(a) conduction

(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

(ii) copper

  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*

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

  *accept pipe is longer*

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

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

  *accept* [A]

  *do not accept lower case a*
voltmeter symbol correct and drawn in parallel with the material

\[ \text{do not accept} \]

(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

(b) (i) 37.5 (Ω)

accept answer between 36 and 39 inclusive

(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

(c) (i) the thicker the putty the lower the resistance

answer must be comparative

accept the converse

1

1

2

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

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

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

(ii) (large) gaps between particles

  accept particles do not touch
  accept particles are spread out

  (so) easy to push particles closer (together)
  or
  forces between particles are negligible / none
  an answer in terms of number of particles is insufficient

(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
(ii) (speed also) increases

1 [6]

(a) (i) conduction
convection

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 \( \times 7 \) 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

5 (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
   so temperature will fall faster / further

(b) larger surface area
   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

(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

(b) answers should be in terms of supply exceeding demand
   accept there is a surplus / excess of electricity (at night)

(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
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)

(d) \[ E = m \times c \times \theta \]

120

allow 1 mark for correct substitution

ie \[ 9 \ 000 \ 000 = m \times 750 \times 100 \]

[8]

(a) (i) conduction

(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
   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

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

(iii) 1800

*allow 1 mark for obtaining heat transfer value = 120

(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

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)

(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
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

(c) (producing) light
allow (producing) sound

(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

(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

joules / J
accept kJ / MJ
do not accept j
for full credit the unit and numerical answer must be consistent
accept atoms / particles for ions throughout

(a metal has) free electrons
accept mobile for free

(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

(free) electrons move faster

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

(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
(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

(ii) (faster) energy / heat transfer to room(s) / house

  accept room(s) / house gets warm(er)
  accept lounge / bedroom / loft for rooms

(a) (i) radiation

(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

(b) (i) bigger temperature difference (between the water and surroundings)

  at the start (than at the end)

  do not accept water is hotter

(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

(iii) 18 °C

  correct answer only

(iv) M
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

(a) (i) 2.0
accept 2000 W or 2000 watt(s)
accept answer given in table
do not accept 2000

(ii) 4.5
allow 1 mark for correct substitution
ie 1.5 × 3
allow 1 mark for the answers 1.5 or 6.0

(iii) 54
or
their (a)(ii) × 12 correctly calculated
allow 1 mark for correct substitution
ie 4.5 × 12
or
their (a)(ii) × 12
allow 1 mark if correct answer is given in pounds eg £54

(b) (i) 6 pm
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
(ii) middle box ticked

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

(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

(b) (i) cavity (wall insulation)
    accept the middle one

(ii) fit hot water jacket and draught-proofing
    both required
    (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