

Answer on Question #45876 – Physics – Astronomy – Astrophysics

Question:

A white dwarf star has a mass of 10^{30} kg and its luminosity is 10^{24} J/s . Calculate how long it can survive with its present luminosity of its internal temperature is 10^7 K.

Answer:

The lifetime of stars is approximately proportional to M/L (mass/luminosity ratio).

$$M_{\text{sun}}/L_{\text{sun}} \sim \text{lifetime of sun}$$

$$M_{\text{white dwarf}}/L_{\text{white dwarf}} \sim \text{lifetime of white dwarf}$$

$$M_{\text{sun}} = 1.988 \cdot 10^{30} \text{ kg}$$

$$L_{\text{sun}} = 384.6 \times 10^{24} \text{ J/s.}$$

The lifetime of sun is approximately 10^{10} years.

We can make the following proportion:

$$1.988 \cdot 10^{30} \text{ kg} / 384.6 \times 10^{24} \text{ J/s} \text{ — } 10^{10} \text{ years}$$

$$10^{30} \text{ kg} / 10^{24} \text{ J/s} \text{ — } X \text{ years}$$

$$\text{Then, } X = 10^{10} \cdot \frac{10^{30}}{10^{24}} \div \frac{1.988 \cdot 10^{30}}{384.6 \cdot 10^{24}} = 10^{10} \cdot \frac{10^{30} \cdot 384.6 \cdot 10^{24}}{10^{24} \cdot 1.988 \cdot 10^{30}} = 193.5 \cdot 10^{10} \text{ years}$$

Answer: $193.5 \cdot 10^{10}$ years