.

Level 1 (1–2 marks)

Considers either solid or gas and describes at least one aspect of the particles.

or

Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)

Considers both solids and gases and describes aspects of the particles.

or

Considers one state and describes aspects of the particles and explains at least one of the properties.

or

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)

Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

extra information

Solids

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

any explanation of a property must match with the given aspect(s) of the particles.

Gases

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container)

- 10** (a) air near freezer compartment is cooled or loses energy
accept air at the top is cold 1
- cool air is (more) dense or particles close(r) together (than warmer air)
do not allow the particles get smaller / condense 1
- so (cooler) air falls 1
- air (at bottom) is displaced / moves upwards / rises
do not allow heat rises
accept warm air (at the bottom) rises 1
- (b) if volume is doubled, energy use is not doubled
or
volume ÷ energy not a constant ratio 1
- correct reference to data, eg 500 is 2×250 but 630 not 2×300 1
- (c) accept suitable examples, eg
advantage:
- reduces emissions into atmosphere
 - lower input power or uses less energy or wastes less energy
 - costs less to run
- cost of buying or installing new fridge is insufficient*
ignore reference to size of fridge 1
- disadvantage:
- land fill
 - energy waste in production
 - cost or difficulty of disposal
 - transport costs
- 1 **[8]**
- 11** (a) conduction 1
- (b) 35 000 1

(c) 500

*their (b) = 2 x c x 35 correctly calculated scores 2 marks**allow 1 mark for correct substitution,**ie 35000 = 2 x c x 35***or***their (b) = 2 x c x 35*

2

J / kg°C

1

(d) energy lost to surroundings

or

energy needed to warm heater

*accept there is no insulation (on the copper block)**do **not** accept answers in terms of human error or poor results or defective equipment*

1

[6]**12**

(a) conduction

must be in correct order

1

convection

1

(b) (i) 70

*accept ± half a square
(69.8 to 70.2)*

1

(ii) 15

*accept 14.6 to 15.4 for 2 marks
allow for 1 mark 70 – 55
ecf from (b)(i) ± half a square*

2

(iii) C

1

biggest drop in temperature during a given time

accept it has the steepest gradient this is a dependent

1

(iv) starting at 70 °C and below graph for C
must be a curve up to at least 8 minutes

1

(v) because 20 °C is room temperature

accept same temperature as surroundings

1

(c) (i) 6720

*correct answer with or without working gains 3 marks**6 720 000 gains 2 marks**correct substitution of $E = 0.2 \times 4200 \times 8$ gains 2 marks**correct substitution of $E = 200 \times 4200 \times 8$ gains 1 mark*

3

(ii) the fastest particles have enough energy

accept molecules for particles

1

to escape from the surface of the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

the lower the mean energy of particles the lower the temperature (of the water)

accept speed for energy

1

[16]**13**(a) (i) temperature (increase) and time switched on are directly proportional*accept the idea of equal increases in time giving equal increases in temperature**answers such as:*

- *as time increases, temperature increases*
- *positive correlation*
- *linear relationship*
- *temperature and time are proportional*

score 1 mark

2

(ii) any **one** from:*"it" refers to the metal block*

- energy transfer (from the block) to the surroundings
accept lost for transfer
accept air for surroundings
- (some) energy used to warm the heater / thermometer (itself)
accept takes time for heater to warm up
- (metal) block is not insulated

1

(iii) 15 000

allow 1 mark for correct substitution, ie 50×300 provided no subsequent step shown

2

(b) lead

reason only scores if lead is chosen

1

needs least energy to raise temperature by 1°C

*accept needs less energy to heat it (by the same amount)**lowest specific heat capacity is insufficient*

1

[7]

14

(a) any **two** from:

- water evaporates

*accept steam / water vapour for water molecules**accept water turns to steam*

- water molecules / particles go into the air

- mirror (surface) is cooler than (damp) air

accept the mirror / surface / glass is cold

- water molecules / particles that hit the mirror lose energy

accept water molecules / particles that hit the mirror cool down

- cooler air cannot hold as many water molecules / particles

2

(causes) condensation (on the mirror)

*accept steam changes back to water (on the mirror)***or**

particles move closer together

1

(b) mirror (surface) is warm

mirror is heated is insufficient

1

(rate of) condensation reduced

accept no condensation (happens)

1

[5]

15

- (a) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the [Marking guidance](#).

0 marks

No relevant content.

Level 1(1-2 marks)

There is a basic explanation of **one** feature

or

a simple statement relating reduction in energy transfer to **one** feature.

Level 2(3-4 marks)

There is a clear explanation of **one** feature

or

a simple statement relating reduction in energy transfer to **two** features.

Level 3(5-6 marks)

There is a detailed explanation of at least **two** features

or

a simple statement relating reduction in energy transfer to all **four** features.

Examples of the points made in response***extra information****accept throughout:**heat for energy**loss for transfer*

plastic cap:

- plastic is a poor conductor
accept insulator for poor conductor
- stops convection currents forming at the top of the flask so stopping energy transfer by convection
- molecules / particles evaporating from the (hot) liquid cannot move into the (surrounding) air so stops energy transfer by evaporation
- plastic cap reduces / stops energy transfer by conduction / convection / evaporation

glass container:

- glass is a poor conductor so reducing energy transfer by conduction
- glass reduces / stops energy transfer by conduction

vacuum:

- both conduction and convection require a medium / particles
- so stops energy transfer between the two walls by conduction and convection
- vacuum stops energy transfer by conduction / convection

silvered surfaces:

- silvered surfaces reflect infrared radiation
accept heat for infrared
- silvered surfaces are poor emitters of infrared radiation
- infrared radiation (partly) reflected back (towards hot liquid)
- silvered surfaces reduce / stop energy transfer by radiation

6

- (b) (the ears have a) small surface area
ears are small is insufficient

1

so reducing energy radiated / transferred (from the fox)

accept heat lost for energy radiated

*do **not** accept stops heat loss*

1

[8]**16**

(a) conduction

1

(b) (i) there is a bigger temperature difference between the water and the surrounding air

accept the water is hottest / hotter

1

so the transfer of energy (from hot water) is faster

accept heat for energy

ignore temperature falls the fastest

1

(ii) 120

*allow **1** mark for converting kJ to J correctly, ie 4 032 000*

or

correctly calculating temperature fall as 8°C

or

allow **2** marks for correct substitution, ie $4\,032\,000 = m \times 4200 \times 8$

answers of 0.12, 19.2 **or** 16.6 gain **2** marks

answers of 0.019 **or** 0.017 gain **1** mark

3

(iii) water stays hot for longer

1

so heater is on for less time

accept so less energy needed to heat water

1

so cost of the jacket is soon recovered from) lower energy costs / bills

accept short payback time

1

[9]**17**

(a) (i) Z

1

(ii) X

1

(b) (i) moving randomly

1

(ii) stronger than

1

(c) (i) evaporation

1

(ii) any **one** from:

- becomes windy
- temperature increases
accept (becomes) sunny
“the sun” alone is insufficient
- less humid

1

[6]**18**

(a) to reflect (the infrared)

accept (shiny surfaces) are good reflectors
ignore reference to incorrect type of wave

1

(b) black

1

best absorber (of infrared)

answer should be comparative
black absorbs (infrared) is insufficient
accept good absorber (of infrared)
ignore reference to emitter
ignore attracts heat
ignore reference to conduction

1

(c) to reduce energy loss

accept to stop energy loss
accept heat for energy
accept to stop / reduce convection

or

so temperature of water increases faster

accept to heat water faster
accept cooks food faster

or

reduces loss of water (by evaporation)

1

(d) 672 000

allow 1 mark for correct substitution, ie $2 \times 4200 \times 80$ provided no subsequent step shown

2

[6]

19

(a) (i) 5(.0)

1

(ii) 35 **or** their (a)(i) $\times 7$ correctly calculated

*allow 1 mark for correct substitution, ie 5 **or** their (a)(i) $\times 7$ provided no subsequent step shown*

2

(iii) 525(p)

or

(£) 5.25

ortheir (a)(ii) $\times 15$ correctly calculated

if unit p or £ given they must be consistent with the numerical answer

1

(iv) decreases

1

temperature difference (between inside and outside) decreases

accept gradient (of line) decreases

*do **not** accept temperature (inside) decreases*

*do **not** accept graph goes down*

1

(b) air (bubbles are) trapped (in the foam)

*do **not** accept air traps heat*

foam has air pockets is insufficient

1

(and so the) air cannot circulate / move / form convection current

air is a good insulator is insufficient

no convection current is insufficient

answers in terms of warm air from the room being trapped are incorrect and score no marks

1

[8]

20

(a) (matt) black is a good emitter of infrared / radiation

accept heat for infrared / radiation

ignore reference to good absorber

attracts heat negates this marking point

1

to give maximum (rate of) energy transfer (to surroundings)

accept temperature (of coolant) falls fast(er)

accept black emits more radiation for 1 mark

black emits most radiation / black is the best emitter of radiation for 2 marks

1

(b) the fins increase the surface area

accept heat for energy

1

so increasing the (rate of) energy transfer

or

so more fins greater (rate of) energy transfer

1

(c) 114 000

allow 1 mark for correct temperature change, ie 15 (°C)

or

allow 2 marks for correct substitution, ie $2 \times 3\,800 \times 15$

answers of 851 200 or 737 200 gain 2 marks

or

substitution $2 \times 3800 \times 112$ or $2 \times 3800 \times 97$ gains 1 mark

an answer of 114 kJ gains 3 marks

3

(d) increases the efficiency

1

less (input) energy is wasted

accept some of the energy that would have been wasted is (usefully) used

or

more (input) energy is usefully used

accept heat for energy

1

[9]

21

(a) there are strong forces (of attraction) between the particles in a solid

accept molecules / atoms for particles throughout

accept bonds for forces

1

(holding) the particles close together

particles in a solid are less spread out is insufficient

1

or

(holding) the particles in a fixed pattern / positions

but in a gas the forces between the particles are negligible

accept very small / zero for negligible

accept bonds for forces

1

so the particles spread out (to fill their container)

accept particles are not close together

gas particles are not in a fixed position is insufficient

1

(b) (i) particles are (shown) leaving (the liquid / container)

accept molecules / atoms for particles throughout

accept particles are escaping

particles are getting further apart is insufficient

1

(ii) *accept molecules / atoms for particles throughout*

accept speed / velocity for energy throughout

particles with most energy leave the (surface of the) liquid

accept fastest particles leave the liquid

1

so the mean / average energy of the remaining particles goes down

1

and the lower the average energy (of the particles) the lower the temperature
(of the liquid)

1

[8]

22

(a) conduction

1

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

- starting temperature (of cold water)
temperature is insufficient
- pipe length
accept size of pipe
- pipe diameter
- pipe (wall) thickness
- volume of cold water
accept amount for volume
- temperature of hot water (in)
- time

1

(ii) copper

1

greatest temperature change

only scores if copper chosen

accept heat for temperature

accept heated water the fastest

accept it was hottest (after 10 minutes)

accept it is the best / a good conductor

1

(c) the pipe has a larger (surface) area

accept pipe is longer

1

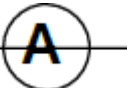
(so) hot / dirty water (inside pipe) is in contact with cold / clean water (outside pipe) for longer

1

[6]

23

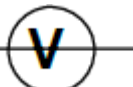
(a) (i) ammeter symbol correct and drawn in series

accept 

do not accept lower case a

1

voltmeter symbol correct and drawn in parallel with the material

do not accept 

1

- (ii) adjust / use the variable resistor
accept change the resistance

or

change the number of cells

accept battery for cell

accept change the pd / accept change the voltage

accept increase / decrease for change

1

- (b) (i) 37.5 (Ω)
accept answer between 36 and 39 inclusive

1

- (ii) 5.6(25) **or** their (b)(i) \times 0.15
*allow 1 mark for correct substitution ie 37.5 **or** their (b)(i) \times 0.15
provided no subsequent step shown*

2

- (c) (i) the thicker the putty the lower the resistance
*answer must be comparative
accept the converse*

1

- (ii) any **one** from:

- measuring length incorrectly
accept may be different length
- measuring current incorrectly
*do **not** accept different currents*
- measuring voltage incorrectly
*do **not** accept different voltage*
- ammeter / voltmeter incorrectly calibrated
- thickness of putty not uniform
*do **not** accept pieces of putty not the same unless qualified*
- meter has a zero error
*do **not** accept systematic / random error
accept any sensible source of error eg putty at different
temperatures
do **not** accept human error without an explanation
do **not** accept amount of putty not same*

1

[8]

24

- (a) (i) random distribution of circles in the box with at least 50 % of circles touching

1

random distribution of circles occupies more than 50 % of the space
judged by eye

1

- (ii) (large) gaps between particles
accept particles do not touch
accept particles are spread out

1

(so) easy to push particles closer (together)

or

forces between particles are negligible / none

an answer in terms of number of particles is insufficient

1

- (b) (i) (both are) random
*accept a correct description of random eg unpredictable or move
around freely or in all directions*
they take up all the space is insufficient
they are spread out is insufficient
they move in straight lines is insufficient

1

- (ii) (speed also) increases

1

[6]

25

- (a) (i) conduction

1

convection

1

correct order only

- (ii) to keep the ceramic bricks hot for a longer time

1

- (b) (i) $E = P \times t$

18.2

*allow 1 mark for correct substitution ie 2.6×7 provided that no
subsequent step is shown*

2

- (ii) 91 (p)
or their (b)(i) $\times 5$ correctly calculated

accept £0.91

do not accept 0.91 without £ sign

1

(c) $E = m \times c \times \theta$

2 250 000

allow **1** mark for correct substitution ie $120 \times 750 \times 25$ provided that no subsequent step is shown

answers 2250 kJ or 2.25 MJ gain both marks

2

[8]**26**(a) **B**

no mark for **B** - marks are for the explanation

first two mark points can score even if **A** is chosen

draught increases (the rate of) evaporation

accept more evaporation happens

accept draught removes (evaporated) particles faster

do **not** accept answers in terms of particles gaining energy from the fan / draught

1

evaporation has a cooling effect

accept (average) kinetic energy of (remaining) particles decreases

1

so temperature will fall faster / further

1

(b) larger surface area

1

increasing the (rate of) evaporation

accept more / faster evaporation

accept easier for particles to evaporate

or

for water to evaporate from

accept more particles can evaporate

accept water / particles which have evaporated are trapped (in the bag)

answers in terms of exposure to the Sun are insufficient

1

[5]

27

(a) $E = P \times t$

91 (p)

*an answer £0.91 gains 3 marks**an answer 0.91 gains 2 marks**allow 2 marks for energy transferred = 18.2 (kWh)***or***substitution into 2 equations combined, ie $2.6 \times 7 \times 5$* *allow 1 mark for correct substitution into $E = P \times t$, ie $E = 2.6 \times 7$* **or***allow 1 mark for multiplying and correctly calculating an incorrect energy transfer value by 5*

3

(b) answers should be in terms of supply exceeding demand

accept there is a surplus / excess of electricity (at night)

1

(c) reduce (rate of) energy transfer (from ceramic bricks)

*accept heat for energy**do **not** accept no energy / heat escapes**do **not** accept answers in terms of lost / losing heat if this implies heat is wasted energy*

1

so keeping the (ceramic) bricks hot for longer

*accept increase time that energy is transferred to the room**accept keep room warm for longer***or**

to stop the casing getting too hot

accept so you do not get burnt (on the casing)

1

(d) $E = m \times c \times \theta$

120

*allow 1 mark for correct substitution**ie $9\,000\,000 = m \times 750 \times 100$*

2

[8]**28**

(a) (i) conduction

1

- (ii) atoms gain (kinetic) energy
accept particles / molecules for atoms
*do **not** accept electrons for atoms*
or
atoms vibrate with a bigger amplitude
accept vibrate faster / more
*do **not** accept start to vibrate*
or
atoms collide with neighbouring atoms

1

transferring energy to (neighbouring / other) atoms
*do **not** accept heat for energy*
or
making these other atoms vibrate with a bigger amplitude
accept faster / more for bigger amplitude
mention of (free) electrons moving and passing on energy negates this mark

1

(b) (i) 5 (°C) to 25 (°C)
either order

1

(ii) a correct example of doubling temperature difference doubling heat transfer
eg going from 5 to 10 (°C) difference doubles heat transfer from 30 to 60 (J/s)
accept for heat transfer number of joules / it
*allow **1** mark for correctly reading 1 set of data eg at 5 °C the heat transfer is 30*
or
for every 5°C increase in temperature difference heat transfer increases by 30 (J/s)
no credit for stating they are directly proportional

2

(iii) 1800
*allow **1** mark for obtaining heat transfer value = 120*

2

(c) payback time calculated as 33 years
calculations must be correct to score the first mark point
explanations must relate to it not being cost effective

1

this is greater than lifetime of windows

or

total savings (over 30 years) = £4800 (1)

this is less than cost of windows (1)

or

$$\frac{5280}{30} = 176 \text{ (1)}$$

this is more than the yearly savings (1)

1

[10]

29

(a) any **two** from:

- black is a good emitter of (infrared radiation)
accept heat for radiation
ignore reference to absorbing radiation
- large surface (area)
- matt surfaces are better emitters (than shiny surfaces)
accept matt surfaces are good emitters
ignore reference to good conductor

2

(b) 90% or 0.9(0)

$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

allow 1 mark for correct substitution, ie $\frac{13.5}{15}$

provided no subsequent step shown

an answer of 90 scores 1 mark

an answer of 90 / 0.90 with a unit scores 1 mark

2

(c) (producing) light

allow (producing) sound

1

(d) any **two** from:

- wood is renewable
accept wood grows again / quickly
accept wood can be replanted
- (using wood) conserves fossil fuels
accept doesn't use fossil fuels
- wood is carbon neutral
accept a description
cheaper / saves money is insufficient

2

(e) $E = m \times c \times \theta$

2 550 000

allow 1 mark for correct substitution
ie $100 \times 510 \times 50$
provided no subsequent step shown
answers of 1 020 000, 3 570 000 gain 1 mark

2

joules /J

accept kJ / MJ
*do **not** accept j*
for full credit the unit and numerical answer must be consistent

1

[10]

30

accept atoms / particles for ions throughout

(a metal has) free electrons

accept mobile for free

1

(kinetic) energy of (free) electrons increases

accept energy of ions increases
accept ions vibrate with a bigger amplitude
accept ions vibrate more
*do **not** accept electrons vibrate more*

1

(free) electrons move faster

1

or

electrons move through metal

accept electrons collide with other electrons / ions

(so) electrons transfer energy to other electrons / ions

accept ions transfer energy to neighbouring ions

1

[4]

31

(a) any **two** from:

- (air) particles / molecules / atoms gain energy
- (air) particles / molecules / atoms move faster
*do **not** accept move more*
*do **not** accept move with a bigger amplitude / vibrate more*
- (air) particles / molecules / atoms move apart
- air expands
ignore particles expand
- air becomes less dense
ignore particles become less dense
- warm / hot air / gases / particles rise
*do **not** accept heat rises*
answers in terms of heat particles negates any of the mark points that includes particles

2

(b) (i) any **two** from

- free / mobile electrons gain (kinetic) energy
accept free / mobile electrons move faster
accept vibrate faster for gain energy
- free electrons collide with other (free) electrons / ions / atoms / particles
- atoms / ions / particles collide with other atoms / ions / particles
answers in terms of heat particles negates this mark point

2

- (ii) (faster) energy / heat transfer to room(s) / house
accept room(s) / house gets warm(er)
accept lounge / bedroom / loft for rooms

1

[5]**32**

- (a) (i) radiation

1

- (ii) traps (small pockets of) air
*do **not** accept it's an insulator*
*do **not** accept reduces conduction and / or convection*
*do **not** allow it doesn't allow heat to escape*

1

- (b) (i) bigger temperature difference (between the water and surroundings)
 at the start (than at the end)
*do **not** accept water is hotter*

1

- (ii) starting temperature (of the water)
accept thickness of fleece
*do **not** accept same amount of fleece*
*do **not** accept thermometer / can*
*do **not** accept time is the same*

1

- (iii) 18 (°C)
correct answer only

1

- (iv) **M**

1

- smallest temperature drop (after 20 mins)
*cannot score if **M** is not chosen*
accept it's the best insulator
accept smallest loss in heat
accept keeps heat / warmth in for longer

1

[7]

33

- (a) (i) 2(.0)
accept 2000 W or 2000 watt(s)
accept answer given in table
*do **not** accept 2000* 1
- (ii) 4.5
allow 1 mark for correct substitution
ie 1.5×3
allow 1 mark for the answers 1.5 or 6(.0) 2
- (iii) 54
or
 their (a)(ii) $\times 12$ correctly calculated
allow 1 mark for correct substitution
ie 4.5×12
or
 their (a)(ii) $\times 12$
allow 1 mark if correct answer is given in pounds eg £54 2
- (b) (i) 6 pm 1
- temperature starts to rise faster
only scores if 6 pm given
- or**
 graph (line) is steeper / steepest
it refers to graph gradient or temperature
accept answers in terms of relative temperature rise
eg 5 to 6 pm 2 °C rise, 6 to 7 pm 6 °C rise
accept temperature rises sharply / rapidly / quickly
*do **not** accept temperature starts to rise* 1
- (ii) middle box ticked 1

[8]

34

- (a) (i) walls
accept sides (of house) 1

(ii) fit double glazing

or

close / fit curtains / fit shutters

accept close windows

accept keep house at a lower temperature

accept fit (foam) draft excluders around the windows / in the jams

accept put plastic (film) across the windows

*do **not** accept fit thicker glass*

1

(b) (i) cavity (wall insulation)

accept the middle one

1

(ii) fit hot water jacket **and** draught-proofing

both required

1

(together) saves most money

only scores if first mark scores

accept saves more than fitting (energy efficient) light bulbs

accept saves £40

accept gives the shortest payback time

*an answer fit energy efficient light bulbs (on its own) gains **1** mark only*

1

[5]