8 An engineer designs a resistor made from a thin layer of graphite mounted on an insulating base. Fig. 8.1 shows the arrangement.

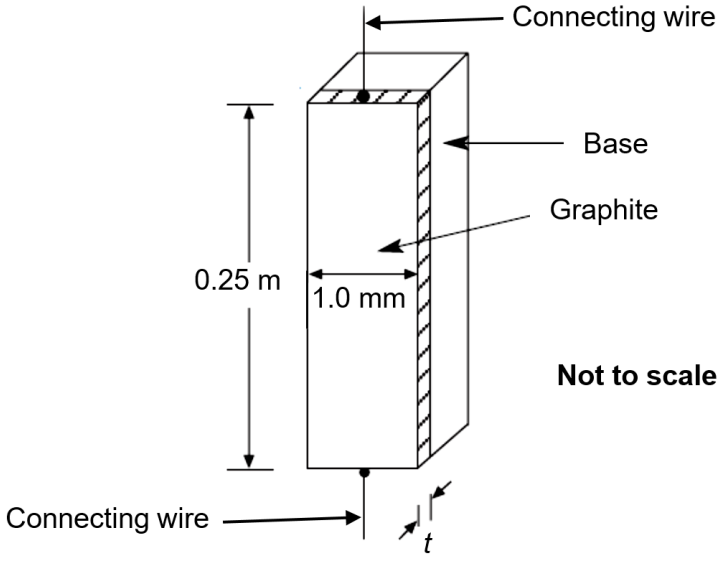

Fig. 8.1

(a) The graphite layer has a length of 0.25 m, a width of 1.0 mm, and a resistance of 1.2 kΩ. The resistivity of graphite is 15.0×10^{-5} Ω m. The number density of electrons in graphite is 2.2×10^{28} m^{-3}.

(i) Calculate the thickness t of the graphite layer.

t = ... m [2]

(ii) A potential difference of 9.0 V is applied to the connecting wires.
Determine the drift velocity of the electrons in the graphite.

drift velocity = ... m s^{-1} [3]

(b) The engineer has also some connecting wires and a cell. The cell has negligible internal resistance. He wants to connect a circuit to provide a potential difference which is dependent on illumination.

(i) State another electrical component that he needs to complete the circuit.

……..
[1]

(ii) With the electrical component in **(b)(i)** and the newly designed resistor, draw a circuit diagram to show how this circuit should be connected.

Your diagram should show clearly the cell and the potential difference output.

[2]

(iii) Explain how your circuit in **(b)(ii)** provides a varying potential difference which is dependent on illumination.

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3]

(c) Two of these newly designed resistors are connected in a circuit with 2 cells and an ammeter. The electromotive force e.m.f. of the cells are 5.0 V and 12.0 V as shown in Fig 8.2. The cells have negligible internal resistance, and the ammeter is considered ideal.

[Turn over

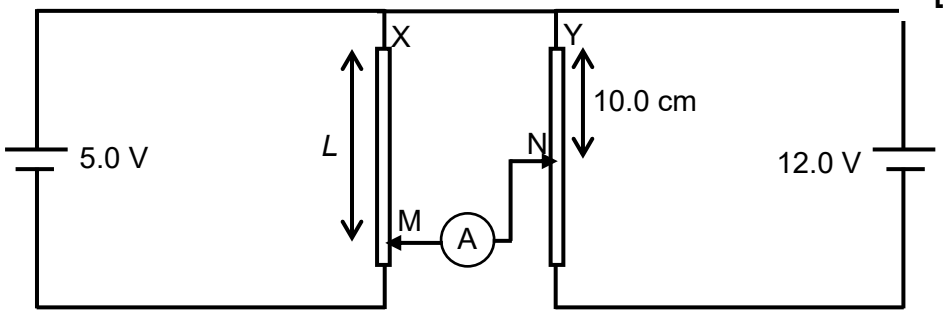

Fig. 8.2

The reading of the ammeter is zero.

(i) Distinguish between electromotive force and potential difference.

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……[
2]

(ii) Explain how the potential difference across XM is compared to YN such that the ammeter reading is zero.

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…

……[
2]

(iii) Determine the length *L*.

L = ... m [2]

(iv) Explain how length *L* should be changed such that the ammeter continues to reads zero current, if the 12.0 V cell has internal resistance, but not the 5.0 V cell.

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……[
3]

[Total: 20]

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