

Chapter 16 Problem 39 †

Given

$$P = 100 \text{ W}$$

$$T = 3.0 \text{ kK} = 3000 \text{ K}$$

$$\sigma = 5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4$$

Solution

Find the surface area of the filament.

Stefan-Boltzmann's law states

$$P = \epsilon \sigma A T^4$$

Assuming the emissivity of the filament is 1, solve for A .

$$A = \frac{P}{\sigma T^4} = \frac{100 \text{ W}}{(5.67 \times 10^{-8} \text{ W/m}^2 \cdot \text{K}^4)(3000 \text{ K})^4} = 2.18 \times 10^{-5} \text{ m}^2$$

Convert to mm^2

$$A = (2.18 \times 10^{-5} \text{ m}^2) \left(\frac{1000 \text{ mm}}{1.000 \text{ m}} \right)^2 = 21.8 \text{ mm}^2$$

†Problem from Essential University Physics, Wolfson