AS Level Physics B

H157/01 Foundations of physics

Question Set 5

1. **Fig. 1** shows a model of current in a wire.

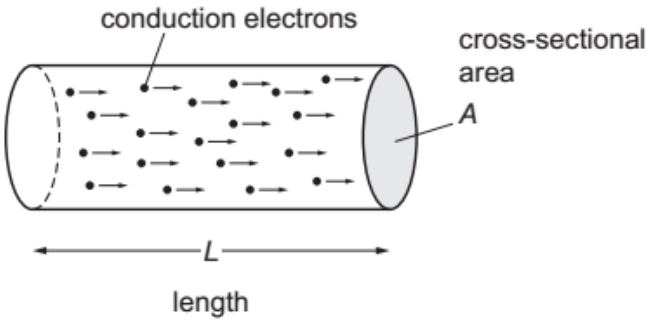


Fig. 1

n is the number density of charge carriers in the wire.

(a) What is the SI unit of charge?

[1]

(b) Show that the total charge, ΔQ, in the cylinder above is $nALe$, where e is the charge of an electron. **[2]**

(c) The current in a cylindrical wire is related to the number density of charge carriers (electrons)by the equation

$I = nAve$

where I is the current and v is the drift velocity of the electrons.

The drift velocity is the average speed of the electrons in the wire in the direction of the current.

The wire carries a current of 3.2A.

Calculate the diameter of the wire.

Drift velocity of electrons in the wire is $0.50\,\text{mm}\,\text{s}^{-1}$.
Number density of electrons is $8.0 \times 10^{28}\,\text{m}^{-3}$.

diameter =……m

[3]

2. A student is investigating the resistivity of a metal.

The student has a 1.0 m length of wire made from the metal.

Fig. 2.1 shows the circuit used by the student.

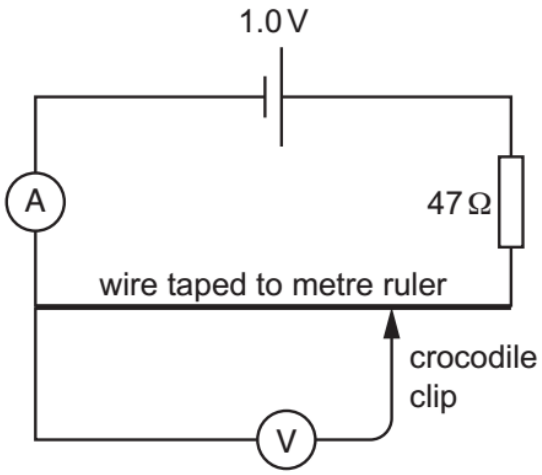


Fig. 2.1

(a) Explain why the voltmeter should have a very high resistance. **[2]**

The cell has an e.m.f. of 1.0 V and negligible internal resistance.

The wire has a resistance of 3.0 Ω.

The crocodile clip is connected at the centre of the wire as shown in **Fig. 2.2**.

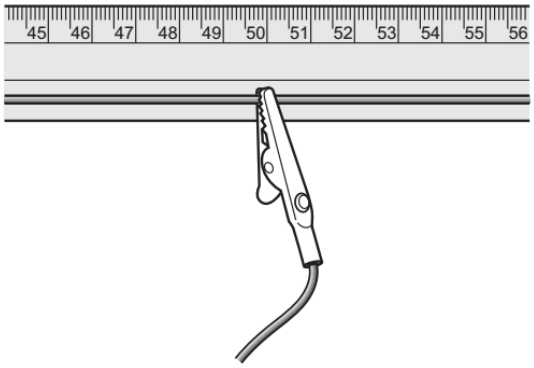


Fig. 2.2.

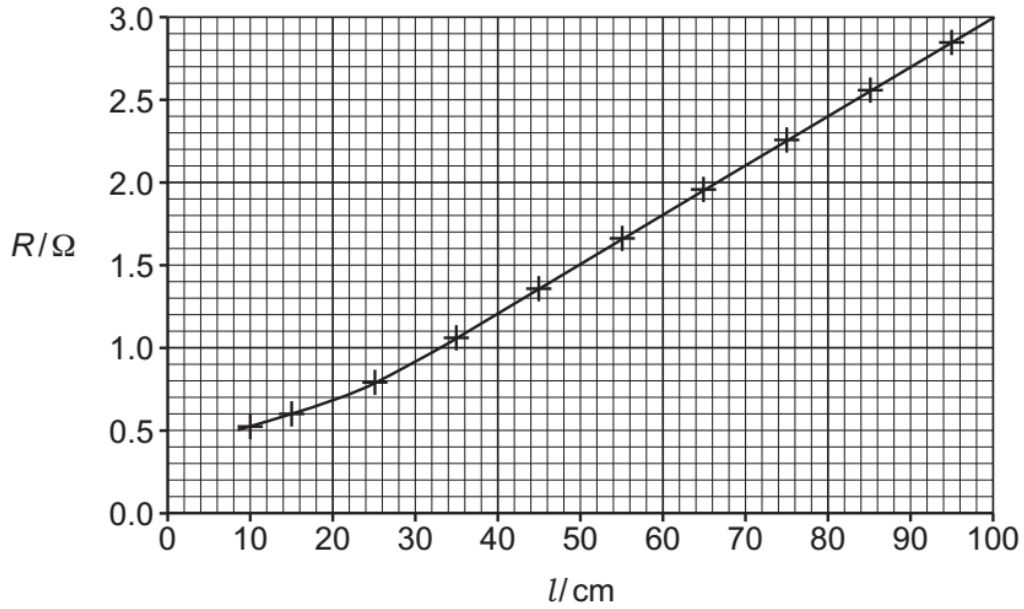
(b) Calculate the voltmeter reading you expect the student to see.

Expected reading = ... V **[2]**

The student records the readings on the voltmeter and ammeter for a range of positions of the crocodile clip.

The student uses the results to calculate the resistance for each length l of wire under test.

The graph shows the results of the investigation.



The student expected the graph to show that R is directly proportional to l.

(c) **(i)** State the shape of graph expected if R were directly proportional to l. **[1]**

(ii) The graph is a curve for small lengths because the higher current heats the wire and its resistivity increases.

The resistivity of the metal increases by 0.4% for each °C temperature rise.

Calculate the temperature rise of the wire when l = 20 cm.

Temperature rise = …… °C **[4]**

(iii) State one other variable, apart from temperature, that should be controlled in this investigation. **[1]**

Another student repeats the experiment. The crocodile clip is replaced with a sliding contact whichhas a sharp edge and measurements are taken as shown in **Fig. 2.3**.

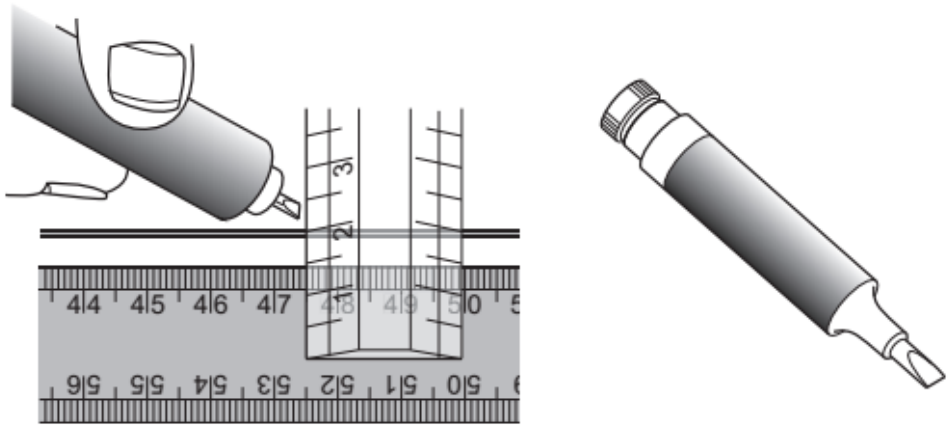


Fig. 2.3

(d) Explain how these changes will affect the quality of the measurements of length.

[2]

Total Marks for Question Set 5: 18