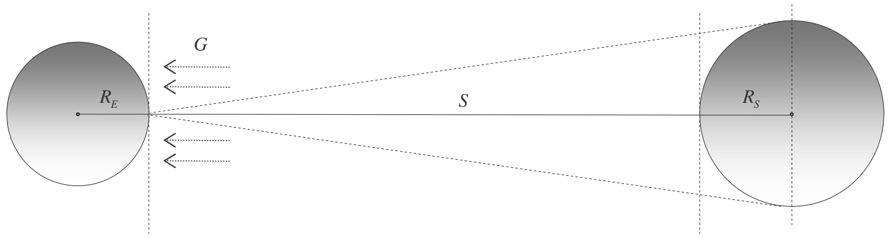
12.20



$G = 1353\left[\frac{W}{m^2}\right]$

$\Omega = \frac{\pi R_S^2}{(S+R_S)^2} = 6.7e\text{-}5[sr]$

a

Energy balance:

$q = E_S \cdot A_S = E_S \cdot (4\pi R_S^2)$

$q = G \cdot A_{S+R_S} = G \cdot 4\pi (S+R_S)^2$

$\Rightarrow \quad E_S \cdot (4\pi R_S^2) = G \cdot 4\pi (S+R_S)^2 \quad \Rightarrow \quad E_S = G \cdot \frac{4\pi (S+R_S)^2}{(4\pi R_S^2)} = G \cdot \frac{(S+R_S)^2}{(R_S^2)}$

$$Solar\ irradiation = G = \int_{2\pi} I_i \cdot cos\theta d\omega \qquad cos0 = 1$$

$$= \int_{2\pi} I_i d\omega$$

$$= I_i \int_{\Omega_{E\to S}} d\omega$$

$$= I_i \cdot \Omega_{E\to S}$$

$$= I_i \cdot \frac{A}{r^2} = I_i \cdot \frac{\pi R_S^2}{(S+R_S)^2} = \pi I_i \cdot \frac{R_S^2}{(S+R_S)^2} = E_S \cdot \frac{R_S^2}{(S+R_S)^2}$$

$$E_S = G \cdot \frac{(S+R_S)^2}{R_S^2} = 6.3e7\left[\frac{W}{m^2}\right]$$

b

$$E_S = \sigma T_S^4 \quad \Rightarrow \quad T_S = \left(\frac{E_S}{\sigma}\right)^{1/4} = 5787\,K$$

c

$$\lambda_{max,S} = \frac{c_3}{T_S} = \frac{2898}{5787} = 0.5\ [\mu m]$$

d

$$q_{intercepted\ by\ Earth} = G \cdot A_{cross\ section\ of\ Earth} = G \cdot \pi \cdot R_E^2$$

$$q_{emitted\ by\ Earth} = E_E \cdot A_{surface\ area\ of\ Earth} = (\sigma T_E^4)\cdot(4\pi R_E^2) \qquad \Rightarrow \qquad T_{Earth} = \left(\frac{G}{4\sigma}\right)^{1/4} = 277.9K = 4.9^oC$$