Mark schemes

## Q1.

(a) chemical

**1**

kinetic

**1**

*in this order only*

(b) $E_k = 0.5 \times 80 \times 12^2$

**1**

$E_k = 5760$ (J)

**1**

*an answer of 5760 (J) scores **2** marks*

(c) $E = 0.040 \times 480 \times 50$

**1**

$E = 960$ (J)

**1**

*an answer of 960 (J) scores **2** marks*

(d) increased

**1**

**[7]**

## Q2.

(a) range of speeds

**1**

moving in different directions

*accept random motion*

**1**

(b) internal energy

**1**

(c) density = mass / volume

**1**

(d) 0.00254 / 0.0141

**1**

0.18

**1**

*accept 0.18 with no working shown for the **2** calculation marks*

kg / $m^3$

**1**

**[7]**

## Q3.

(a) decreased

*correct order only*

**1**

decreased

**1**

increased

**1**

(b) (i) A

*reason only scores if A chosen*

**1**

uses least / less energy (in 1 year)

*a comparison is required*

*accept uses least power*

*accept uses least kWh*

**1**

(ii) greater the volume the greater the energy it uses (in 1 year)

**1**

(iii) a very small number sampled

*accept only tested 3*

*accept insufficient evidence / data*

*allow not all fridges have the same efficiency **or** a correct description implying different efficiencies*

*only tested each fridge once is insufficient*

*there are lots of different makes is insufficient*

**1**

**[7]**

## Q4.

(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]**

## Q5.

(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]**

## Q6.

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)

**[6]**

## Q7.

(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]**

## Q8.

(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]**

## Q9.

(a) (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**

(b) (i) 6720

*correct answer with or without working gains **3** marks*

*6 720 000 gains **2** marks*

*correct substitution of E = 0.2 × 4200 × 8 gains **2** marks*

*correct substitution of E = 200 × 4200 × 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**

**[14]**

## Q10.

(a) (i) temperature (increase) and time switched on are <u>directly</u> <u>proportional</u>

*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]**

## Q11.

(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]**

## Q12.

(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]**

## Q13.

(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 × 4200 × 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]**

## Q14.

(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]**

## Q15.

(a) (i) 5(.0)

1

(ii) 35 **or** their (a)(i) × 7 correctly calculated

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

2

(iii) 525(p)
**or**
(£) 5.25
**or**
their (a)(ii) × 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]**

## Q16.

(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 × 4200 × 80 provided no subsequent step shown*

**2**

**[6]**

## Q17.

(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 × 3 800 × 15*
*answers of 851 200 **or** 737 200 gain **2** marks*
***or***
*substitution 2 × 3800 × 112 **or** 2 × 3800 × 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]**

## Q18.

(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 <u>mean / average</u> 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]**

## Q19.

(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]**

## Q20.

(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]**

## Q21.

(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) <u>kinetic</u> 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]**

## Q22.

(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 × 7 × 5*

*allow **1** mark for correct substitution into E = P × t, ie E = 2.6 × 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 × 750 × 100*

**2**

**[8]**

## Q23.

(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 (1)

this is more than the yearly savings (1)

**1**

**[10]**

## Q24.

(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)

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

*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 × 510 × 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]**

## Q25.

*accept atoms / particles for ions throughout*

(a metal has) free <u>electrons</u>

*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) <u>electrons</u> 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]**

## Q26.

(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]**

## Q27.

(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]**

## Q28.

(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) (type of) material is categoric

*accept one variable is categoric*
*accept variable(s) are categoric*
*accept it is categoric*
*accept variable(s) are not continuous*
*descriptions of variables ie names and numbers is insufficient*

**1**

(iii) 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) larger (surface) area

*accept the pipe is longer*
*accept hot (dirty) water (inside pipe) is in contact with the cold water (outside pipe) for a longer time*
*he pipe is a spiral is insufficient*

**1**

**[6]**

## Q29.

(a) (i) 2.1

*correct answer only*

**1**

(ii) 3.15
**or**
their (a)(i) × 1.5 correctly calculated

*allow **1** mark for correct substitution*
*ie 2.1 × 1.5*
***or***

*their (a)(i) × 1.5*

**2**

kilowatt-hour

*accept kWh*

***or***

*a substitution 2100 × 5400 scores **1** mark*

*2100 × 5400 incorrectly calculated with answer in joules scores **2** marks*

*an answer of 11 340 000 scores **2** marks*

*an answer of 11 340 000 J scores **3** marks*

**1**

(iii) most (input) energy is usefully transformed

*accept does not waste a lot of energy*

*accept most of the output / energy is useful*

*do **not** accept it does not waste energy*

**1**

(b) the room is losing energy / heat

**1**

at the same rate as the heater supplies it

*this mark only scores if the first is scored*

*do **not** accept heater reaches same temperature as room / surroundings*

*rate of heat gain = rate of heat loss scores both marks*

**1**

**[7]**

## Q30.

(a) (i) silvered surfaces

*more than the correct number of ticks in a row negates the mark*

radiation

**2**

plastic cap

conduction, convection (both required)

| | conduction | convection | radiation | |
|---|---|---|---|---|
| vacuum | ✓ | ✓ | | |
| silvered surfaces | | | ✓ | (1) |
| plastic cap | ✓ | ✓ | | (1) |

(ii)

*any mention of air or any other substance in a vacuum*

*scores zero*

because there are no particles in a vacuum

*accept atoms / molecules for particles*

*accept vacuum is empty space*

*accept there is nothing in a vacuum*

*accept there is no air / gas in the vacuum*

conduction **and** convection need particles / medium

*need reference to both conduction **and** convection*

*accept correct descriptions*

**2**

(b) (i) less heat lost (to air above the heater)

*do **not** accept **no** heat lost*

light shiny surfaces are poor emitters (of radiation)

*accept radiators for emitters*
*references to reflection are neutral*

**or** dull, matt surfaces are good emitters (of radiation)

*do **not** credit answers which infer reflection from the underside of the hood*

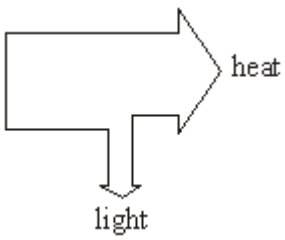
*ignore correct reference to absorption*

**2**

(ii) correct diagram drawn with one output arrow narrower than the other

*ignore input*

arrows correctly labelled with energy form
eg




*flow charts score zero*

**2**

(iii) energy cannot be destroyed

*accept (principle of) conservation of energy*

*do **not** accept because energy cannot be lost without clarification*

**1**

**[9]**

## Q31.

(a) the bigger the surface area, the faster the water cools down / temperature falls

*answers must imply rate*

*accept heat for temperature provided rate is implied*
*do **not** accept cools down more unless qualified*

**1**

(b) any **two** from:

the ears:

- have large surface / area
  *not just has large ears*
- radiate heat
  *accept loses heat, but does not score*
  *if the reason given for heat loss is wrong*
- keep blood cooler

**2**

(c) (i) radiation

**1**

(ii) conduction

**1**

**[5]**

## Q32.

(a) conduction
*do **not** accept conductor*

**1**

(b) the freezer
*both parts needed*

greater <u>temperature</u> difference (between freezer and room)
*do **not** accept because it is the coldest*

**1**

(c) any **two** from:

- poor absorber of heat / radiation
  *accept does not absorb heat poor emitter of heat / radiation*
  *is neutral*
- reflects heat / radiation (from room away from fridge-freezer)
- reduces heat transfer <u>into</u> the fridge-freezer
- reduces power consumption of fridge-freezer
  *do **not** accept it is a bad conductor / good insulator*

**2**

**[4]**

## Q33.

(a) (i) makes it warmer / raises the temperature

*accept produces convection (current)*
*accept makes it less dense*

**1**

(ii) reduced **or** slows down

**1**

(b) (i) electrical energy (to run the pump) must be paid for
*accept electricity for electrical energy*
*accept electricity is needed for the pump*
*accept it uses electricity*
*accept because of the pump*

**1**

(ii) more useful (heat) energy is transferred into the house than the energy used to operate the pump

**or** reduced cost of heating the house is greater than the cost of running the (electrical) pump

**or** costs little to run compared to the savings made
*accept for **1** mark*
*reduces energy bills*
***or** reduced fuel costs / heating costs owtte*
*do **not** accept it's cheap*

**2**

**[5]**

## Q34.

(a) (i) 7pm
*accept 19.00 / 1900*

**1**

(ii) 8pm
*accept 20.00 / 2000*

**1**

temperature drops more slowly
*accept heat for temperature accept line is less steep*

**1**

(b) insulator

**1**

conduction *

**1**

convection *
* *answers can be either way around*

**1**

(c) (i) 4 (years)

**1**

(ii) it is the cheapest / cheaper / cheap

*do **not** accept answers in terms of heat rising or DIY*

**1**

has the shortest / shorter payback time

*do **not** accept short payback time*

**1**

**[9]**

## Q35.

(a) (i) as a source of thermal <u>radiation</u>

*accept heat for thermal radiation*

*accept to act as the Sun*

*do **not** accept sunlight alone*

**1**

(ii) any **one** from:

- volume of water

  *accept amount for volume*
- distance between lamp and boiling tube
- initial / starting temperature of water
- same room temperature

  *do **not** accept time or same insulation material*

**1**

(iii) any **one** from:

- greater sensitivity / precision

  *do **not** accept more reliable (negates mark)*
- could link to a computer for (automatic) data analysis
- could take more frequent readings
- reduces instrument reading error

  *accept more accurate*

  *do **not** accept easier to use on its own*

**1**

(b) (i) acts as a control

*accept to be able to make a comparison*

*accept to see the difference*

*do **not** accept 'to make it a fair test' OWTTE on its own*

**1**

(ii) (plastic) <u>foam</u> and aluminium foil

**1**

(iii) (aluminium) <u>foil</u> is a <u>poor</u> absorber of thermal radiation

*accept heat / infra red for thermal radiation*

**1**

**or** (aluminium) foil is a (good) reflector of thermal radiation

*do **not** accept 'reflects sunlight' on its own*

(plastic) foam traps air which is a (good) insulator

*accept (plastic) foam is a poor conductor / (good) insulator*

*do **not** accept 'the material' is a good insulator / poor conductor*

**1**

(c) particles vibrate with a bigger / stronger amplitude / faster / with more (kinetic) energy

*accept particles vibrate more*

*do **not** accept start to vibrate only*

**1**

energy transferred by collisions with other particles

*do **not** accept answers in terms of free/mobile electrons*

**1**

**[9]**