

- 4 A filament lamp contains a thin coil of tungsten wire called the filament as shown in Fig. 4.1. This heats up when an electric current passes through it, and produces light as a result.

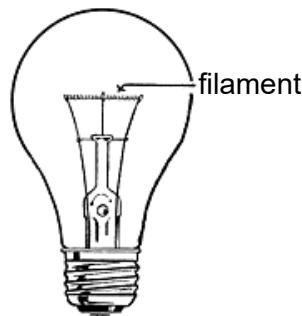


Fig. 4.1

The tungsten wire has a diameter of 0.046 mm. The variation with temperature θ of the resistivity of tungsten ρ is shown in Fig. 4.2.

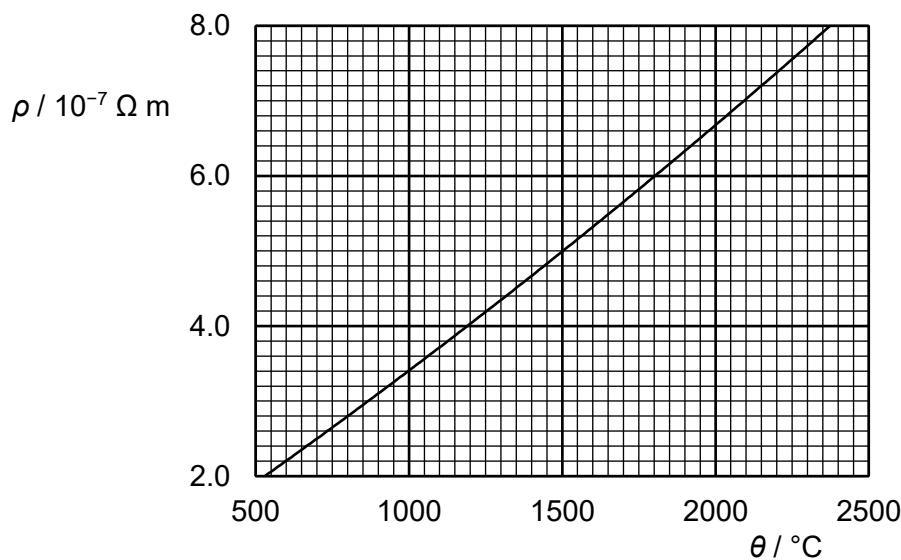


Fig. 4.2

- (a) By considering the microscopic model of the tungsten wire, explain why the resistance of tungsten wire in the filament lamp increases with temperature.

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[2]

(b) The filament lamp is rated at 60 W and 120 V. When operating at this rating, the resistivity of the tungsten wire is $6.9 \times 10^{-7} \Omega \text{ m}$.

(i) State the operating temperature of the filament.

$$\text{temperature} = \dots \text{ } ^\circ\text{C} \quad [1]$$

(ii) Calculate the resistance of the tungsten wire when it operates at this rating.

$$\text{resistance} = \dots \Omega \quad [2]$$

(iii) Calculate the length of the tungsten wire.

$$\text{length} = \dots \text{m} \quad [2]$$

- (iv) The filament is a 'coiled coil' as shown in Fig. 4.3. To form the filament, the tungsten wire is first made into a single coil. The single coil is then further coiled to form the coiled coil.

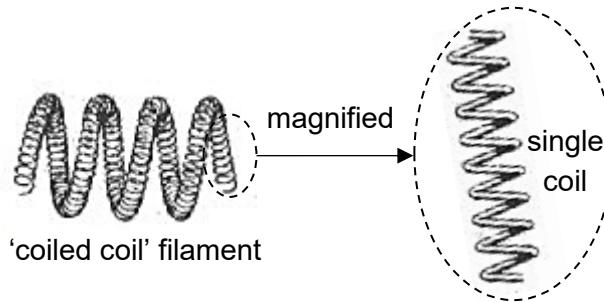


Fig. 4.3

Suggest an advantage of shaping the tungsten wire into a coiled coil.

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[1]

- (v) The filament lamp is connected to a power supply of electromotive force (e.m.f.) of E as shown in Fig. 4.4. The power supply has an internal resistance of the *same value* as that calculated in (b)(ii). It has a terminal potential difference of 120 V.

5.0% of the power dissipated in the filament lamp is converted to visible light.

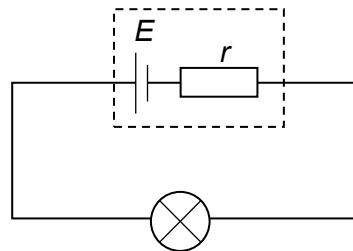


Fig. 4.4

Calculate the efficiency of this setup to produce visible light.

efficiency = % [2]