PHYS 321: PROBLEM SET 4

Due Feb 28, 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) Using the root-mean-square speed v_{rms}, estimate the mean free path of the nitrogen molecules in your classroom at room temperature (300 K). What is the average time between collisions? Take the radius of a nitrogen molecule to be 0.1 nm and the density of air to be 1.2 kg m^{-3}. A nitrogen molecule contains 28 nucleons (protons and neutrons).

2. (2 credits) Calculate how far you could see through Earth's atmosphere if it had the opacity of the solar photosphere. Use the value for the Sun's opacity at 500 nm from Example 9.2.2 in the textbook and 1.2 kg m^{-3} for the density of Earth's atmosphere.

3. (2 credits) If the temperature of a star's atmosphere is increasing outward, what type of spectral lines would you expect to find in the star's spectrum at those wavelengths where the opacity is greatest?

4. (2 credits) Consider a large hollow spherical shell of hot gas surrounding a star. Under what circumstances would you see the shell as a glowing ring around the star? What can you say about the optical thickness of the shell?

5. (2 credits) Calculate the density scale height in the photosphere of the Sun. Assume the temperature is constant at $T = 5800$ K.