

33-467: Astrophysics of Stars and the Galaxy

Due: Monday 19th September.

Problem Set 2

1. Using Eq. (2) from Problem Set 1 and the Virial theorem, determine the internal energy, U of such a star as a function of stellar mass M and radius R .
2. A spherical star has an equation of state $P = K\rho^2$ where K is a constant. Show that the radius R is given by,

$$R = \left(\frac{K\pi}{2G} \right) \quad (1)$$

[*Hint: consider a trial solution of the form $\sin(Ar)/r$, where A is a constant to be determined*]

3. Show that in equilibrium, a non-rotating star satisfies,

$$\frac{d}{dr} \left(P + \frac{Gm^2}{8\pi r^4} \right) < 0 \quad (2)$$

where $m(r) = \int_0^r 4\pi r'^2 \rho dr'$. Use this relation to deduce a lower limit for the central pressure P_c in a star as a function of stellar mass M and radius R .