Electricity part 1 AQA Triple Physics

Name: ____________________

Class: ____________________

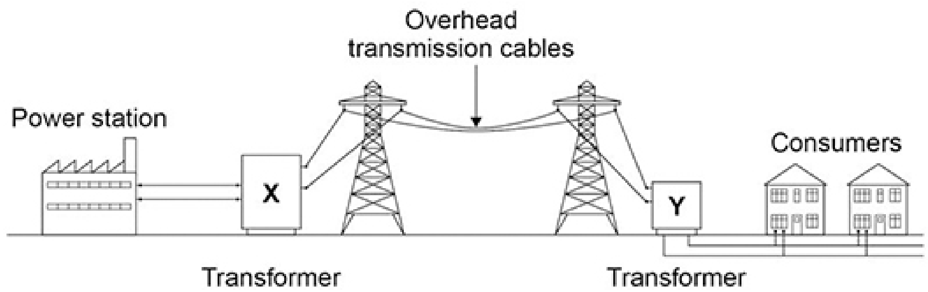
Date: ____________________

Time: **93 minutes**

Marks: **87 marks**

Comments:

1. The figure below shows how electricity is supplied to consumers by the National Grid.



(a) Explain why transformer **X** is used in the National Grid.

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(4)

(b) Explain why transformer **Y** is used in the National Grid.

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(2)

(c) The town of Hornsdale in Australia has electricity supplied by a huge battery.

On one day the battery transferred 3.24×10^{11} J of energy to the town.

The potential difference of the town s electricity supply is 230 V.

Calculate the charge flow to the town on this day.

Use the Physics Equations Sheet.

Give your answer to **3** significant figures.

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Charge flow (3 significant figures) = ____________________ C

(4)

(Total 10 marks)

2. A student rubbed a plastic rod with a cloth.

The rod became negatively charged and the cloth became positively charged.

(a) Explain why the cloth became positively charged.

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(3)

Figure 1 shows the negatively charged rod on a balance.

Figure 1

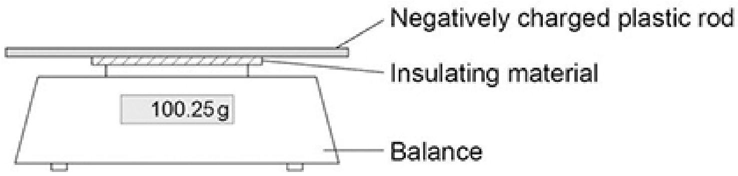
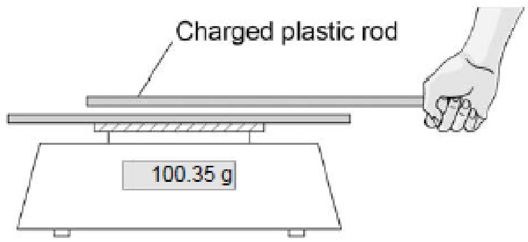


Figure 2 shows another charged rod being held stationary above the rod on the balance.

The rods do not touch each other.

Figure 2



(b) Explain why the reading on the balance increases.

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(3)

(c) The balance had a zero error.

The zero error is not important in this experiment.

Give the reason why.

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(1)

(d) A negatively charged rod is held near an earthed conductor.

Explain why a spark jumps between the negatively charged rod and the earthed conductor.

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(3)

(Total 10 marks)

3. An engineering company has invented pavement tiles that generate electricity as people walk on them.

The figure below shows someone walking on the pavement tiles.

Use the Physics Equations Sheet to answer parts (a) and (b).

(a) What equation links current (I), potential difference (V) and power (P)?

Tick (✓) **one** box.

$P = \frac{V}{I}$	☐
$P = V \times I$	☐
$I = P \times V$	☐
$V = I^2 \times P$	☐

(1)

(b) When a person walks on a tile, a potential difference of 40 V is induced across the tile.

The power output of the tile is 4.4 W.

Calculate the current in the tile.

____

____

____

____

____

Current = ________________ A

(3)

Use the Physics Equations Sheet to answer parts (c) and (d).

(c) What equation links efficiency, total power input and useful power output?

Tick (✓) **one** box.

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

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

Efficiency = useful power output × total power input ☐

(1)

(d) The tiles are used to power LED lights in the pavement.

An LED light has a total power input of 4.0 W.

The efficiency of the LED light is 0.85

Calculate the useful power output of the LED light.

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____

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____

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Useful power output = ________________ W

(3)

(Total 8 marks)

4. A student investigated how the current in a circuit varied with the number of lamps connected in parallel in the circuit.

Figure 1 shows the circuit with three identical lamps connected in parallel.

Figure 1

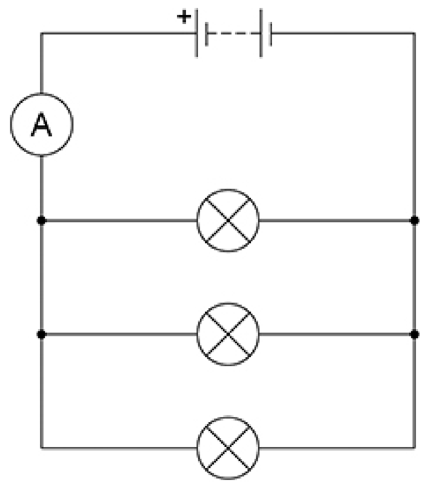
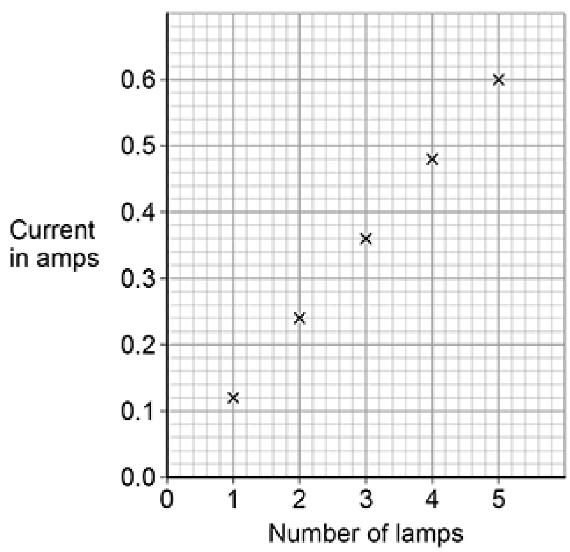


Figure 2 shows the results**.**

Figure 2



(a) Complete the sentences.

Choose answers from the box.

Each answer can be used once, more than once or not at all.

decreased	**stayed the same**	**increased**

As the number of lamps increased, the current __________________.

As the number of lamps increased, the total resistance of the circuit

____________________ .

As the number of lamps increased, the potential difference across the battery

____________________ .

(3)

(b) When there were three lamps in the circuit the ammeter reading kept changing between 0.35 A and 0.36 A.

What type of error would this lead to?

Tick (✓) **one** box.

Random error ☐

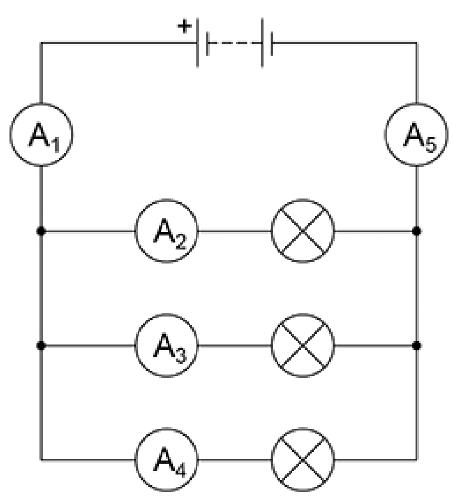
Systematic error ☐

Zero error ☐

(1)

Figure 3 shows a circuit with five ammeters and three identical lamps.

Figure 3



(c) Complete the table below to show the readings on ammeters A_2 and A_5.

Ammeter	**A_1**	**A_2**	**A_3**	**A_4**	**A_5**
Current in amps	0.36		0.12	0.12	

(2)

(d) The resistance of one lamp is 15 Ω.

The current in the lamp is 0.12 A.

Calculate the power output of the lamp.

Use the equation:

$$\text{power} = (\text{current})^2 \times \text{resistance}$$

____

____

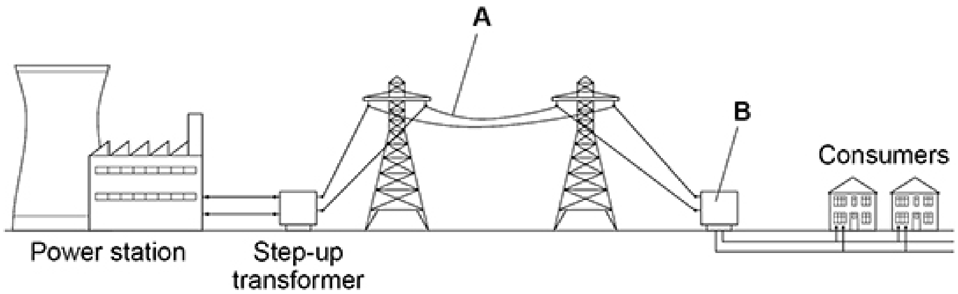
____

Power = _______________ W

(2)

(Total 8 marks)

5. The figure below shows part of the National Grid linking a power station to consumers.



(a) Name the parts of the figure above labelled **A** and **B**.

A ____

B ____

(2)

(b) Electricity is transmitted through **A** at a very high potential difference.

What is the advantage of transmitting electricity at a very high potential difference?

Tick (✓) **one** box.

A high potential difference is safer for consumers.	☐
Less thermal energy is transferred to the surroundings.	☐
Power transmission is faster.	☐

(1)

(c) The power station generates electricity at a potential difference of 25 000 V.

The energy transferred by the power station in one second is 500 000 000 J.

Calculate the charge flow from the power station in one second.

Use the equation:

$$\text{charge flow} = \frac{\text{energy}}{\text{potential difference}}$$

____

____

____

Charge flow in one second = ________________ C

(2)

The electricity supply to a house has a potential difference of 230 V.

The table below shows the current in some appliances in the house.

Appliance	Current in amps
Dishwasher	6.50
DVD player	0.10
Lamp	0.40
TV	0.20

(d) Calculate the total power of all the appliances in the table above.

Use the equation:

power = potential difference × current

___

___

___

___

___

Total power = ___ W

(3)

(e) Each appliance in the table above is switched on for 2 hours.

Which appliance will transfer the most energy?

Give a reason for your answer.

Appliance ___

Reason ___

___

___

(2)

(f) The average energy transferred from the National Grid every second for each person in the UK is 600 J.

There are 32 000 000 seconds in one year.

Calculate the average energy transferred each year from the National Grid for each person in the UK.

___

___

___

Average energy transferred = ___ J

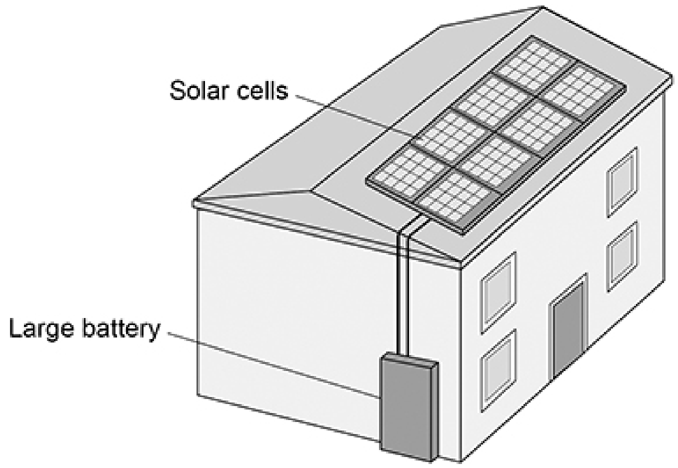
(2)

(Total 12 marks)

6. The figure below shows a house with a solar power system.

The solar cells generate electricity.

When the electricity generated by the solar cells is not needed, the energy is stored in a large battery.



(a) The solar cells on the roof of the house always face in the same direction.

Explain **one** disadvantage caused by the solar cells only facing in one direction.

___

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___

___

(2)

(b) The mean current from the solar cells to the battery is 3.5 A.

Calculate the charge flow from the solar cells to the battery in 3600 seconds.

Use the equation:

charge flow = current × time

___

___

___

Charge flow = ______________ C

(2)

(c) Write down the equation which links efficiency, total power input and useful power output.

___

(1)

(d) At one time in the day, the total power input to the solar cells was 7500 W.

The efficiency of the solar cells was 0.16

Calculate the useful power output of the solar cells.

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____

____

Useful power output = _______________ W

(3)

(e) The wasted energy that is **not** usefully transferred by the solar cells is dissipated.

What happens to energy that has been dissipated?

Tick (✓) **one** box.

The energy becomes less useful.	☐
The energy is destroyed.	☐
The energy is used to generate electricity.	☐

(1)

(f) Why is it unlikely that all the UK’s electricity needs could be met by solar power systems?

Tick (✓) **one** box.

A very large area would need to be covered with solar cells.	☐
Solar power is a non-renewable energy resource.	☐
The efficiency of solar cells is too high.	☐

(1)

(Total 10 marks)

7. The photograph below shows an electric car being recharged.

(a) The charging station applies a direct potential difference across the battery of the car.

What does 'direct potential difference' mean?

____

____

____

(1)

(b) Which equation links energy transferred (*E*), power (*P*) and time (*t*)?

Tick (✓) **one** box.

energy transferred = $\frac{\text{power}}{\text{time}}$ ☐

energy transferred = $\frac{\text{time}}{\text{power}}$ ☐

energy transferred = power × time ☐

energy transferred = power^2 × time ☐

(1)

(c) The battery in the electric car can store 162 000 000 J of energy.

The charging station has a power output of 7200 W.

Calculate the time taken to fully recharge the battery from zero.

____

____

____

____

____

Time taken = _______________ s

(3)

(d) Which equation links current (*I*), potential difference (*V*) and resistance (*R*)?

Tick (✓) **one** box.

$I = V \times R$	☐
$I = V^2 \times R$	☐
$R = I \times V$	☐
$V = I \times R$	☐

(1)

(e) The potential difference across the battery is 480 V.

There is a current of 15 A in the circuit connecting the battery to the motor of the electric car.

Calculate the resistance of the motor.

____

____

____

____

____

Resistance = _______________ Ω

(3)

(f) Different charging systems use different electrical currents.

- Charging system **A** has a current of 13 A.
- Charging system **B** has a current of 26 A.
- The potential difference of both charging systems is 230 V.

How does the time taken to recharge a battery using charging system **A** compare with the time taken using charging system **B**?

Tick (✓) **one** box.

Time taken using system **A** is half the time of system **B**	☐
Time taken using system **A** is the same as system **B**	☐
Time taken using system **A** is double the time of system **B**	☐

(1)
(Total 10 marks)

8. A student investigated how the current in a series circuit varied with the resistance of a variable resistor.

Figure 1 shows the circuit used.

Figure 1

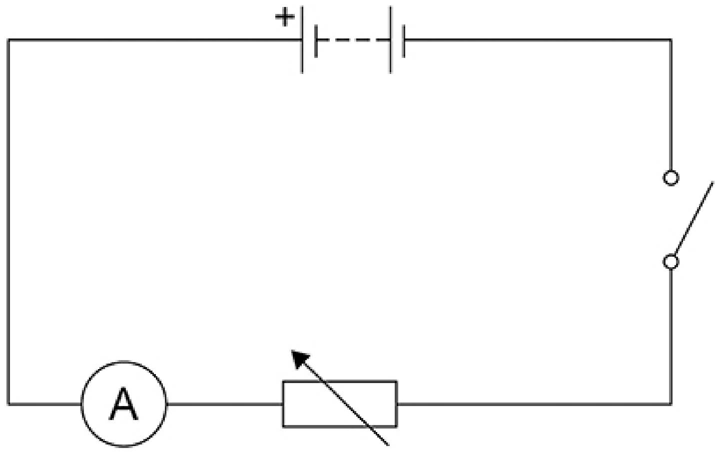
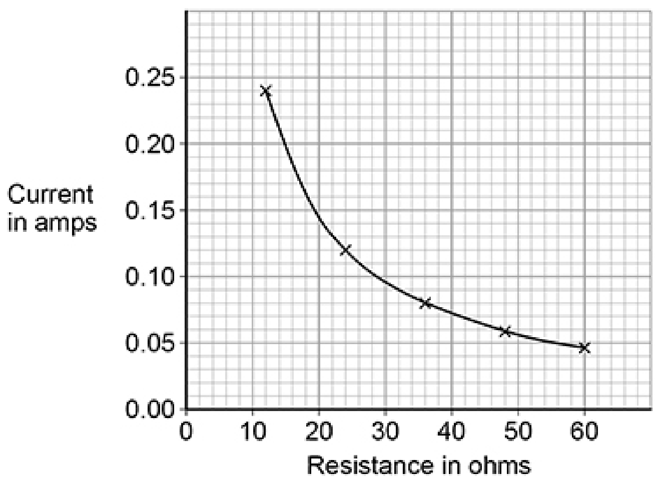


Figure 2 shows the results.

Figure 2



(a) The battery had a power output of 230 mW when the resistance of the variable resistor was 36 Ω.

Determine the potential difference across the battery.

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Potential difference = ______________ V

(4)

(b) The student concluded:

'the current in the circuit was inversely proportional to the resistance of the variable resistor.'

Explain how **Figure 2** shows that the student is correct.

____

____

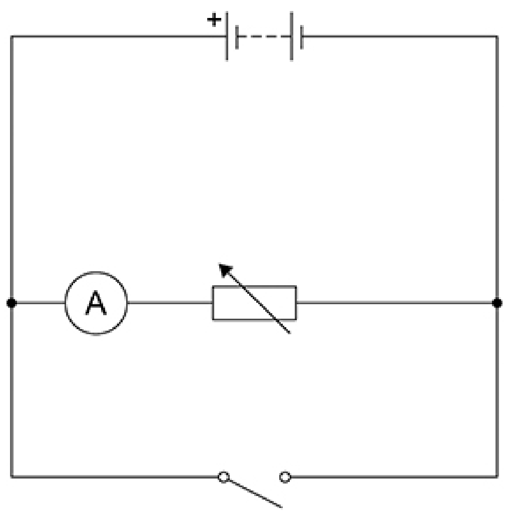
____

____

(2)

(c) **Figure 3** shows a circuit with a switch connected incorrectly.

Figure 3



Explain how closing the switch would affect the current in the variable resistor.

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(2)
(Total 8 marks)

9. (a) During one year, 1.25×10^{18} J of energy was transferred from the National Grid.

number of seconds in 1 year = 3.16×10^{7}

Calculate the mean energy transferred from the National Grid each second.

Give your answer to 3 significant figures.

____

____

____

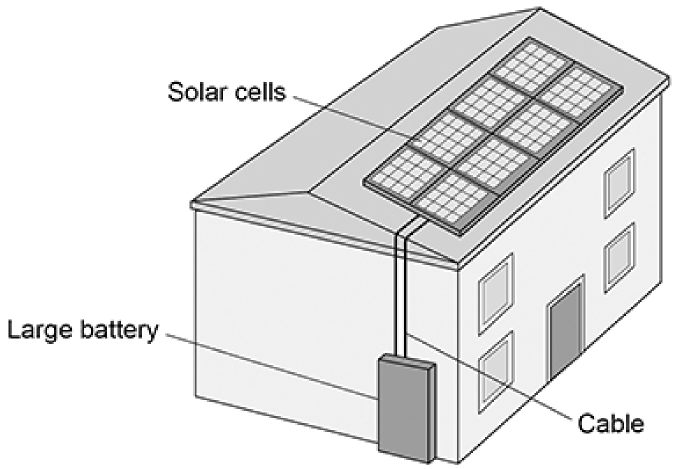
Energy each second (3 significant figures) = _______________ J

(2)

The figure below shows a house with a solar power system.

The solar cells generate electricity.

When the electricity generated by the solar cells is not needed, the energy is stored in a large battery.



(b) The charge flow through the cable between the solar cells and the battery in 24 hours was 27 000 coulombs.

Calculate the mean current in the cable.

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____

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Mean current = _______________ A

(4)

(c) At one time, the total power input to the solar cells was 7.8 kW.

The efficiency of the solar cells was 0.15

Calculate the useful power output of the solar cells.

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____

Useful power output = ________________ W

(3)

(d) It is unlikely that **all** of the electricity that the UK needs can be generated by solar power systems.

Explain why.

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____

(2)
(Total 11 marks)

1. (a) transformer **X** increases potential difference
1

and decreases current

do not accept if student states that potential difference decreases
1

reducing (thermal) energy transfer to surroundings

do not accept no energy transfer to surroundings

or

reducing (thermal) energy transfer from transmission cables
1

increasing the efficiency (of power transmission)
1

(b) transformer **Y** decreases the potential difference
1

to a safe / safer value

dependent on scoring 1st marking point
1

(c) $3.24 \times 10^{11} = Q \times 230$
1

$Q = \frac{3.24 \times 10^{11}}{230}$
1

Q = 1408 695 652 (C)
1

$Q = 1.41 \times 10^9$ (C)

or

Q = 1 410 000 000 (C)

allow correct rounding of an incorrect answer using data from the question
1

[10]

2. (a) electrons transferred from the cloth (to the rod)
1

electrons are negatively charged

this mark only scores if linked to the first marking point
1

(so) there are more positive charges than negative charges on the cloth

ignore more protons than electrons unqualified
1

any mention of transfer of positive charge scores 0

any mention of positive electrons scores 0

(b) there is an additional (downwards) force on the balance (increasing the mass reading)

1

(because) the (held) rod is negatively charged

allow both rods have the same (negative) charge

1

(and rods with) like charges repel

or

(and rods with) negative charges repel each other

1

(c) only the change in reading / mass is being observed

allow difference / increase for 'change in'

1

(d) the (large) potential difference between the two objects

allow (strong) electric field causes breakdown of air

do not accept earthed conductor is positively charged

1

(causes negative) electrons / charges to move (through the air)

allow there is a current in the air (between the two objects)

1

(from the rod) to the conductor

1

[10]

3. (a) $P = V \times I$

1

(b) $4.4 = 40 \times I$

1

$I = \frac{4.4}{40}$

1

$I = 0.11$ (A)

1

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

1

(d) $0.85 = \frac{P}{4.0}$

1

$P = 0.85 \times 4.0$

1

$P = 3.4$ (W)

1

[8]

4. (a) increased 1

decreased 1

stayed the same 1

(b) random error 1

(c) $A_2 = 0.12$ (A) 1

$A_5 = 0.36$ (A) 1

(d) $P = 0.12^2 \times 15$ 1

$P = 0.216$ (W) 1

[8]

5. (a) A: transmission / power cables

allow transmission / power lines

allow cables

ignore wires

1

B: <u>step-down transformer</u> 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

$P = 1656$ (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

$E = 19\ 200\ 000\ 000$ (J)
or
$E = 1.92 \times 10^{10}$ (J)

1

[12]

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 × t

1

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

1

t = 22 500 (s)

1

(d) *V* = *I* × *R*

1

(e) 480 = 15 × R

1

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

1

R = 32 (Ω)

1

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

1

[10]

8. (a) $I = 0.08$ (A)

an incorrect value of I from the graph can score all subsequent marks

1

$0.230 = 0.08 \times V$

allow a correct substitution of an incorrectly/not converted value of P

1

$V = \frac{0.230}{0.08}$

allow a correct rearrangement using an incorrectly/not converted value of P

1

$V = 2.875$ (V)

OR

$I = 0.08$ (A) (1)

$V = 0.08 \times 36$ (2)

$V = 2.88$ (V) (1)

OR

$0.230 = I^2 \times 36$ (1)

$I = 0.08$ (A) (1)

$V = 0.08 \times 36$ (1)

$V = 2.88$ (V) (1)

allow a correct calculation using an incorrectly/not converted value of P

1

(b) the product of current and resistance = a constant

1

calculation of constant (2.88) using three or more pairs of values

if no other marks scored allow for one mark a statement that doubling one quantity (R or I) halves the other quantity

1

(c) current would be (almost) zero (in the variable resistor)

1

(because) the switch has (effectively) zero resistance
or
the potential difference across the variable resistor is (effectively) zero

the switch's resistance is much lower than the variable resistor

allow the switch creates a short circuit

1

[8]

9. (a) $E = \frac{1.25\times10^{18}}{3.16\times10^{7}}$

1

$E = 3.96 \times 10^{10}$ (J)

*an answer that rounds to 3.96×10^{10} (J) scores **1** mark*

1

(b) t = 86 400 (s)

1

27 000 = I × 86 400

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

1

$I = \frac{27\ 000}{86\ 400}$

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

1

I = 0.3125 (A)

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

allow a correctly calculated answer rounded to 2 or 3 sf

1

(c) $0.15 = \frac{\text{useful power output}}{7800}$

allow a correct substitution of an incorrectly/not converted value of total power input

1

useful power output =
0.15 × 7800

allow a correct rearrangement using an incorrectly/not converted value of total power input

1

useful power output = 1170 (W)

this answer only but allow 1200 (W) if correct working shown

1

(d) a really large area of land would need to be covered with solar cells

1

due to the low useful power output of the solar cells

allow due to the low efficiency of the solar cells

or

number of hours of daylight is too low (in UK)

or

low solar intensity (in UK)

or

solar radiation (in UK) is too low

or

material for construction of solar cells and/or lithium batteries is in limited supply

1

[11]