Worksheet: Estimating Central Pressure
(based on textbook problem 6.3)

We can estimate the pressure at the center of a planet by assuming hydrostatic equililbrium:

$$P(r) = \int_{r}^{R} g_P(r')\rho(r')\,dr'$$

a) First calculate $P(r=0)$ taking the simplest approach, approximating the planet to consist of one slab of material with thickness R, the planetary radius. Assume gravity $g_p(r) = g_p(R)$, and assume a constant mean density $\rho(r) = \rho$. State your answer in terms of R and the planet's total mass M.

b) Now calculate $P(r=0)$ using the correct expression for gravity $g_p(r)$ based on the mass internal to r. Again, assume a constant mean density $\rho(r) = \rho$.

c) Use each formula to estimate the central pressure of the Moon, Earth, Jupiter and the Sun. For the first three, compare your answers to the more sophisticated estimates in Table 6.1 of your book. For the Sun, these simple estimates are actually too small by a factor of ~100!