Grid 10. The brightnesses of a star

The luminosity of a star Σ, is $L_\Sigma = 100 \cdot L_S$, where L_S is the luminosity of the Sun, and the star's surface temperature is $T_\Sigma = \frac{1}{2} \cdot T_S$, where T_S is the Sun's surface of the Sun.

Relation between the radius of the star and the radius of the Sun is:

a) $\frac{R_\Sigma}{R_S} = 40$; b) $\frac{R_\Sigma}{R_S} = 30$; c) $\frac{R_\Sigma}{R_S} = 60$; d) $\frac{R_\Sigma}{R_S} = 50$.

Solution

The luminosity of a star, meaning the energy of the total radiation emitted by that star, in the unit of time, through its entire surface, at all wavelengths, in accordance with the Stefan-Boltzmann law, results:

$$L_\Sigma = 100 \cdot L_S;$$

$$L_\Sigma = 4\pi \cdot R_\Sigma^2 \cdot \sigma \cdot T_\Sigma^4; \; L_S = 4\pi \cdot R_S^2 \cdot \sigma \cdot T_S^4;$$

$$4\pi \cdot R_\Sigma^2 \cdot \sigma \cdot T_\Sigma^4 = 10^2 \cdot 4\pi \cdot R_S^2 \cdot \sigma \cdot T_S^4; \; R_\Sigma^2 \cdot T_\Sigma^4 = 10^2 \cdot R_S^2 \cdot T_S^4;$$

$$\frac{R_\Sigma^2}{R_S^2} = 10^2 \cdot \frac{T_S^4}{T_\Sigma^4} = 10^2 \cdot \left(\frac{T_S}{T_\Sigma}\right)^4 = 10^2 \cdot 2^4;$$

$$\frac{R_\Sigma}{R_S} = 40.$$