# PHYS 321: PROBLEM SET 3

Due Feb 14, 2018 Wed @ 11:30 am

*Solve the problems listed below, and* **write up your answers clearly and completely**. *Do not turn in rough work – instead, make a clean copy after checking your calculations. Use English sentences and phrases to explain your solution and describe your answers step by step. Even if you did not get the correct answer, you may get partial credits for these steps!*

1. (2 credits) Show that at room temperature, the thermal energy $kT \approx 1/40$ eV. At what temperature is $kT$ equal to 1 eV? to 13.6 eV?

2. (4 credits) Consider a gas of neutral hydrogen atoms:
   (a) At what temperature will equal numbers of atoms have electrons in the ground state $(n = 1)$ and in the second excited state $(n = 3)$?
   (b) At a temperature of 85,400 K, when equal numbers $(N)$ of atoms are in the ground state $(n = 1)$ and in the first excited state $(n = 2)$, how many atoms are in the second excited state $(n = 3)$? Express your answer in terms of $N$.
   (c) As the temperature $T \to \infty$, how will the electrons in the hydrogen atoms be distributed, according to the Boltzmann equation? That is, what will be the relative numbers of electrons in the $n = 1, 2, 3, ...$ orbitals? Will this in fact be the distribution that actually occurs? Why or why not?

3. (2 credits) Figure 8.14 in the textbook shows that a white dwarf star typically has a radius that is only 1% of the Sun's. Determine the average density of a 1-$M_\odot$ white dwarf.

4. (2 credits) The blue-white star Fomalhaut ("the fish's mouth" in Arabic) is in the southern constellation of Pisces Austrinus. Fomalhaut has an apparent visual magnitude of $V = 1.19$. Use the H-R diagram in Figure 8.16 of the textbook to determine the distance to this star.