**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 ($mm^2$) 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 (Ω)

**1**

*allow 3.83(Ω) 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

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

*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)

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

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

1.6 (W)

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

**2**

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

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 $CO_2$ 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 × 0.4(0) 150 × 40*

*allow ecf from **(c)(i)***

**2**

(iii) 25 (years)

*an answer of 6000 / 240*
***or***
*6000 / their **(c)(ii)** × 4*
*gains **2** marks*

*an answer of 6000 / 60*
***or***
*6000 / 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 $\left(\frac{£30.00}{48000}\right)$ = 0.0625p/£0.000625

buying cost per hour for halogen = $\left(\frac{£1.50}{2000}\right)$ = 0.075p/£0.00075

*a calculation of both buying costs scores **1** mark*

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

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

**1**

**[12]**