MAE 4425: Space Environment  
Homework #1  
Due: 09 Sep 08, 16:30 MDT

The gas in the classroom is composed air at atmospheric pressure and a temperature of 300 K. Note: Atmospheric pressure = 1 atm = 760 mmHg (Torr) = 1.01325 x 10^6 dyne/cm^2

For the gas in the classroom, calculate the following:

1. The number density of molecular nitrogen (N2).
2. The average kinetic energy of molecular nitrogen. Is it any different than the average kinetic energy of a heavier oxygen molecule in the room? Explain.
3. The average speed of a nitrogen molecule. Is it any different than that of a typical oxygen molecule? Explain.
4. The mean collision rate for molecular nitrogen?
5. The mean distance between nitrogen molecules. Compare this distance to the diameter of the nitrogen molecule (d_{N2} = 3.75 Å).

Classify the following flow fields from most to least rarefied. Justify your choice in terms of the Knudsen number of the flow. Use Figure A3 and assume solar maximum conditions, that the atmosphere above 300 km is composed entirely of oxygen atoms, and that T=300K for all flows. Hint: 1 Torr = 1 mm Hg and 760 Torr = 1 atm. Diameter of O atom is 3.64 Å.

6. The flow around the shuttle nose (1 m diameter) at an altitude of 350 km.
7. The flow around a micrometeorite (1 mm diameter) at an altitude of 700 km.
8. The flow field around a probe (1 cm diameter) in a vacuum chamber at 1 Torr.