



## Mark schemes

1.

- (a) A: transmission / power cables

*allow transmission / power lines**allow cables**ignore wires*

1

B: step-down transformer

1

- (b) less thermal energy is transferred to the surroundings.

1

- (c) charge flow =
- $\frac{500\,000\,000}{25\,000}$

1

charge flow = 20 000 (C)

1

- (d) total current = 7.20 (A)

1

$$P = 230 \times 7.20$$

*allow a correct substitution of an incorrect total current*

1

$$P = 1656 \text{ (W)}$$

*allow a correct calculation using an incorrect total current*

1

- (e) dishwasher

1

has the largest current

**or**

has the largest power (input)

1

- (f)
- $E = 600 \times 32\,000\,000$

1

$$E = 19\,200\,000\,000 \text{ (J)}$$

**or**

$$E = 1.92 \times 10^{10} \text{ (J)}$$

1

[12]



<b>2.</b>	(a) increased	1
	decreased	1
	stayed the same	1
	(b) random error	1
	(c) $A_2 = 0.12 \text{ (A)}$	1
	$A_5 = 0.36 \text{ (A)}$	1
	(d) $P = 0.12^2 \times 15$	1
	$P = 0.216 \text{ (W)}$	1
		<b>[8]</b>
<b>3.</b>	(a) ammeter and voltmeter symbols correct	1
	voltmeter in parallel with wire	1
	ammeter in series with wire	1
	(b) <b>Level 3:</b> The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.	5–6
	<b>Level 2:</b> The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.	3–4
	<b>Level 1:</b> The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.	1–2
	<b>No relevant content</b>	0



### Indicative content

- length measured
- length varied
- current measured
- potential difference measured
- repeat readings
- calculate resistance for each length
- $\text{resistance} = \frac{\text{potential difference}}{\text{current}}$
- plot a graph of resistance against length
- hazard: high current
- may cause wire to melt / overheat
- may cause burns (to skin)
- use low currents

(c) the temperature of the wire would not change

1

(d) the accuracy of the student's results would be higher

1

the resolution of the length measurement would be higher

1

[12]

4.

(a)  $P = \frac{120\,000}{8.0}$

1

$P = 15\,000 \text{ (W)}$

1

*an answer of 15 000 (W) scores 2 marks*

(b) energy is transferred in heating the surroundings

1

friction causes energy to be transferred in non-useful ways

1

(c) the switches are in parallel

1

(so) closing either switch completes the circuit

1

(d) gravitational potential energy = mass × gravitational field strength × height

*allow  $E_p = m g h$*

1



(e)  $E_p = 280 \times 9.8 \times 14$

1

$E_p = 38\,416 \text{ (J)}$

1

$E_p = 38\,000 \text{ (J)}$

*an answer that rounds to 38 000 scores 2 marks*

1

*an answer of 38 000 scores 3 marks*

[10]

5.

- (a) transfer of electrons

*mention of positive charge moving negates both marks*

1

from the carpet to the student

1

- (b) three arrows perpendicular to sphere's surface with all arrows directed inwards and distributed evenly around sphere

1

- (c) there is a potential difference between the student and the tap

*do **not** accept the tap / sink is charged*

1

which causes electrons / charges to transfer from the student

**or**

which causes electrons / charges to transfer to the tap

1

which earths the charge

*allow the tap is earthed*

1

- (d) carpet / copper has a low resistance

*allow carpet is a conductor*

**or**

*copper is a conductor*

1

lower / no build-up of charge (on the student)

**or**

(so there is a) smaller / no potential difference between student and tap / earth

1

[8]



6.

- (a) (fixed) solar cells aren't always pointed (directly) at the Sun

or

(fixed) solar cells don't track the Sun (through the sky)

1

(fixed) solar cells don't (always) receive maximum intensity of solar radiation

*allow solar cells won't receive as much (solar) energy*

*allow solar cells won't generate as much electricity*

1

- (b)  $Q = 3.5 \times 3600$

1

$Q = 12\,600$  (C)

1

- (c)

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

1

- (d)

$$0.16 = \frac{\text{useful power output}}{7500}$$

1

useful power output =

$$0.16 \times 7500$$

1

useful power output = 1200 (W)

1

- (e) the energy becomes less useful

1

- (f) a very large area would need to be covered with solar cells

1

[10]

7.

- (a) the polarity (of the supply) does not change

*allow potential difference in one direction (only)*

1

- (b) energy transferred = power  $\times$  time

1



(c)  $162\,000\,000 = 7200 \times t$

1

$$t = \frac{162\,000\,000}{7200}$$

1

$$t = 22\,500 \text{ (s)}$$

1

(d)  $V = I \times R$

1

(e)  $480 = 15 \times R$

1

$$R = \frac{480}{15}$$

1

$$R = 32 \text{ (}\Omega\text{)}$$

1

(f) time taken using system **A** is double the time of system **B**

1

[10]

8.

(a) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

**Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the plan is not fully logically sequenced.

3–4

**Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

#### Indicative content

- measure the current in **R** using the ammeter
- measure the p.d. across **R** using the voltmeter
- vary the resistance of the variable resistor  
(or vary the number of cells or use a variable power supply)
- record a range of values of current and p.d.
  
- ensure current is low to avoid temperature increase
- switch circuit off between readings
- reverse connection of **R** to power supply
- repeat measurements of **I** and **V** in negative direction
- plot a graph of current against p.d.



(b) current and p.d. would not be directly proportional

**or**

I-V graph would not be straight

**or**

I-V graph would be curved

1

(because) resistance of **R** would increase

1

(c) 0.2 (A)

1

(d) any **one** from:

- less chance of misreading

- no parallax error

*allow position of eye(s) does not affect reading*

- it can give a reading closer to the true value

*allow 'it is more accurate'*

*ignore 'no human error' ignore 'easier to read'*

1

[10]

9.

(a) K = step-up transformer

1

L = transmission cables

*allow power cables*

*ignore wires*

1

M = step-down transformer

*allow 1 mark if K and M are labelled transformer but step-up and step-down labels are incorrect or not present*

1

(b) 8 (%) and 32 (%)

*both required*

1

Number of times = 4

1

(c) (burning gas) releases carbon dioxide

1

which causes global warming

*allow greenhouse effect **or** climate change*

1

(d) An energy resource that can be replenished quickly.

1



- (e) higher power output  
*allow more electricity generated*

1

lower variation in power output

1

[10]

10.

- (a) M

1

- (b)



or



1

- (c)

*an answer of 0.8 (A) scores 2 marks*

$$\text{current} = \frac{24}{30}$$

1

$$\text{current} = 0.80 \text{ (A)}$$

1

- (d)

*an answer of 216 (J) scores 2 marks*

$$E = 60 \times 3.6$$

1

$$E = 216 \text{ (J)}$$

1

- (e) The reading in Y would be lower

1

- (f) The total resistance of Y is greater

1

- (g) potential difference = current  $\times$  resistance

or

$$V = IR$$

1



(h)

*an answer of 4.5 ( $\Omega$ ) scores 3 marks*

$$3.6 = 0.80 \times R$$

$$R = \frac{3.6}{0.80}$$

$$R = 4.5 (\Omega)$$

1

1

1

[12]

11.

(a) A

1

(b) C

1

(c) repels

1

increases

1

increases

1

*in this order only*

(d) another scientist repeats the experiment and

gets the same results

1

[6]

12.

(a) The energy transferred each second to the bulb.

1

(b) power = potential difference  $\times$  current  
or

$$P = VI$$

1

(c)

*an answer of 0.17 (A) scores 3 marks*

$$40 = I \times 230$$

$$I = \frac{40}{230}$$

1

$$I = 0.17 (A)$$

1

Electronics (F)

*a correct answer that  
rounds to 0.17 (A) scores  
3 marks*





1

(d)

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

1

(e)

*an answer of 2.7 (W) scores 3 marks*

$$0.30 = \frac{\text{useful power output}}{9.0}$$

1

$$\text{useful power output} = 0.30 \times 9.0$$

1

$$\text{useful power output} = 2.7 \text{ (W)}$$

1

(f) bulbs also transfer thermal energy

*allow light bulbs emit infrared radiation as well as visible light*

*ignore so people know how bright the bulb is*

1

the efficiency of the light bulb also needs to be considered

*allow the cost to power the light bulb depends on the efficiency*

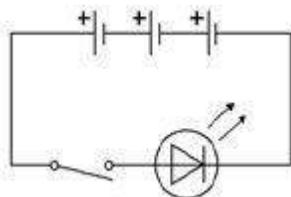
*allow to see how much energy is wasted*

1

[11]

13.

(a)



1

(b) charge flow = current  $\times$  time

**or**

$$Q = It$$

1



(c)  $I = 0.050 \text{ (A)}$

1

$$Q = 0.050 \times 14\,400$$

*allow a correct substitution using an incorrectly/not converted value of  $I$*

1

$$Q = 720 \text{ (C)}$$

*allow a correct calculation using an incorrectly/not converted value of  $I$*

1

(d) there is no current in a diode (in the reverse direction)

**or**

charge will not flow through a diode (in the reverse direction)

*allow diode will not conduct (electric charge)*

*do not accept the circuit is not complete*

1

(because) a diode has a (very) high resistance (in the reverse direction)

1

(e) Efficiency =  $\frac{\text{Useful power output}}{\text{Total power input}}$

1

(f)  $0.75 = \frac{\text{Useful power output}}{0.24}$

1

$$\text{Useful power output} = 0.75 \times 0.24$$

1

$$\text{Useful power output} = 0.18 \text{ (W)}$$

1

[11]

14.

(a) density =  $\frac{\text{mass}}{\text{volume}}$

**or**

$$\rho = \frac{m}{V}$$

1



(b)  $998 = \frac{m}{6\,500\,000}$

1

$$m = 998 \times 6\,500\,000$$

1

$$m = 6\,487\,000\,000$$

1

$$m = 6.487 \times 10^9 \text{ (kg)}$$

*allow a correct conversion of their calculated value of mass into standard form*

1

(c) energy transferred = power  $\times$  time

or

$$E = Pt$$

1

(d)  $t = 18\,000$  (s)

or

$$t = 5 \times 60 \times 60$$

1

$$E = 1.5 \times 10^9 \times 18\,000$$

*allow a correct substitution using an incorrectly/not converted value of  $t$*

1

$$E = 2.7 \times 10^{13} \text{ (J)}$$

*allow a correct calculation using an incorrectly/not converted value of  $t$*

1

(e) the variation in demand is (much) greater than  $1.5 \times 10^9$  W

*allow the increase in demand is greater than the (power) output of the (hydroelectric) power station*

1

demand remains high for longer than 5 hours

*allow 04:00 to 16:00 is 12 hours*

*allow 04:00 to 16:00 is greater than 5 hours*

1

[11]

15.

(a) ammeter and voltmeter symbols correct

1

voltmeter in parallel with lamp

1

ammeter in series with lamp

1



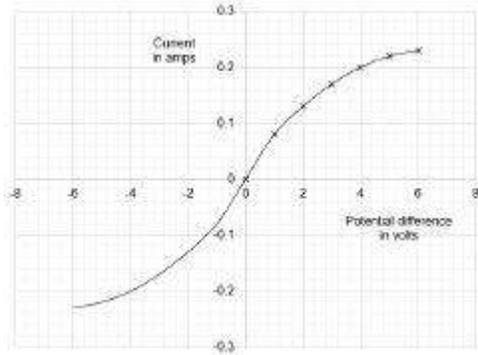
- (b) smooth curved line of correct shape  
*do not accept a line that becomes horizontal*

1

passing through - 4.0 V, - 0.2 A

or

- 6.0 V, - 0.23 A



*2<sup>nd</sup> mark conditional on scoring 1<sup>st</sup> mark*

1

- (c) potential difference = current × resistance

or

$$V = IR$$

1

- (d)  $I = 0.08$  (A)

1

$$1.0 = 0.08 \times R$$

*allow 1.0 = their  $I \times R$  provided their  $I$  has been obtained from the graph*

1

$$R = \frac{1.0}{0.08}$$

*allow  $R = \frac{1.0}{\text{their } I}$*

1

$$R = 12.5 \text{ (}\Omega\text{)}$$

*allow an answer consistent with their  $I$*

1

- (e) ammeter displays a reading when not connected (to a circuit)

1

[11]

16.

- (a) kg

*allow kilogram*

1

°C

*allow degrees Celsius*





(b)



1

(c)  $P = 12^2 \times 15$ 

1

$$P = 2160 \text{ (W)}$$

1

(d) The heating element in the kettle takes time to heat up

1

(e) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

**Level 2:** The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced 3–4

3–4

**Level 1:** The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

**No relevant content**

0

**Indicative content:**

- measure the mass of water using a balance  
**or**  
measure the volume of water using a measuring cylinder
- measure the initial temperature of the water
- pour the water into the kettle
- put temperature probe in the water  
**or**  
put a thermometer in the water
- switch kettle on
- record temperature
- measure time with a stopclock
- use an interval of 5 seconds

(f)  $\Delta\theta = 80 \text{ (}^\circ\text{C)}$ 

1

$$E = 0.50 \times 4200 \times 80$$

*allow  $E = 0.50 \times 4200 \times$  their value of  $\Delta\theta$*

1

$$E = 168\,000 \text{ (J)}$$

*allow an answer consistent with their value of  $\Delta\theta$*

1



(g)  $m = 0.005 \text{ (kg)}$

1

$E = 0.005 \times 2\,260\,000$

*this mark may score if m is not/incorrectly converted*

1

$E = 11\,300 \text{ (J)}$

*allow an answer consistent with their value of m*

1

**[18]**

**17.**

(a)  $R = \frac{36.0}{3}$

1

$R = 12.0 \text{ (}\Omega\text{)}$

1

(b)  $0.1 \Omega$

1

(c) The measurements are grouped closely together

1

(d) The results give a straight line that would go through the origin.

1

(e)  $84 \text{ (}\Omega\text{)}$

*allow an answer between 83 and 85 (}\Omega\text{) inclusive*

1

(f) decreases

1

decreases

1

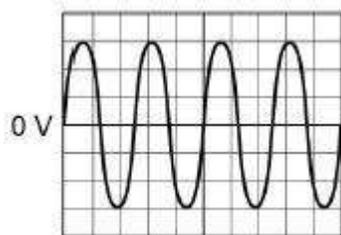
**[8]**

**18.**

(a)  $50 \text{ Hz}$

1

(b)



1

(c)  $P = 0.020 \times 230$

1

$P = 4.6 \text{ (W)}$

(g)  $m = 0.005$  (kg)

1





(d)  $E = 180 \times 230$

1

$E = 41\,400 \text{ (J)}$

1

(e) Hazard:  
live wire

**or**

high potential difference

*ignore current in his body*

1

Risk:

electric shock

**or**

electrocution

*allow (electrical) burn*

*allow death (by electric shock)*

*allow 1 mark for hazard and risk in incorrect order*

1

[8]

19.

(a) 0.08 (s)

1

(b) the current goes higher than normal value

*allow the current goes (too) high*

**or**

the current goes higher than 1.5 A

1

(c)  $P = 1.5 \times 24$

1

$P = 36 \text{ (W)}$

1

*an answer of 36 (W) scores 2 marks*

(d) LED lamps waste a smaller proportion of the input energy than filament lamps

1

[5]



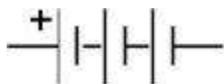
**20.**

- (a) correct circuit symbol

1

3 cells joined in series in correct orientation

e.g.



*ignore absence of + symbol*

1

(b)  $R = \frac{12}{1.6}$

1

$R = 7.5 (\Omega)$

1

*an answer of 7.5 ( $\Omega$ ) scores 2 marks*

- (c) 4.0 ( $\Omega$ )

*allow their answer to part (b) – 3.5 correctly calculated*

1

- (d) it decreases

1

the current would be higher (for the same p.d.)

*reason only scores if correct box is chosen*

**or**

more than one path for charge to flow

*allow current for charge*

**or**

total resistance is always less than the smallest individual resistance

1

[7]

**21.**

- (a) 

1

(b)  $E = 13 \times 230$

1

$E = 2990 (J)$

1

*an answer 2990 (J) scores 2 marks*

- (c) charge flow = current  $\times$  time

*allow  $Q = It$*



(d)  $1.52 = I \times 0.40$

1

$$I = \frac{1.52}{0.40}$$

1

$$I = 3.8 \text{ (A)}$$

1

*an answer of 3.8 (A) scores 3 marks*

(e)  $E = 0.00175 \times 205\,000$

1

$$E = 359 \text{ (J)}$$

*allow an answer that rounds to 360 (J) for 2 marks*

1

*an answer of 359 (J) scores 2 marks*

**[9]**