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 1.1×10^{-7} m^2. The current in the wire is 3.0 A. The number n of free electrons per m^3 for copper is 8.0×10^{28} 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 = ... m s^{-1}

[3]

[Total 12 marks]

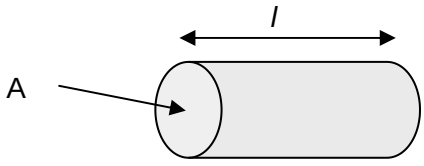
2. (a) Name the charge carriers responsible for electric current in a metal and in an electrolyte.

.....

.....

[2]

(b)



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

The resistivity of copper is 1.7×10^{-8} Ω 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]

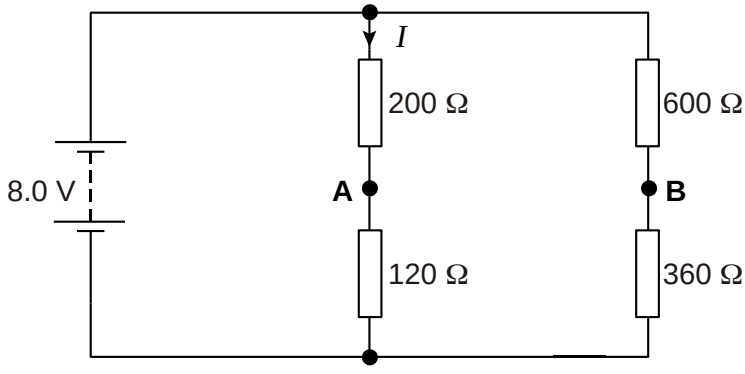
2. the total number of electrons passing any point in the rod per second.

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 Ω.

p.d. = ... V

[1]

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

.....

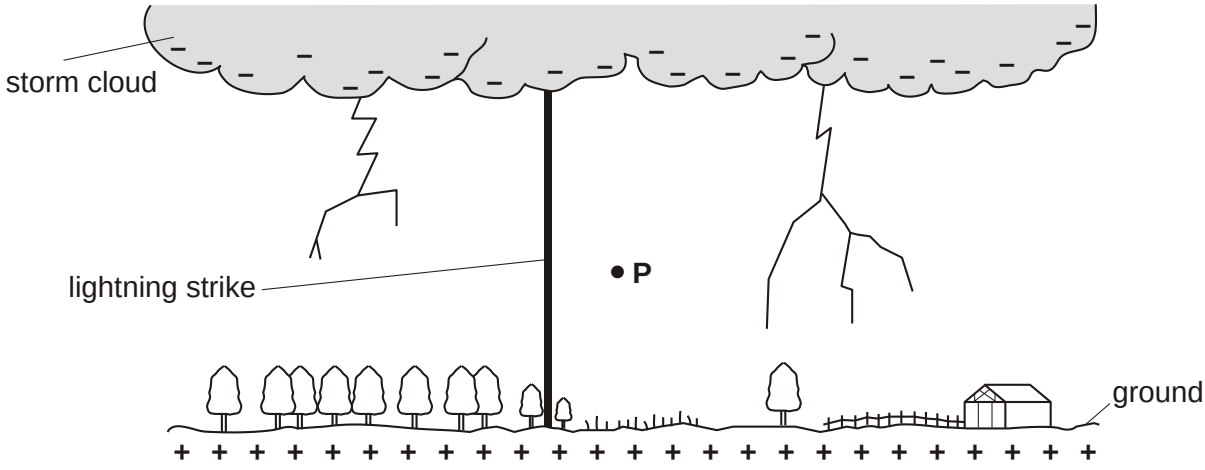
.....

.....

[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]

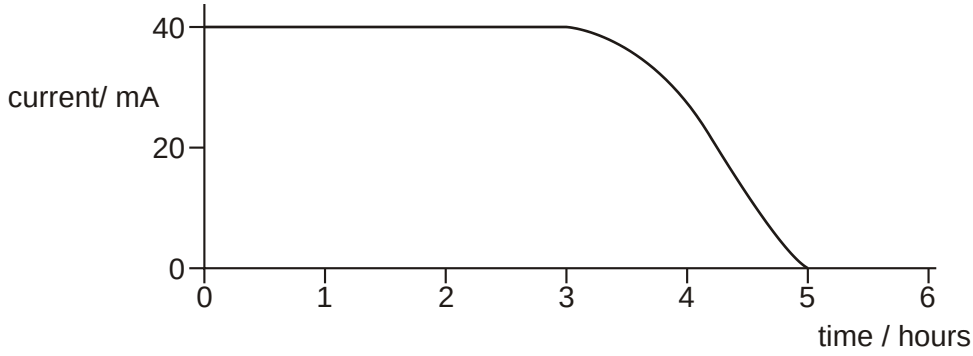
5. A small radio receiver uses a battery that is capable of delivering a constant current of 40 mA for a period of 5.0 hours.

(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)**.

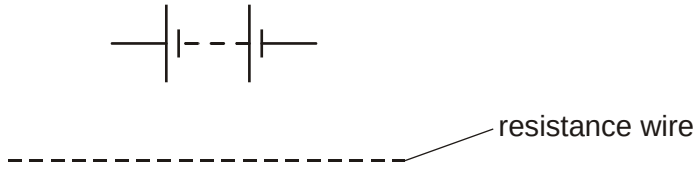
.....

.....

[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 ρ.



(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 ρ 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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

[6]

Quality Of Written Communication [2]

[Total 10 marks]

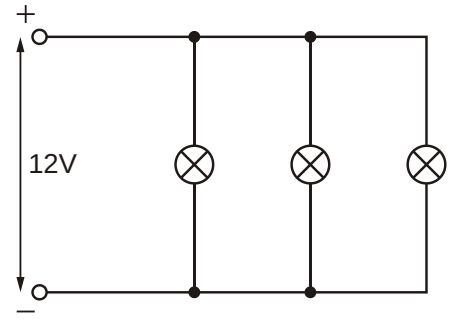
7. State the SI unit for electrical charge.

.....

[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 Ω when operating at 12 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.

resistence = ... Ω

[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 Ω. State and explain how its brightness will compare with one of the other two remaining lamps.

.....

.....

.....

.....

[2]

[Total 13 marks]

9. State Kirchhoff's first law.

.....

.....

.....

[Total 2 marks]