(a)  (i)  5.88 (watts)

   an answer of 5.9 scores 2 marks
   allow 1 mark for correct substitution ie

   \[ \frac{\text{power out}}{14} = 0.42 \]

   allow 1 mark for an answer of 0.0588 or 0.059

(ii)  8.12

   allow 14 – their (a)(i) correctly calculated

(b)  (i)  input power / energy would be (much) less (reducing cost of running)

   accept the converse

   electricity is insufficient

   (also) produce less waste energy / power

   accept ‘heat’ for waste energy

   (as the waste energy / power) increases temperature of the cabinet

   so cooler on for less time

(ii)  line graph

   need to get both parts correct

   accept scattergram or scatter graph

   both variables are continuous

   allow the data is continuous

(c) number of bulbs used-halogen=24 (LED=1)

   total cost of LED = £30 + £67.20 = £97.20

   accept a comparison of buying costs of halogen £36 and LED £30

   total cost of halogen= 24 x £1.50 + 24 x £16.00 = £420

   or

   buying cost of halogen is £36 and operating cost is £384

   accept a comparison of operating costs of halogen £384 and LED £67.20

   allow for 3 marks the difference in total cost is £322.80 if the

   number 24 has not been credited
statement based on correct calculations that overall LED is cheaper

must be both buying and operating costs

an alternative way of answering is in terms of cost per hour:

buying cost per hour for LED \( \frac{£20.00}{48000} \) = 0.0625p/£0.000625

buying cost per hour for halogen = \( \frac{£15.00}{30000} \) = 0.075p/£0.00075

a calculation of both buying costs scores 1 mark

operating cost per hour for LED = \( \frac{£67.00}{48000} \) = 0.14p/£0.0014

operating cost per hour for halogen= \( \frac{£16.00}{30000} \) = 0.8p/£0.008

a calculation of both operating costs scores 1 mark

all calculations show a correct unit

all units correct scores 1 mark

statement based on correct calculations of both buying and operating costs, that overall LED is cheaper

 correct statement scores 1 mark
allow 1 mark for each correct line if more than one line is drawn from any symbol then all of those lines are wrong

(b) (i) half

(ii) \(3(V)\)

(iii) \(V_1\)

(c) (i) potential difference / voltage of the power supply
    
    accept the power supply
    accept the voltage / volts
    accept number of cells / batteries
    accept (same) cells / batteries
    do not accept same ammeter / switch / wires

(ii) bar drawn – height \(1.00\)A
    ignore width of bar
    allow 1 mark for bar shorter than \(3^{rd}\) bar

(iii) as the number of resistors increases the current decreases
(a) (i) Wire Plug terminal

<table>
<thead>
<tr>
<th>Wire</th>
<th>Plug terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Live</td>
<td>C</td>
</tr>
<tr>
<td>Neutral</td>
<td>A</td>
</tr>
<tr>
<td>Earth</td>
<td>B</td>
</tr>
</tbody>
</table>

all 3 correct for 2 marks
allow 1 mark for 1 correct

(ii) plastic
or rubber
accept:
ABS
UF / urea formaldehyde
nylon
PVC

(b) (i) 600
allow 1 mark for correct substitution,

\[ P = \frac{30000}{50} \]
provided no subsequent step

(ii) power is greater than 820 (W)
power is 1200 W is insufficient

the lead /cable / wire will overheat / get (too) hot
accept lead / cable will melt
may overheat / get hot is insufficient

so there is a risk of fire
accept causing a fire

(c) any one from:
• most / more efficient
• smallest energy input (per second)
• cheapest to operate
mark only scores if X is chosen
mark is for the reason
accept smallest input (power) for same output (power)
accept wastes least energy
smallest (power) input is insufficient
uses least electricity is insufficient

(a) 450

allow 1 mark for correct substitution,
ies 18 × 10 × 2.5 provided no subsequent step shown

(b) (i) friction between child (‘s clothing) and slide
accept friction between two insulators
accept child rubs against the slide
accept when two insulators rub (together)

causes electron / charge transfer (between child and slide)
accept specific reference, eg electrons move onto / off the child / slide
reference to positive electrons / protons / positive charge / atoms
transfer negates this mark
answers in terms of the slide being initially charged score zero

(ii) all the charges (on the hair) are the same (polarity)
accept (all) the charge/hair is negative / positive
accept it is positive/negative

charges / hairs are repelling
both parts should be marked together

(iii) charge would pass through the metal (to earth)
accept metal is a conductor
accept metal is not an insulator
accept there is no charge / electron transfer
accept the slide is earthed
accept metals contain free electrons

[9]
[7]
(a) (i) 

![Diagram]

(ii) 360

allow 1 mark for correct substitution, ie $9 = 0.025 \times R$

(iii) sketch graph of correct shape, ie

![Graph]

(iv) An automatic circuit to switch a heating system on and off.

(b) so ammeter reduces / affects current as little as possible

accept so does not reduce / change the current (it is measuring)
accurate reading is insufficient
not change the resistance is insufficient

(c) gives a common understanding

accept is easier to share results
accept can compare results
do not need to be converted is insufficient
prevent errors is insufficient

(d) replace Bunsen (and water) with a lamp

accept any way of changing light level

replace thermometer with light sensor

accept any way of measuring a change in light level
datalogger alone is insufficient

(a) water heated by radiation (from the Sun)

accept IR / energy for radiation
water used to heat buildings / provide hot water

allow for 1 mark heat from the Sun heats water if no other marks given

references to photovoltaic cells / electricity scores 0 marks

(b) 2 (minutes)

\[ 1.4 \times 10^3 = \frac{168 \times 10^3}{t} \]

gains 1 mark

calculation of time of 120 (seconds) scores 2 marks

(c) (i) 150 (kWh)

(ii) £60(.00) or 6000 (p)

an answer of £6000 gains 1 mark

allow 1 mark for 150 \times 0.4(0) 150 \times 40

allow ecf from (c)(i)

(iii) 25 (years)

an answer of 6000 / 240

or

6000 / their (c)(ii) \times 4

gains 2 marks

an answer of 6000 / 60

or

6000 / their (c)(ii) gains 1 mark, ignore any other multiplier of (c)(ii)

(iv) any one from:

- will get £240 per year

accept value consistent with calculated value in (c)(iii)

- amount of light is constant throughout the year

- price per unit stays the same

- condition of cells does not deteriorate

(d) any one from:

- angle of tilt of cells

- cloud cover

- season / shade by trees

- amount of dirt

(a) decreases
(b) a filament bulb

allow bulb

an LED

(c) Marks awarded for this answer will be determined by the Quality of Communication (QoC) as well as the standard of the scientific response.

0 marks
No relevant content.

Level 1 (1–2 marks)
There is a basic description of the method. This is incomplete and would not lead to any useful results.

Level 2 (3–4 marks)
There is a description of the method which is almost complete with a few minor omissions and would lead to some results.

Level 3 (5–6 marks)
There is a detailed description of the method which would lead to valid results. To gain full marks an answer including graph, or another appropriate representation of results, must be given.

examples of the physics points made in the response:

• read V and I
• read temperature
• apply heat
  allow hot water to cool
• read V and I at least one other temperature
• determine R from V / I
• range of temperatures above 50 °C

extra detail:
• use thermometer to read temperature at regular intervals of temperature
• remove source of heat and stir before taking readings
• details of attaining 0 °C or 100 °C
• last reading taken while boiling
• graph of R against T
• at least 3 different temperatures

(d) (i) Q

(ii) (80, 3.18)
(iii) any one from:

- measurement of $V$ too small
- measurement of $I$ too big
- incorrect calculation of $R$
- thermometer misread
  
  allow misread meter

ignore any references to an error that is systematic  

1

(iv) any two from:

- not portable
  
  allow requires a lot of equipment allow takes time to set up
- needs an electrical supply
- cannot be read directly
  
  accept it is more difficult to read compared to liquid-in-glass

2

8 (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 $50 \times 300$ provided no subsequent step shown

2
(b) lead

reason only scores if lead is chosen

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

(a) (i) to obtain a range of p.d. values
accept increase / decrease current / p.d. / voltage / resistance
accept to change / control the current / p.d. / voltage / resistance
to provide resistance is insufficient
a variable resistor is insufficient
do not accept electricity for current

1

(ii) temperature of the bulb increases
accept bulb gets hot(ter)
accept answers correctly
expressed in terms of collisions between (free) electrons and ions / atoms
bulb gets brighter is insufficient

1

(iii) 36
allow 1 mark for correct substitution, ie 12 × 3 provided no subsequent step shown

watt(s) / W
accept joules per second / J/s
do not accept w

2

(b) 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, and apply a ‘best-fit’ approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic comparison of either a cost aspect or an energy efficiency aspect.
Level 2 (3-4 marks)
There is a clear comparison of either the cost aspect or energy efficiency aspect or a basic comparison of both cost and energy efficiency aspects.

Level 3 (5-6 marks)
There is a detailed comparison of both the cost aspect and the energy efficiency aspect.

For full marks the comparisons made should support a conclusion as to which type of bulb is preferable.

Examples of the points made in the response:

cost
• halogen are cheaper to buy
  *simply giving cost figures is insufficient*
• 6 halogen lamps cost the same as one LED
• LEDs last longer
• need to buy 18 / more halogen lamps to last the same time as one LED
• 18 halogens cost £35.10
• costs more to run a halogen than LED
• LED has lower maintenance cost (where many used, eg large departmental store lighting)

energy efficiency
• LED works using a smaller current
• LED wastes less energy
• LEDs are more efficient
• LED is 22% more energy efficient
• LED produces less heat
• LED requires smaller input (power) for same output (power)
(a) 35

an answer with more than 2 sig figs that rounds to 35 gains 2 marks
allow 2 marks for correct method, ie \( \frac{230}{6.5} \)

allow 1 mark for \( I = 6.5 \text{ (A)} \) or \( R = \frac{230}{26} \)

an answer 8.8 gains 2 marks
an answer with more than 2 sig figs that rounds to 8.8 gains 1 mark

(b) (maximum) current exceeds maximum safe current for a 2.5 mm\(^2\) wire
accept power exceeds maximum safe power for a 2.5 mm\(^2\) wire

or
(magnitude) current exceeds 20 (A)

(maximum) current = 26 (A) is insufficient

a 2.5 mm\(^2\) wire would overheat / melt
accept socket for wire
do not accept plug for wire

(c) a.c. is constantly changing direction
accept a.c. flows in two directions
accept a.c. changes direction
a.c. travels in different directions is insufficient

d.c. flows in one direction only