

Answer Question #65353 – Physics – Electric Circuit

A Tungsten filament for a light bulb is found to have a resistance of $0.25\ \Omega$ when measured at a temperature of 20°C . When the light bulb has been on for a substantial period of time, the filament has heated up and the resistance is found to be $3.50\ \Omega$. What is the temperature of the heated filament? Tungsten's temperature coefficient of resistivity is $4.5 \cdot 10^{-3}$ per degree C, and do not consider thermal expansion of the filament.

Solution. Temperature dependence of electrical resistance of tungsten filament bulbs excluding thermal expansion, it is possible to find a formula

$$R = R_0(1 + \alpha(T - T_0))$$

where $R = 3.5\Omega$ – resistance at temperature T , $R_0 = 0.25\Omega$ – resistance at temperature $T_0 = 20^\circ\text{C}$, $\alpha = 4.5 \cdot 10^{-3}$ per degree C – temperature coefficient of resistance.

Therefore

$$\frac{R}{R_0} = 1 + \alpha(T - T_0) \rightarrow T = T_0 + \frac{1}{\alpha} \left(\frac{R}{R_0} - 1 \right) \approx 2909^\circ\text{C}.$$

Answer. 2909°C .