$$P^2 = \left(\frac{4\pi^2}{GM}\right)^3$$

$$P_{\rm years}^2 = \left(\frac{1}{M_{\rm solar}}\right) {a_{\rm AU}}^3$$

$$a_{\rm AU}^3 = (M_{\rm solar})\, {P_{\rm years}}^2$$

$$M_{\rm planet} = M_{\rm star} \left(\frac{a_{\rm star}}{a_{\rm planet}}\right)$$

$$\text{Incoming energy} = \left(\frac{L_*}{4\pi a^2}\right) \pi R^2$$

$$\text{Outgoing energy} = \left(\sigma T^4\right)\ 4\pi R^2$$

$$\left(\frac{L_*}{4\pi a^2}\right) \pi R^2 = \left(\sigma T^4\right)\ 4\pi R^2$$

$$T^4 = \frac{L_*}{16\pi a^2 \sigma}$$

$$T = \left(\frac{L_*}{16\pi\sigma}\right)^{1/4} \left(\frac{1}{a^2}\right)^{1/4}$$

$$\frac{T_{\rm b}}{T_{\rm Earth}} = \left(\frac{0.00155/1.0}{(0.052/1.0)^2}\right)^{1/4}$$

$$= 0.89$$