3 A battery of electromotive force (e.m.f.) 4.5 V and negligible internal resistance is connected to two filament lamps P and Q and a resistor R, as shown in Fig. 3.1
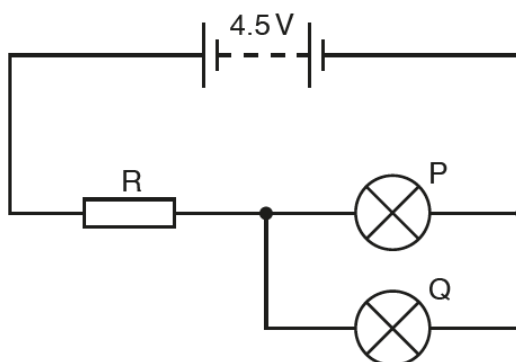

Fig. 3.1

The current in lamp P is 0.15 A.

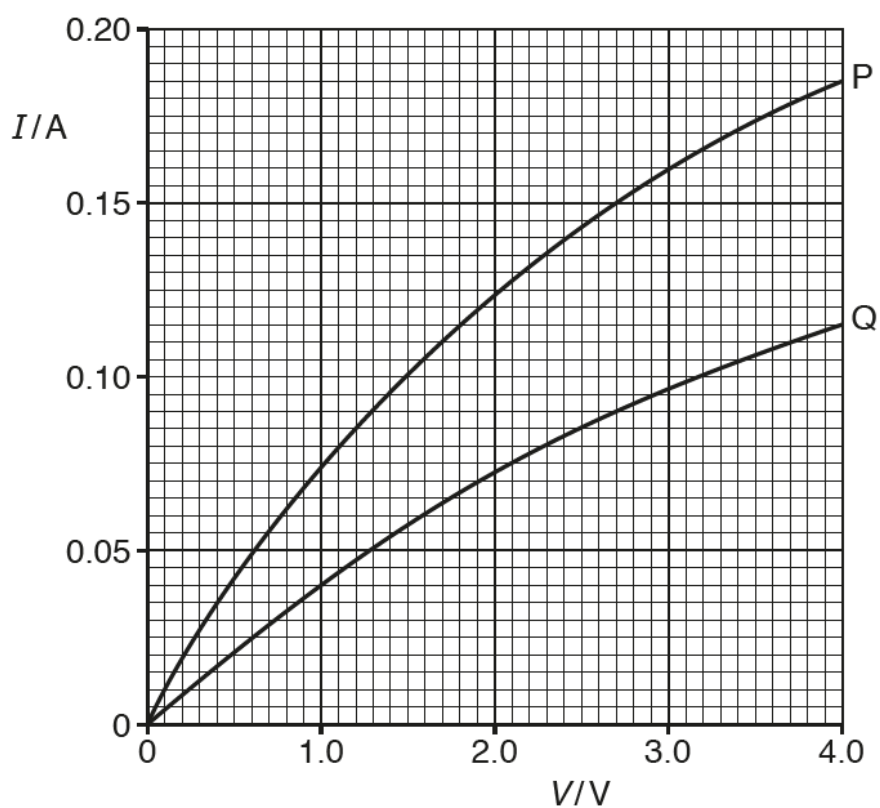The *I-V* characteristics of the filament lamps are shown in Fig. 3.2.

Fig. 3.2

(a) Use Fig. 3.2 to determine the current in the battery.

current = ………………….. A   [2]

(b) **(i)** Calculate the resistance of resistor R.

resistance = ………………….. Ω   [2]

(ii) Draw the *I-V* characteristics of resistor R in Fig. 3.2.   [1]

(c) The filament wires of the two lamps are made from material with the same resistivity at their operating temperatures in the circuit. The diameter of the wire of lamp P is twice the diameter of the wire of lamp Q.

Determine the ratio

$$\frac{\text{length of filament wire of lamp P}}{\text{length of filament wire of lamp Q}}$$

ratio = ………………..   [3]

(d) The filament wire of lamp Q breaks and stops conducting.

State and explain, with the aid of Fig. 3.2, the effect on the resistance of lamp P.

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[Total: 10]