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 × 7.20

allow a correct substitution of an incorrect total current

1

P = 1656 (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 × 32 000 000

1

E = 19 200 000 000 (J)
or
E = 1.92 × 1010 (J)

1

[12]

2. (a) increased **1**

decreased **1**

stayed the same **1**

(b) random error **1**

(c) A2 = 0.12 (A) **1**

A5 = 0.36 (A) **1**

(d) P = 0.122 × 15 **1**

P = 0.216 (W) **1**

[8]

3. (a) ammeter and voltmeter symbols correct **1**

voltmeter in parallel with wire **1**

ammeter in series with wire **1**

(b) **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**

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

- 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 (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 **1**
allow Ep = m g h

(e) Ep = 280 × 9.8 × 14

1

Ep = 38 416 (J)

1

Ep = 38 000 (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 =
0.16×7500

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 × time

1

(c) $162\,000\,000 = 7200 \times t$ **1**

$$t = \frac{162\,000\,000}{7200}$$ **1**

$t = 22\,500$ (s) **1**

(d) $V = I \times R$ **1**

(e) $480 = 15 \times R$ **1**

$$R = \frac{480}{15}$$ **1**

$R = 32\ (\Omega)$ **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

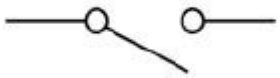
[10]

10. (a) M

1

(b)

or



1

(c)

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

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

1

current = 0.80 (A)

1

(d)

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

E = 60 × 3.6

1

E = 216 (J)

1

(e) The reading in **Y** would be lower

1

(f) The total resistance of **Y** is greater

1

(g) potential difference = current × resistance

or

V = IR

1

(h)

an answer of 4.5 (Ω) scores ***3*** *marks*

$3.6 = 0.80 \times R$ **1**

$R = \frac{3.6}{0.80}$ **1**

$R = 4.5\ (\Omega)$ **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 × current

or

$P = VI$ **1**

(c)

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

$40 = I \times 230$ **1**

$I = \frac{40}{230}$ **1**

$I = 0.17\ (A)$

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

useful power output = 0.30 × 9.0

1

useful power output = 2.7 (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

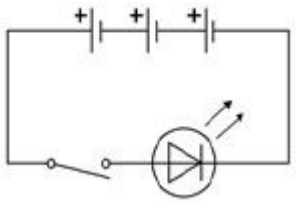
allow the cost to power the light bulb depends on the efficiency

allow to see how much energy is wasted

1

[11]

13. (a)



1

(b) charge flow = current × time

or

$Q = It$

1

(c) I = 0.050 (A)

1

Q = 0.050 × 14 400

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

1

Q = 720 (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

Useful power output = 0.75 × 0.24

1

Useful power output = 0.18 (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

$m = 6.487 \times 109$ (kg)

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

1

(c) energy transferred = power × time

or

$E = P \times t$

1

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

or

$t = 5 \times 60 \times 60$

1

$E = 1.5 \times 109 \times 18\,000$

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

1

$E = 2.7 \times 1013$ (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 × 109 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

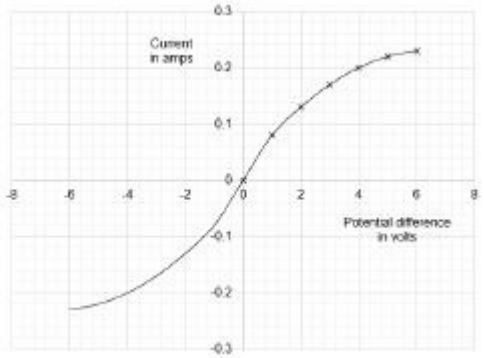
ammeter in series with lamp

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



2nd mark conditional on scoring 1st mark

1

(c) potential difference = current × resistance
or
V = IR

1

(d) I = 0.08 (A)

1

1.0 = 0.08 × R
allow 1.0 = their I × 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 (Ω)
allow an answer consistent with their I

1

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

1

[11]

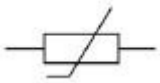
16. (a) kg
allow kilogram

1

°C
allow degrees Celsius

1

(b)



1

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

1

$P = 2160$ (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) $\Delta\Theta = 80$ (°C)

1

$E = 0.50 \times 4200 \times 80$

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

1

$E = 168\,000$ (J)

allow an answer consistent with their value of $\Delta\Theta$

1

(g) m = 0.005 (kg)

1

E = 0.005 × 2 260 000

this mark may score if m is not/incorrectly converted

1

E = 11 300 (J)

allow an answer consistent with their value of m

1

[18]

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

1

R = 12.0 (Ω)

1

(b) 0.1 Ω

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 (Ω)

allow an answer between 83 and 85 (Ω) inclusive

1

(f) decreases

1

decreases

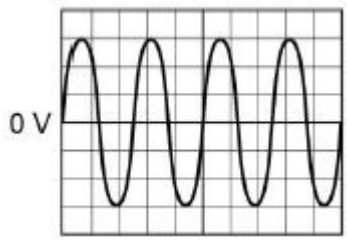
1

[8]

18. (a) 50 Hz

1

(b)



1

(c) P = 0.020 × 230

1

P = 4.6 (W)

1

(d) E = 180 × 230

1

E = 41 400 (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 × 24

1

P = 36 (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

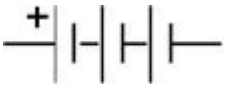
[5]

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 (Ω)

1

*an answer of 7.5 (Ω) scores **2** marks*

(c) 4.0 (Ω)

*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 × 230

1

E = 2990 (J)

1

*an answer 2990 (J) scores **2** marks*

(c) charge flow = current × time

allow Q = It

1

(d) $1.52 = I \times 0.40$ **1**

$$I = \frac{1.52}{0.40}$$ **1**

$I = 3.8$ (A) **1**

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

(e) $E = 0.00175 \times 205\,000$ **1**

$E = 359$ (J)

*allow an answer that rounds to 360 (J) for **2** marks* **1**

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

[9]