888.

Problem 55.45 (RHK)

Let us assume that the core of the Sun has one-eighth the Sun's mass and is compressed within a sphere whose radius is one-fourth of the solar radius. We assume further that the composition of the core is 35% *hydrogen by mass and that essentially all the Sun's energy is generated there. We also assume that the Sun continues to burn hydrogen at the rate of* 6.2×10^{11} kg s^{-1}. *We have to find the time in which the hydrogen in the Sun's core will be entirely consumed. The Sun's mass is* 2.0×10^{30} kg.

Solution:

We assume that the core of the Sun has one-eighth the Sun's mass. The mass of the Sun is 2.0×10^{30} kg.

Therefore, the mass of the Sun's core will be

$$M_{\text{sun's core}} = \frac{1}{8}\times 2.0\times10^{30}\ \text{kg} = 0.25\times10^{30}\ \text{kg}.$$

We assume further that the composition of the core is 35% hydrogen by mass and that essentially all the Sun's

energy is generated there. Therefore, the mass of hydrogen in the core of the sun will be

$$M_{\text{hydrogen-sun's core}} = 0.25 \times 10^{30} \times 0.35 \text{ kg}$$
$$= 8.75 \times 10^{28} \text{ kg.}$$

We also assume that the Sun continues to burn hydrogen at the rate of 6.2×10^{11} kg s^{-1}. Therefore, the time in which the hydrogen in the Sun's core will be completely consumed will be

$$t = \frac{8.75 \times 10^{28} \text{ kg}}{6.2 \times 10^{11} \text{ kg s}^{-1}} = 1.41 \times 10^{17} \text{ s}$$
$$= \frac{1.41 \times 10^{17}}{3.156 \times 10^{7}} \text{ y}$$
$$= 4.47 \times 10^{9} \text{ y.}$$