

- M1.** (a) (because the) potential of the live wire is 230 V 1
- (and the) potential of the electrician is 0 V 1
- (so there is a) large potential difference between live wire and electrician 1
- charge / current passes through his body  
*allow voltage for potential difference* 1
- (b) diameter between 3.50 and 3.55 (mm)  
*allow correct use of value of cross-sectional area of 9.5 to 9.9 (mm<sup>2</sup>) with no final answer given for 1 mark* 2
- (c)  $18000 = I \times 300$  1
- $I = 18000 / 300 = 60$  1
- $13\,800 = (60^2) \times R$  1
- $R = 13\,800 / 60^2$  1
- 3.83 ( $\Omega$ ) 1

*allow 3.83( $\Omega$ ) with no working shown for 5 marks  
answer may also be correctly calculated using  $P = IV$  and  $V = IR$  if 230 V is used.*

**[11]**

- M2.** (a) electric current  
(rate of) flow of (electric) charge / electrons

$$I = \frac{Q}{t}$$

accept  
with Q and t correctly named

1

potential difference

work done / energy transferred per coulomb of charge (that passes between two points in a circuit)

$$V = \frac{W}{Q}$$

accept  
with W and Q correctly named

1

- (b) metals contain free electrons (and ions)  
accept mobile for free

1

as temperature of filament increases ions vibrate faster / with a bigger amplitude

accept atoms for ions

accept ions/atoms gain energy

accept vibrate more for vibrate faster

do not accept start to vibrate

1

electrons collide more (frequently) with the ions

**or**

(drift) velocity of electrons decreases

do not accept start to collide

accept increasing the p.d. increases the temperature (1 mark)

**and**

(and) resistance increases with temperature (1 mark) if no other marks scored

1

- (c) 7.8

allow 1 mark for obtaining value 1.3 from graph

**or allow 1 mark for a correct calculation using an incorrect current in the range 1.2-1.6 inclusive**

2

[7]

M3. (a) (i) 
$$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$

1.6 (W)

allow 1 mark for correct substitution ie 
$$0.2 / \frac{20}{100} = \frac{\text{output}}{8}$$

2

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

32 (%) / 0.32

or

their (a)(i) ÷ 5 correctly calculated

ignore any units

1

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

- comparison over same period of time of relative numbers of bulbs required eg over 50 000 hours 5 CFL's required to 1 LED  
*accept an LED lasts 5 times longer*
- link number of bulbs to cost eg 5 CFL's cheaper than 1 LED  
*an answer in terms of over a period of 50 000 hours CFLs cost £15.50 (to buy), LED costs £29.85 (to buy) so CFLs are cheaper scores both marks*  
*an answer in terms of the cost per hour (of lifetime) being cheaper for CFL scores 1 mark if then correctly calculated scores both marks*
- over the same period of time LEDs cost less to operate (than CFLs)

2

(ii) any **one** from:

- price of LED bulbs will drop  
*do **not** accept they become cheaper*
- less electricity needs to be generated  
*accept we will use less electricity*
- less CO<sub>2</sub> produced

- fewer chips needed (for each LED bulb)
  - fewer bulbs required (for same brightness / light)
  - less energy wasted
- do **not** accept electricity for energy*

1

[6]

**M4.** (a) water heated by radiation (from the Sun)  
*accept IR / energy for radiation* 1

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* 1

(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* 3

(c) (i) 150 (kWh) 1

(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)* 2

(iii) 25 (years)  
*an answer of  $6000 / 240$*   
**or**  
 *$6000 / \text{their (c)(ii)} \times 4$*   
*gains 2 marks*  
*an answer of  $6000 / 60$*   
**or**  
 *$6000 / \text{their (c)(ii)}$  gains 1 mark, ignore any other multiplier of (c)(ii)* 3

(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

1

(d) any **one** from:

- angle of tilt of cells
- cloud cover
- season / shade by trees
- amount of dirt

1

[13]



**M5.** (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]

M6.

(a) (i) 5.88 (watts)

*an answer of 5.9 scores 2 marks*

*allow 1 mark for correct substitution ie*

$$0.42 = \frac{\text{power out}}{14}$$

*allow 1 mark for an answer of 0.0588 or 0.059*

2

(ii) 8.12

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

1

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

*accept the converse*

*electricity is insufficient*

1

(also) produce less waste energy / power

*accept 'heat' for waste energy*

1

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

1

so cooler on for less time

1

(ii) line graph

*need to get both parts correct  
accept scattergram or scatter graph*

both variables are continuous  
*allow the data is continuous*

1

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

1

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

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

1

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*

1

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  $\left(\frac{£30.00}{48000}\right) = 0.0625\text{p}/£0.000625$

buying cost per hour for halogen =  $\left(\frac{£1.50}{2000}\right) = 0.075\text{p}/£0.00075$   
*a calculation of both buying costs scores 1 mark*

operating cost per hour for LED =  $\left(\frac{£67.20}{48000}\right) = 0.14\text{p}/£0.0014$

operating cost per hour for halogen =  $\left(\frac{£16.00}{2000}\right) = 0.8\text{p}/£0.008$   
*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*

1

[12]