



## Mark schemes

1

(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  $1.5 \times 3$*   
*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  $4.5 \times 12$*

**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]

2

(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]

3

(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]**

4

(a) (i) 2.1

*correct answer only*

1

(ii) 3.15

**or**

their (a)(i)  $\times$  1.5 correctly calculated

*allow 1 mark for correct substitution*

*ie 2.1  $\times$  1.5*

**or**

*their (a)(i)  $\times$  1.5*

2

kilowatt-hour

*accept kWh*

**or**

*a substitution 2100  $\times$  5400 scores 1 mark*

*2100  $\times$  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]

5

(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*

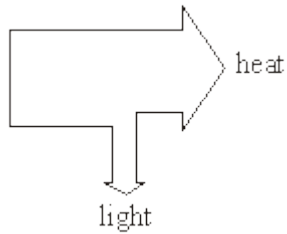
*ignore correct reference to absorption*

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]

6

- (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]

7

- (a) conduction  
do **not** accept conductor 1

- (b) the freezer  
both parts needed  
greater temperature 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 into the fridge-freezer
  - reduces power consumption of fridge-freezer  
do **not** accept it is a bad conductor / good insulator 2

[4]

8

- (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]

9

(a) (i) £190  
*nb mention idea of cost per J in £ will come to an approx figure full credit given*  
*allow 1 mark for showing that the energy loss through the roof is 1/4 of the total energy loss ie 150 / 600* 2

(ii) £142.50  
*allow ecf 50 % of their (a)(i) × 1.5 ie their (a)(i) × 0.75* 1

(b) transferred to surroundings / atmosphere  
**or** becomes spread out 1

[4]

10

- (a) (i) as a source of thermal radiation  
*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) foam and aluminium foil 1
- (iii) (aluminium) foil is a poor 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]

11

- (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 \* 1
- \* answers can be either way around*
- (c) (i) 4 (years) 1
- (ii) it is the cheapest / cheaper / cheap 1
- do **not** accept answers in terms of heat rising or DIY*
- has the shortest / shorter payback time 1
- do **not** accept short payback time*

[9]

12

- (a) the outside colour of the cans 1
- (b) (i) 18 (°C) **or** 88 to 70 1
- ignore negative sign*
- (ii) 8 (°C) **or** 70 to 62 1
- ignore negative sign*
- (c) greater temperature difference between water and surroundings (at start) 1
- must mention temperature difference*
- ignore just water hotter*
- accept energy used to heat cans initially*

(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]

13

(a) four calculations correctly shown

$$200 \times 10 - 1800 = \text{£}200$$

$$100 \times 10 - 2400 = -\text{£}1400$$

$$50 \times 10 - 600 = -\text{£}100$$

$$20 \times 10 - 75 = 125$$

*accept four final answers only or obvious rejection of solar water heater and underfloor heating, with other two calculations*

*completed any 1 complete calculation correctly*

*shown or showing each saving  $\times 10$  of all four calculations = 1 mark*

*answers in terms of savings as a percentage of installation cost*

*may score savings mark only*

2

hot water boiler

*correct answers only*

1

(b) less electricity / energy to be generated / needed from power stations

*accept less demand*

1

reduction in (fossil) fuels being burnt

*accept correctly named fuel*

*accept answer in terms of:*

*fewer light bulbs required because they last longer (1 mark)*

*less energy used / fuels burnt in production / transport etc. (1 mark)*

*ignore reference to CO<sub>2</sub> or global warming*

*ignore reference to conservation of energy*

1

[5]

14

(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]

15

(a) (i) 20

1

(ii) convection

1

(iii) fit draughtproof strips

1

*accept lay carpet*

*accept fit curtains*

*accept close doors / windows / curtains*

*accept any reasonable suggestion for reducing a draught*

*'double glazing' alone is insufficient*

- (b) 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
- (c) (i) most cost effective 1
- 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*
- (ii) 4 1

[7]

16

- (a) (i) vacuum 1
- do not allow stopper*
- (ii) (absence of particles) means no (transfer of energy between) particles for conduction 1
- accept particles **or** atoms **or** molecules **or** electrons*
- 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]**

**17**

- (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]**

**18**

- (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]

19

(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]

20

- (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]

21

*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]

22

(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 x 510 x 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]