Name: ______________________________ Due December 2, 2003 9:20 a.m.

Physics/Astronomy/Planetary Sciences 589 Homework 7

1) a) Prove that for a star in hydrostatic equilibrium the sound travel time across the star is roughly equal to the free-fall time from the periphery to the center. b) How does this time scale with the average density of the star? c) What is the approximate relationship between this time and the period of a Keplerian orbit at the star's outer radius?

2) a) Calculate the binding energy in Joules or ergs of the Sun assuming it is a polytrope, $n = 3$, and $\gamma = 5/3$. b) Derive the relation:

$$P_c = W_n \frac{GM^2}{R^4},$$

where

$$W_n = \left(4\pi(n+1)\left(\frac{d\theta_n}{d\xi}\right)^2\right)^{-1}.$$

$d\theta_n/d\xi$ is its value at the outer boundary.

c) What are the central pressures in Megabars of the Sun and Jupiter, approximately?

3) a) Calculate $P(\rho)$ for a relativistic degenerate electron gas as a function of fundamental constants and Y_e, the ratio of the electron number to the nucleon number. b) With this result, calculate the Chandrasekhar mass (M_{ch}) as a function of Y_e. For $Y_e = 0.5$, what is M_{ch} in solar masses?