Answers Problem Set #4
ASTR 1040

1. $T = 10^{10} \cdot \frac{M}{L}$ years

a) $T = 10^{10} \cdot \frac{10}{1000} = 10^{8}$ years

b) $T = 10^{10} \cdot \frac{0.1}{.001} = 10^{12}$ years

2. $L = \sigma A T^4 = \sigma \cdot 4\pi R^2 T^4$

$$R = \left(\frac{L}{\sigma 4\pi T^4}\right)^{1/2} = \left(\frac{1000 \times 4 \times 10^{26} W}{5.7 \times 10^{-8} \times 4 \times 3.14 \times 3000^4}\right)^{1/2}$$

$= 8.3 \times 10^{10}$ m $= 83$ million km

Mercury and Venus would be engulfed

3 $\rho_{\oplus} = \frac{M_{\oplus}}{\frac{4}{3}\pi R_{\oplus}^3} = 5.52$ g/cm$^3$ $\rho_{WD} \approx 10^6$ g/cm$^3$

$R = R_{\oplus} \cdot \left(\frac{5.52}{10^6}\right)^{1/3} = 6400$ km $\cdot \frac{1}{56} = 110$ km

4 Sun cannot ever be Type I SN because it is not in a binary. White dwarf is a binary, the stars are too far apart to exchange significant mass

5. $\rho_{NS} \sim 10^{14}$ g/cm$^3$ $R = 6400$ km $\cdot \left(\frac{5.52}{10^{14}}\right)^{1/3} = 24$ km

6 Point moves $8000 \times 2\pi$ m in .001 s $\quad v = 5 \times 10^7$ m/s

$$\beta = \frac{v}{c} = \frac{5 \times 10^7}{3 \times 10^8} = 16\% \text{ of } c$$

7 $R_S = 3$ km per $M_\odot$ $\quad R_{sol} = 10^{11} \times 3$ km $= 3 \times 10^{14}$ m

$$R_H = 3000 \text{ m} \cdot \frac{10 \text{ kg}}{2 \times 10^{30}} = 1.5 \times 10^{-25} \text{ m}$$ way less than nucleus

8 $R_{1M} = 3000$ m $\quad R_{12} = 3 \times 10^{15}$ m

$$a_1 = \frac{GM}{R^2} = \frac{6.7 \times 10^{-11} \times 2 \times 10^{30}}{3000^2} = 1.5 \times 10^{13} \text{ m/s}^2$$

$$a_{12} = \frac{GM}{R^2} = \frac{a_1 \cdot 10^{12}}{(10^{12})^2} = 15 \text{ m/s}^2 = 1.5 \text{ gees}$$