5 **(a)** The variation with potential difference V of the current I in a semiconductor diode is shown in Fig. 5.1.
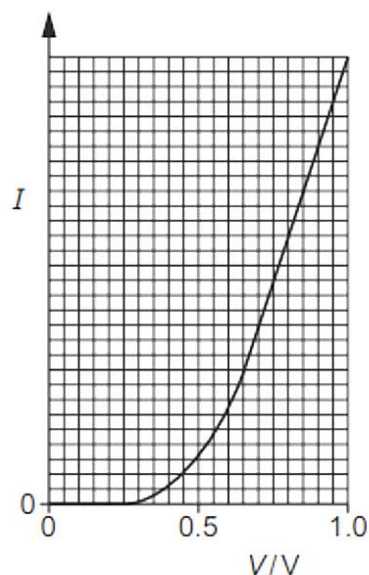

Fig. 5.1

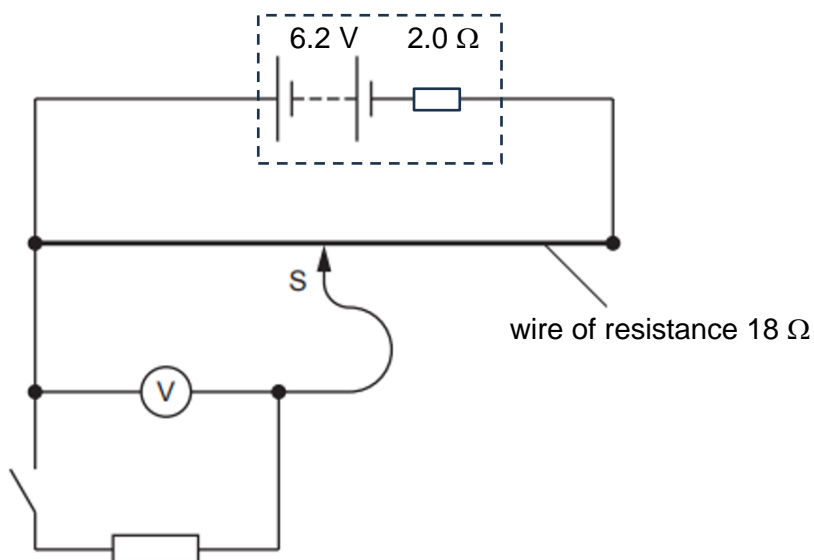Use Fig. 5.1 to describe qualitatively,

(i) the resistance of the diode in the range $V = 0$ to $V = 0.25$ V, and

....

.... [1]

(ii) the variation, if any, in the resistance of the diode as V changes from $V = 0.75$ V to 1.0 V.

....

.... [1]

(b) A battery of electromotive force (e.m.f.) 6.2 V and internal resistance 2.0 Ω is connected in a circuit to a uniform resistance wire, a voltmeter, a fixed resistor and a switch, as shown in Fig. 5.2.

Fig. 5.2

The resistance wire has resistance 18 Ω, length 0.94 m and diameter 0.30 mm.

(i) Calculate the resistivity ρ of the material of the resistance wire.

ρ = ……………………... Ω m [1]

(ii) The slider S is positioned half-way along the length of the wire. The switch is open.

Determine the reading on the voltmeter.

voltmeter reading = ……………………... V [2]

(iii) The switch is now closed.

State whether there is an increase, decrease or no change to

1. the current in the battery, and

……………………………………………………………………………………...………..

2. the voltmeter reading.

……………………………………………………………………………………...………..

[2]

(c) The circuit in **(b)** is altered by changing the battery for one of a different e.m.f.

The switch is open.

A student records the following data for the resistance wire:

current in the wire 0.93 A

mean drift speed of charge carriers 1.3×10^{-3} m s^{-1}

number density of charger carriers 9.0×10^{28} m^{-3}

(i) Determine the charge q of a charge carrier in the wire suggested by this data.

q = ……………………... C [1]

(ii) With reference to the value of q, explain why the data by the student cannot be correct.

……………………………………………………………………………………….………….....

……………………………………………………………………………………………………… [1]

[Total: 9]