Example 11.1 ✓

Ch.11: Stellar Evolution

Exercise 11.2: $M = 2M_\odot$, $R = 3R_\odot$, $L = 60L_\odot$

"we know: $M_\odot = 1.989\times10^{30}$ kg, $R_\odot = 6.96\times10^{8}$ m, $L_\odot = 3.9\times10^{26}$ J/s

$$t_t = \frac{0.5GM^2}{RL} = \frac{0.5 * 6.673\times10^{-11} \times (2*1.989\times10^{30})^2}{3*6.96\times10^{8} * 60*3.9\times10^{26}}$$

$$= 1.081\times10^{13} \text{ sec.} * \frac{1}{3600} * \frac{1}{24} * \frac{1}{365.25}$$

$$= 3.42\times10^{5} \text{ years}$$

$$t_n = 0.007 * 0.1 * \frac{Mc^2}{L}$$

$$= 0.007 * 0.1 * \frac{2*1.989\times10^{30} * (3\times10^{8})^2}{60*3.9\times10^{26}}$$

$$= 1.07\times10^{16} \text{ sec.}$$

$$= 3.4\times10^{8} \text{ years.}$$

Exercise 11.3 Main sequence: 10^9 years $= t_{mo}$

& burns 10% of its hydrogen

$L = L_o$

Red Giant: $L_R = 100 L_o$

$t_{mR} = ??$, if it burns the remaing hydrogen

$$t_{no} = 0.007 * 0.1 * \frac{Mc^2}{L_o} = 10^9 \text{ years} \longrightarrow (1)$$

$$t_{nR} = 0.007 * 0.9 * \frac{Mc^2}{L_R} = ?? \longrightarrow (2)$$

0.9 ↑ Remaing hydrogen

L_R ↑ $100 L_o$

$$t_{nR} = \frac{0.007 * 0.9 * Mc^2}{100 \; L_o} = 6.3 \times 10^{-5} \frac{Mc^2}{L_o} \longrightarrow (3)$$

from Eq. (1): $10^9 \text{ years} = \frac{Mc^2}{L_o} * 7 \times 10^{-4}$.

$$\Rightarrow \boxed{\frac{Mc^2}{L_o} = \frac{10^9 \text{ years}}{7 \times 10^{-4}}}$$

Subtitute in (3)

$$t_{nR} = 6.3 \times 10^{-5} * \frac{10^9 \text{ years}}{7 \times 10^{-4}}$$

$$\boxed{t_{nR} = 9 \times 10^7 \text{ years}} \approx 90 \text{ million Years.}$$