ASTR 702
HW #4

1) $P_{e,deg} = P_{gas}$

$$P_{e,deg} = K_1' \left(\frac{\rho}{\mu_e}\right)^{5/3}$$

$$P_{gas} = \left(\frac{1}{\mu_I} + \frac{1}{\mu_e}\right)\frac{k_B T}{m_H}$$

$$K_1' \left(\frac{\rho}{\mu_e}\right)^{5/3} = \left(\frac{1}{\mu_I} + \frac{1}{\mu_e}\right)\frac{k_B T}{m_H}$$

$$\rho^{2/3} = \frac{\mu_e^{5/3}}{K_1'}\left(\frac{1}{\mu_I} + \frac{1}{\mu_e}\right)\frac{k_B T}{m_H}$$

$$\rho = \left[\frac{\mu_e^{5/3}}{K_1'}\left(\frac{1}{\mu_I} + \frac{1}{\mu_e}\right)\frac{kT}{m_H}\right]^{3/2}$$

$\mu_e = 1.17$

$\mu_I = 1.29$

$K_1' = 1.00 \times 10^{7}\ m^4\ kg^{-2/3}\ s^{-2}$

$\Rightarrow \rho = 7.3 \times 10^{-5}\ T^{3/2}$

$T_\odot = 1.6 \times 10^7$ K $\rightarrow$ 6×10^3 K

$\rho_\odot = 34 \rightarrow 2.3 \times 10^6$ kg m^{-3}

Since $\rho_{\odot,core} = 1.6 \times 10^5$ kg m^{-3}, never degenerate pressure dominated

2) $P_{rad} = P_{gas}$

$$\frac{1}{3} a T^4 = \left(\frac{1}{a_T} + \frac{1}{m_e} \right) \frac{\rho k T}{m_H}$$

$$\rho = \frac{\frac{1}{3} a m_H}{k} \left(\frac{1}{m_I} + \frac{1}{m_e} \right)^{-1} T^3$$

$T_\odot = 1.6 \times 10^7 K \rightarrow 6 \times 10^3 K$

$\Rightarrow \rho = 7 \hat{C} 7 \rightarrow 4.04 \times 10^8 \ kg\ m^{-3}$

P_{rad} never dominates!