8.5. We apply Stefan's law directly.

since Stefan's law gives temperature, yet the book asks for eV, assume we are looking for $k_B T$.

$$\Rightarrow \quad \eta = \sigma T^4 \Rightarrow T^4 = \frac{\eta}{\sigma}.$$

$$\Rightarrow (k_B T)^4 = \frac{k_B^4 \eta}{\sigma}$$

$$= \frac{\cancel{k_B^4} \eta \, 60 \hbar^3 c^2}{\pi^2 \cancel{k_B^4}}$$

$$= \frac{\eta \, 60 \hbar^3 c^2}{\pi^2}.$$

$\eta =$ ~~total power = Flux · area~~

$$\Rightarrow \eta = \text{flux} = \frac{\text{Power}}{\text{area}}$$

$$= \frac{10^{13}\ \text{W}}{\pi \times 2 \times (8 \times 10^{-4})^2 \text{m}^2} \approx \frac{10^{13}\ \text{W}}{402 \times 10^{-8}\ \text{m}^2} \approx \cancel{\frac{10^{13}}{4}}$$

$$\approx \frac{10^{13}}{10^{-6}} \frac{\text{W}}{\text{m}^2} \approx 10^{19} \frac{\text{W}}{\text{m}^2}.$$

$$\frac{60 \hbar^3 c^2}{\pi^2} \approx \frac{6\cancel{0} \times 10^{-102} \times 10^{\cancel{17} 16}\ \text{J}^3 \text{s}^{\cancel{3}} \text{m}^2}{\cancel{10}\ \cancel{s^2}} \approx 6 \times 10^{-85}\ \frac{\text{W}^3}{\text{m}^2 \text{s}^4} \cdot \cancel{s^2}$$

$$\Rightarrow (k_B T)^4 \approx 10^{19} \frac{\text{W}}{\cancel{\text{m}^2}} \cdot 6 \times 10^{-85} \frac{\text{W}^3}{\cancel{\text{m}^2} \text{s}^4} = 6 \times 10^{-66}\ \text{J}^4.$$

$$\Rightarrow k_B T \approx 10^{-16.5}\ \text{J} \approx \boxed{6.2 \times 10^{1.5}\ \text{eV} = 196\ \text{eV}}$$