If the radius of a star is R and it acts as a black body, what would be the temperature of the star, in which the rate of energy production is q (c stands for Stefan "s constant)

Solution

Total surface area of the star

$$A = 4\pi R^2.$$

By Stefan – Boltzmann black body kept at temperature T radiates heat per unit surface area per second given by

$$E = cT^4,$$

c - Stefan-Boltzmann constant.

Now

$$E = \frac{q}{A} = \frac{q}{4\pi R^2} \rightarrow \frac{q}{4\pi R^2} = cT^4.$$

The temperature of the star

$$T = \sqrt[4]{\frac{q}{4\pi c R^2}} = \frac{1}{\sqrt{2R}} \sqrt[4]{\frac{q}{\pi c}}.$$

Answer: $\boldsymbol{\frac{1}{\sqrt{2R}} \sqrt[4]{\frac{q}{\pi c}}}$.