8 (a) The filament of a 230 V light bulb is 0.72 m long and has a radius of $6.0 \times 10^{-2}$ mm. The resistivity of the filament metal is $1.2 \times 10^{-5}\ \Omega$ m.

(i) Calculate the resistance of the filament of the light bulb. [2]

(ii) Calculate the power supplied by the 230 V supply. [2]

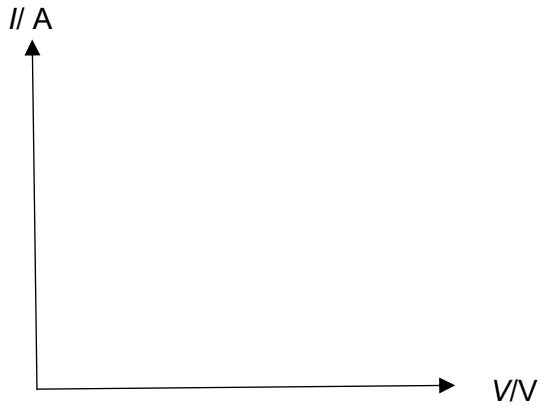
(iii) The filament of the bulb becomes thinner over time. Suggest why this happens. [1]

(iv) Explain the effect the thinning of the filament wire will have on:

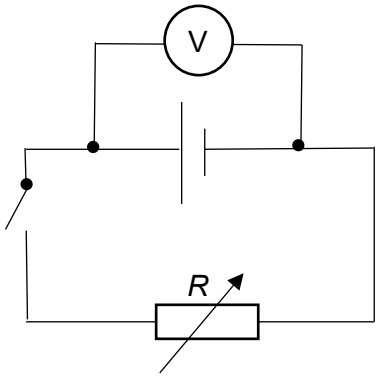
1. the resistance of the filament, [2]

2. its power output. [1]

(v) On the same graph, sketch the current-voltage characteristics for a filament lamp and an ohmic device. [2]




(b) The following circuit is set up, with an ideal voltmeter connected across the terminals of a dry-cell battery. The battery is connected to a variable resistor *R*.




(i) Initially the switch is open and the voltmeter reads 2.10 V.

1. Determine the e.m.f. of the battery. [1]

2. State the energy supplied by the battery for every coulomb of charge delivered by the battery. [1]

3. With the switch open, explain whether any energy is being generated in the battery if the voltmeter is ideal. [2]

(ii) The variable resistance $R$ is set to 10 Ω. When the switch is closed, the voltmeter reading drops to 2.00 V. Deduce a value for the internal resistance of the battery. [3]

(iii) The efficiency of the dry-cell battery is defined as the ratio of energy dissipated in variable resistor $R$ over the energy dissipated in the complete circuit. Explain how the efficiency of cell will change when $R$ increases. [3]

End of paper