

Intro. Astrophysics II**NAME:****HW #2****Due Fri. Jan. 23**

FOR ALL PROBLEMS, SHOW YOUR WORK

1. In Ch. 16 of the notes, we derived an expression for the pressure in a degenerate fermion gas. Show that the energy density of such a gas is

$$U = \frac{3}{2}P$$

Remember that the kinetic energy of a particle is $\frac{p^2}{2m}$. Note: It is possible to show this without actually evaluating any integral! (4 points)

2. For a fully ionized helium gas ($Y=1.0$) with a temperature of $T = 10^7 K$:

Derive the relation $\text{Log } P$ vs. $\log \rho$ (cgs, please, see part c below) for the ideal gas pressure, degenerate electron pressures (both relativistic and non-relativistic), and radiation pressure. (2 points)(Note: the author of your textbook lists things like the radiation constant in Appendix 3)

make a clean sketch (or plot digitally) these functions for $-4 < \log \rho < +9$. (2 points)

Using the figure shown on page 8 of the Ch. 16 notes (from your textbook – note that she uses cgs units for the density!), comment on the relative importance of the 4 different types of pressure to the core of the Sun (plotted in the figure; note that the plot actually shows $P_{rad} = 10P_{ideal}$). (2 points)

Currently, the core of the Sun does NOT have $Y=1.0$, but you can look up the value in the paper on the Standard Solar Model (SSM) by Bahcall & Pinsonneault (2004) on the class web page. What is it? Based on the expressions for the pressures, what is going to happen to the core pressure as more and more H is converted into He? (2 points)