6 **(a)** Define the *coulomb*.

....[1]

(b) A resistor X is connected to a cell as shown in Fig. 6.1.

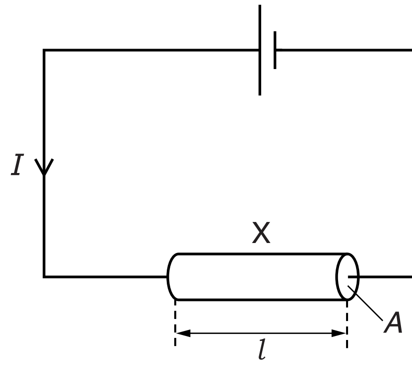

Fig. 6.1

The resistor is a wire of cross-sectional area A and length l. The current in the wire is I.

Show that the average drift speed v of the charge carriers in X is given by the equation

$$v = \frac{I}{nAe}$$

where e is the charge on a charge carrier and n is the number of charge carriers per unit volume in X.

[3]

(c) A 12V battery with negligible internal resistance is connected to two resistors Y and Z, as shown in Fig. 6.2.

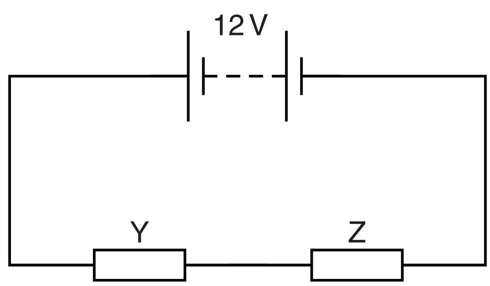

Fig. 6.2

The resistors are made from wires of the same material. The wire of Y has a diameter d and length l. The wire of Z has a diameter $2d$ and length $2l$.

(i) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in Y}}{\text{average drift speed of the charge carriers in Z}}\ .$$

ratio = ... [3]

(ii) Show that

$$\frac{\text{resistance of Y}}{\text{resistance of Z}} = 2.$$

[2]

(iii) Determine the potential difference across Y.

potential difference = ... V [2]

(iv) Determine the ratio

$$\frac{\text{power dissipated in Y}}{\text{power dissipated in Z}}\ .$$

ratio = ... [1]

[Total: 12]

5 **(a)** **(i)** State what is meant by an *electric current*.

....

.... [1]

(ii) Define electric *potential difference* (*p.d.*).

....

.... [1]

(b) A power supply of electromotive force (e.m.f.) 8.7 V and negligible internal resistance is connected by two identical wires to three filament lamps, as shown in Fig. 5.1.

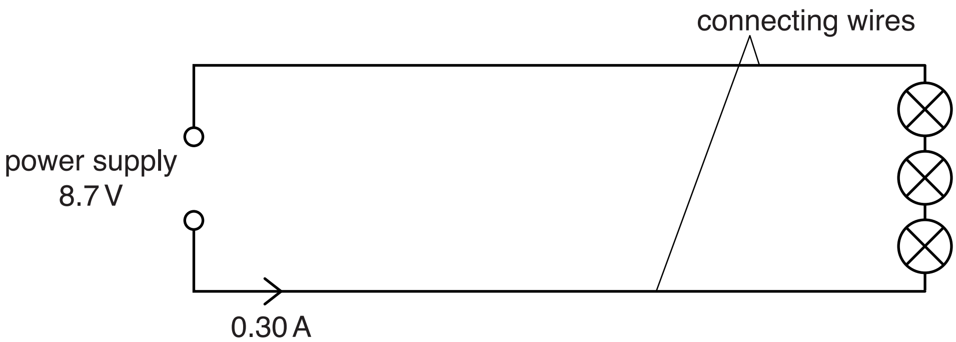

Fig. 5.1 (not to scale)

The power supply provides a current of 0.30 A to the circuit.
The filament lamps are identical. The I–V characteristic for **one** of the lamps is shown in Fig. 5.2.

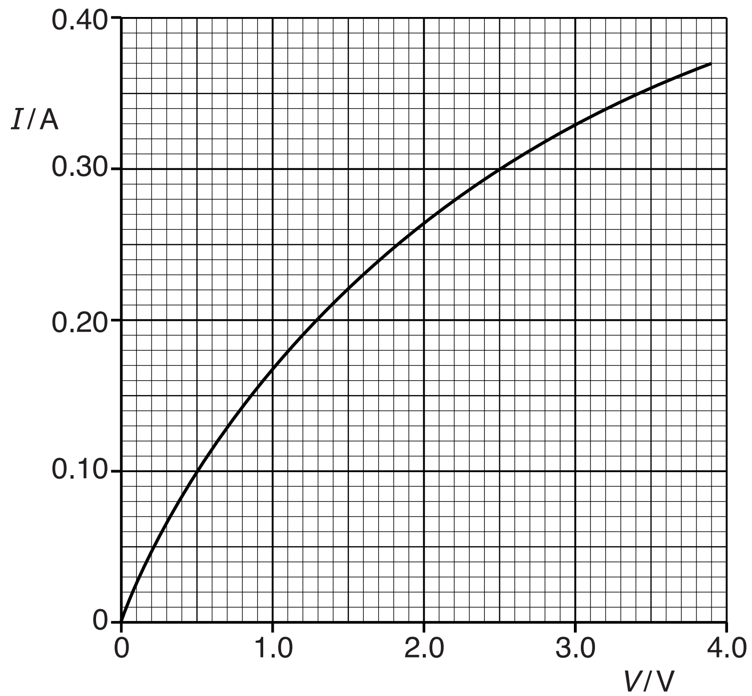

Fig. 5.2

(i) Show that the resistance of each connecting wire is 2.0 Ω.

[2]

(ii) The resistivity of the metal of the connecting wires does not vary with temperature.
On Fig. 5.2, sketch the I–V characteristic for **one** of the connecting wires. [2]

(iii) Calculate the power loss in one of the connecting wires.

power = ... W [2]

(iv) Some data for the connecting wires are given below.

cross-sectional area = 0.40 mm^2
resistivity = 1.7×10^{-8} Ω m
number density of free electrons = $8.5 \times 10^{28}\,m^{-3}$

Calculate

1. the length of one of the connecting wires,

length = ... m [2]

2. the drift speed of a free electron in the connecting wires.

drift speed = ... $m\,s^{-1}$ [2]

[Total: 12]

5 **(a)** The I-V characteristic of a semiconductor diode is shown in Fig. 5.1.

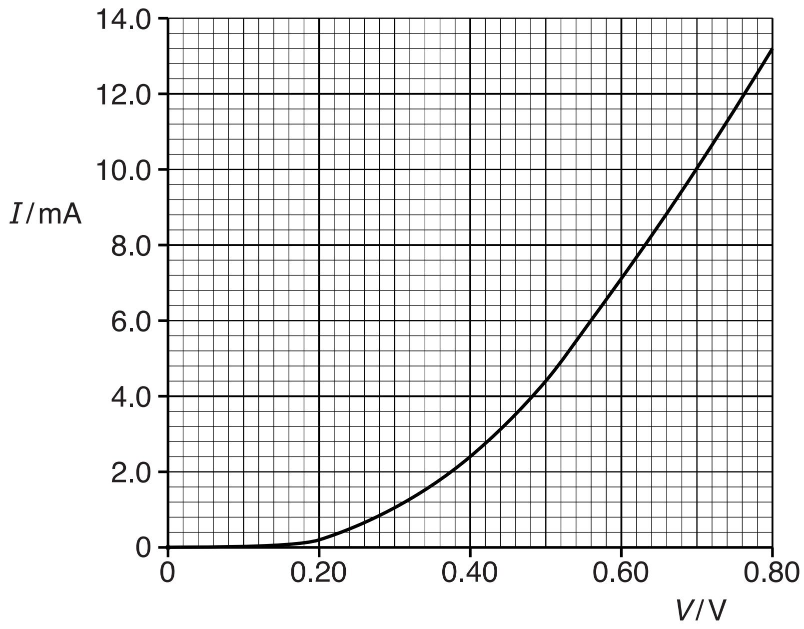

Fig. 5.1

(i) Use Fig. 5.1 to explain the variation of the resistance of the diode as V increases from zero to 0.8 V.

....

....

....

....

....

.... [3]

(ii) Use Fig. 5.1 to determine the resistance of the diode for a current of 4.4 mA.

resistance = ... Ω [2]

(b) A cell of e.m.f. 1.2 V and negligible internal resistance is connected in series to a semiconductor diode and a resistor R_1, as shown in Fig. 5.2.

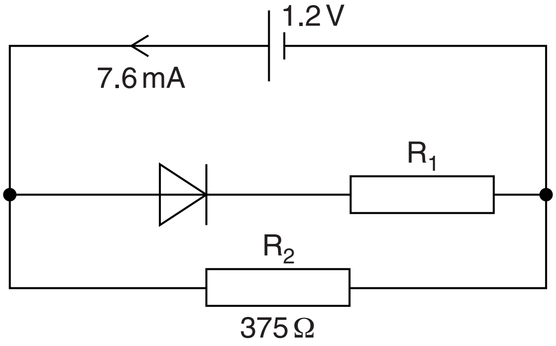

Fig. 5.2

A resistor R_2 of resistance 375 Ω is connected across the cell.
The diode has the characteristic shown in Fig. 5.1. The current supplied by the cell is 7.6 mA.

Calculate

(i) the current in R_2,

current = ... A [1]

(ii) the resistance of R_1,

resistance = ... Ω [2]

(iii) the ratio

$$\frac{\text{power dissipated in the diode}}{\text{power dissipated in } R_2}.$$

ratio = ...[2]