

Answer on Question #41557, Physics, Electric Circuits

Calculate the electric power which must be supplied to the filament of a light bulb operating at 3000K. The total surface area of the filament is $8 \times 10^{-6} \text{ m}^2$ and its emissivity is 0.92.

20.3W 33.8W 46.4W 56.7W

Solution

Any object at Kelvin temperature T will radiate electromagnetic waves. The spectrum of this blackbody radiation depends only on the temperature and not on the type of material. The formula governing the total power radiated is

$$P = \sigma AT^4,$$

where $\sigma = 5.67 \cdot 10^{-8} \frac{\text{W}}{\text{m}^2 \text{K}^4}$ is Stefan-Boltzmann constant.

A total power radiated (real, non-blackbody radiation):

$$P = k\sigma AT^4,$$

where $k = 0.92$ is emissivity. So

$$P = 0.92 \cdot 5.67 \cdot 10^{-8} \cdot 8 \cdot 10^{-6} (3000)^4 = 33.8 \text{ W}.$$

Answer: 33.8 W.