

1. (a) A 12 V 36 W lamp is lit to normal brightness using a 12 V car battery of negligible internal resistance. The lamp is switched on for one hour (3600 s). For the time of 1 hour, calculate

- (i) the energy supplied by the battery

energy = ..... J

[2]

- (ii) the charge passing through the lamp

charge = ..... unit .....

[3]

- (iii) the total number of electrons passing through the lamp.

number of electrons = .....

[2]

- (b) The wires connecting the 36 W lamp to the 12 V battery are made of copper. They have a cross-sectional area of  $1.1 \times 10^{-7} \text{ m}^2$ . The current in the wire is 3.0 A. The number  $n$  of free electrons per  $\text{m}^3$  for copper is  $8.0 \times 10^{28} \text{ m}^{-3}$ .

- (i) Describe what is meant by the term *mean drift velocity* of the electrons in the wire

.....  
 .....  
 .....

[2]

(ii) Calculate the mean drift velocity  $v$  of the electrons in this wire.

$$v = \dots\dots\dots \text{ m s}^{-1}$$

[3]

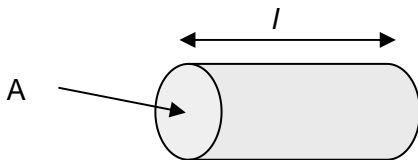
[Total 12 marks]

2. (a) Name the charge carriers responsible for electric current in a metal and in an electrolyte.

.....  
 .....

[2]

(b)



The diagram above shows a copper rod of length  $l = 0.080\text{m}$ , having a cross-sectional area  $A = 3.0 \times 10^{-4} \text{ m}^2$ .

The resistivity of copper is  $1.7 \times 10^{-8} \Omega \text{ m}$ .

The copper rod is used to transmit large currents. A charge of 650 C passes along the rod every 5.0 s. Calculate

1. the current in the rod

current = ..... A

[2]

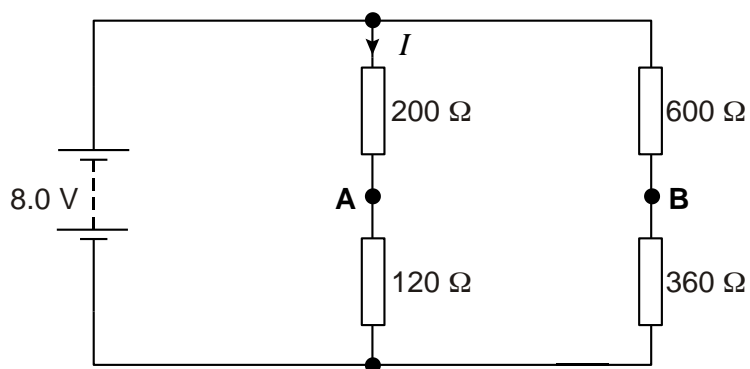
2. the total number of electrons passing any point in the rod per second.

number = .....

[2]

[Total 6 marks]

3. The diagram below shows an electrical circuit.



The battery has negligible internal resistance.

(a) Show that the current  $I$  is 25 mA.

[2]

(b) Calculate the potential difference (p.d.) across the resistor of resistance  $120 \Omega$ .

p.d. = ..... V

[1]

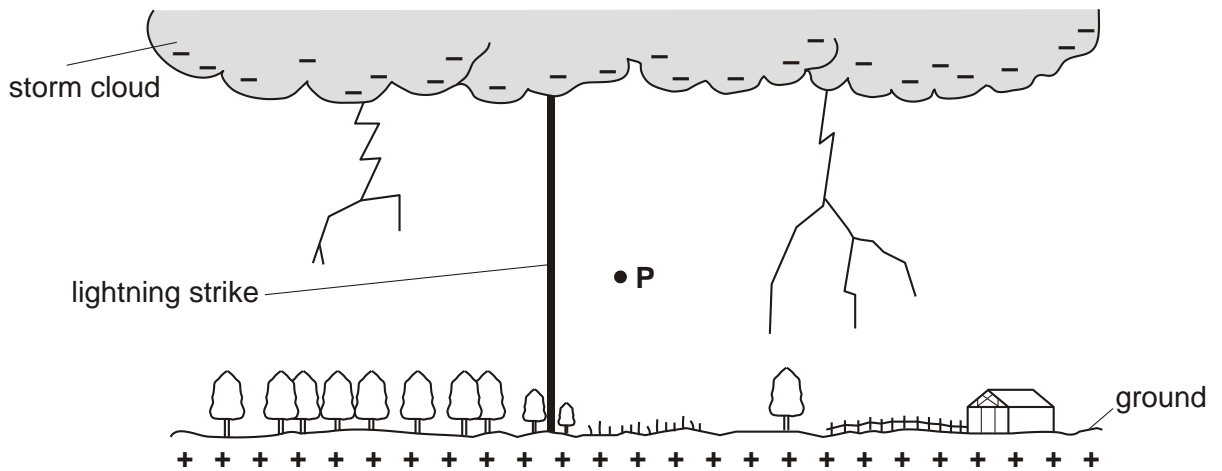
(c) Explain why a voltmeter connected between points **A** and **B** will read 0 V.

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.....

[2]

[Total 5 marks]

4. The diagram below shows a lightning strike between a storm cloud and the ground.



(a) State the direction of the magnetic field at point **P** due only to the lightning strike.

.....

[1]

(b) The current in the lightning strike is 7800 A. The strike lasts for a time of 230 ms.

Calculate

1. the charge flowing between the cloud and the ground

charge = ..... C

[3]

2. the number of electrons transferred to the ground.

number = .....

[2]

[Total 6 marks]

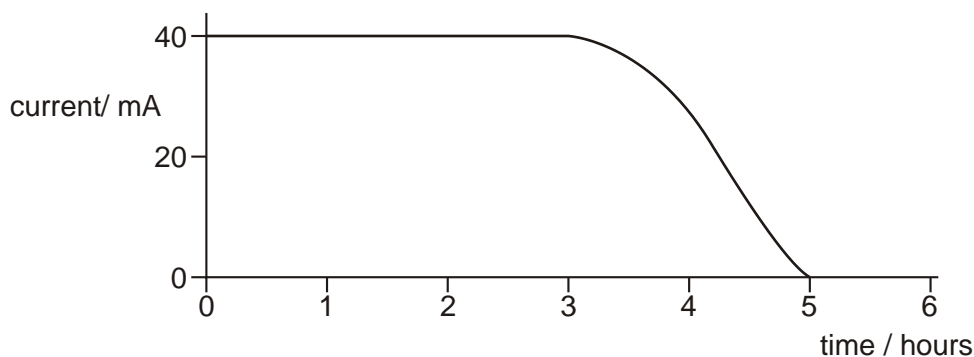
5. A small radio receiver uses a battery that is capable of delivering a constant current of 40 mA for a period of 5.0 hours.

(a) Calculate the total charge delivered by the battery.

charge = ..... unit .....

[3]

(b) Below is the graph of current against time for a different battery.



Explain whether the charge delivered by this battery is the same as, greater than or less than your answer to (a).

.....

.....

[1]

[Total 4 marks]

6. The figure below shows an incomplete circuit with a battery and a resistance wire made of a material of resistivity  $\rho$ .



(a) Complete the circuit of the figure and show how you would connect suitable meters to determine the current in the resistance wire and the potential difference across the resistance wire.

[2]

(b) In this question, two marks are available for the quality of written communication.

Use your answer to (a) to describe an experiment to determine the resistivity  $\rho$  of the material of the resistance wire. Your description should include

- the measurements taken
- the instruments used to take the measurements
- how the measurements are used to determine the resistivity of the material.

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[6]

Quality Of Written Communication [2]

[Total 10 marks]

7. State the SI unit for electrical charge.

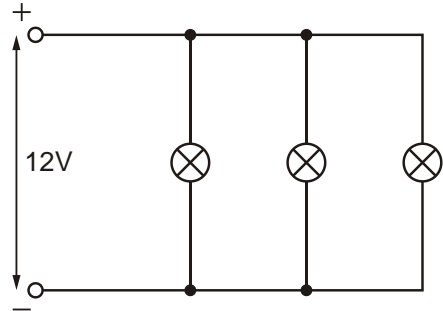
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[Total 1 mark]

8. The figure below shows an arrangement of three – filament lamps used to illuminate a room.



equivalent to



- (a) Name the arrangement in which the three lamps are connected.

.....

[1]

- (b) Each lamp has resistance  $8.0 \Omega$  when operating at  $12 \text{ V}$ .

Calculate

- (i) the current drawn by **each** lamp

current = ..... A

[2]

- (ii) the power dissipated by **each** lamp

power = ..... W

[3]



(iii) the **total** resistance of the lamps as connected in the picture above.

resistance = .....  $\Omega$

[3]

(iv) the **total** energy transformed by the three lamps in kilowatt hour when operated for 12 hours.

energy = ..... kW h

[2]

(c) One of the lamps is replaced by another lamp that also operates at 12 V but has a smaller resistance than 8.0  $\Omega$ . State and explain how its brightness will compare with one of the other two remaining lamps.

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[2]

[Total 13 marks]

9. State Kirchhoff's first law.

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[Total 2 marks]