4 **(a)** On Fig. 4.1, sketch a line to show the $I-V$ characteristic of

(i) a metallic conductor at a constant temperature and label the line M,

(ii) a filament lamp and label the line F.

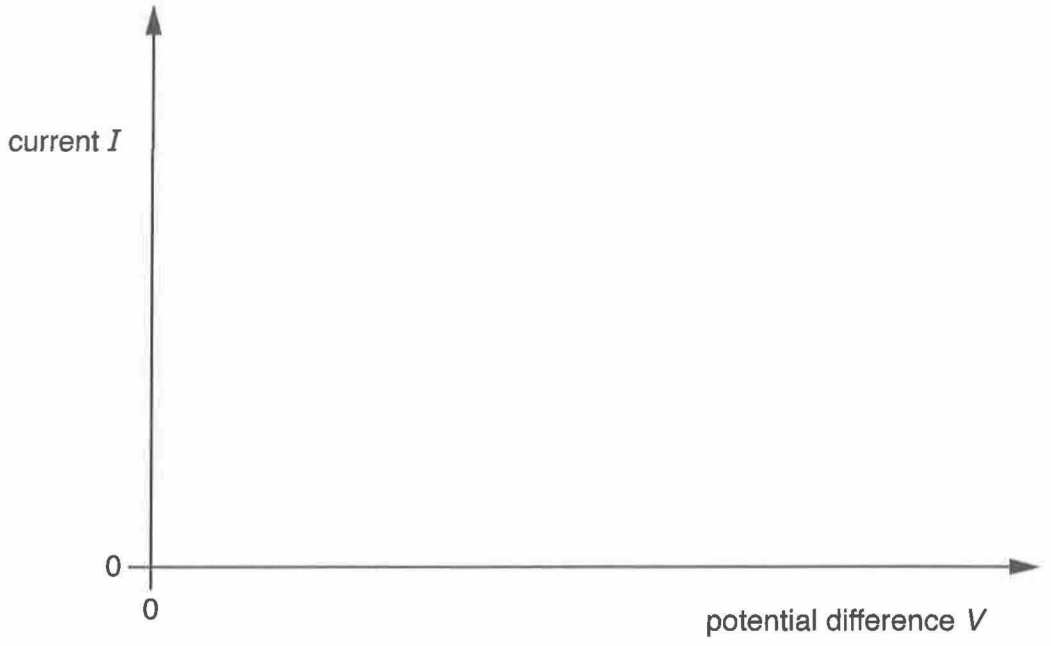

Fig. 4.1

[2]

(b) On Fig. 4.2, sketch a graph showing how the resistance of a thermistor varies with temperature.

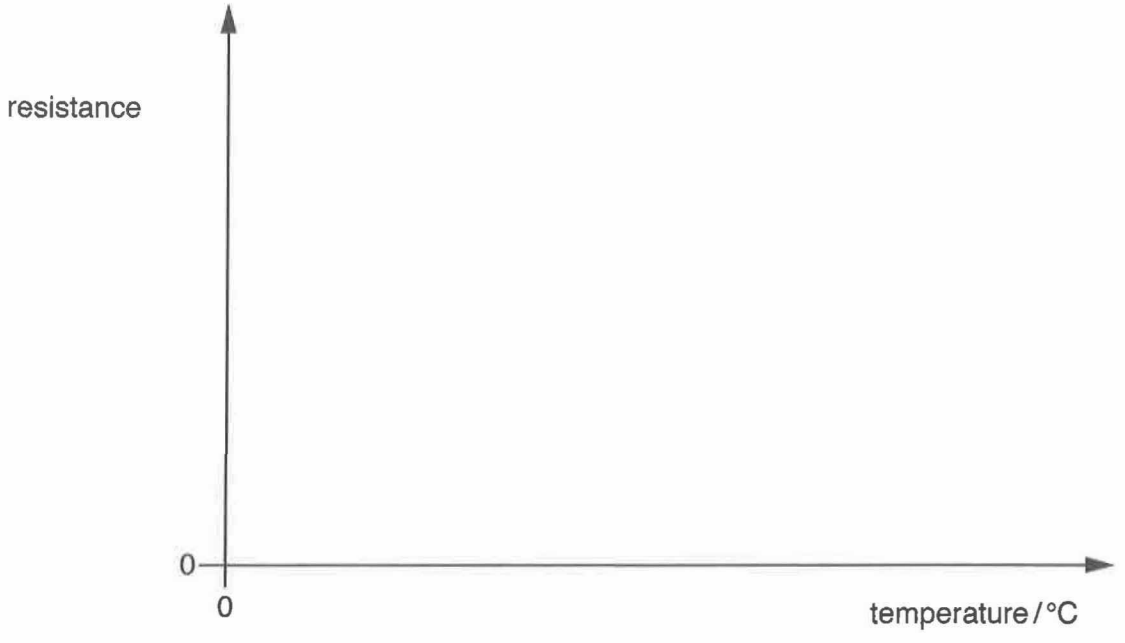

Fig. 4.2

[1]

(c) The filament of an electric lamp, suitable for use with 110 V mains, has an area of cross-section of $7.9 \times 10^{-12}\,m^2$, a length of 32 mm and a resistivity of $5.5 \times 10^{-8}\,\Omega m$ at room temperature.

(i) Calculate the resistance of the lamp at room temperature.

resistance = ... Ω [3]

(ii) Draw a circuit diagram to show how six of these lamps can be connected to a 220 V mains supply so that all of the lamps shine with normal brightness.

[2]

[Total: 8]