PHYS 3110 – Homework set 8-II

Due Date: 2/5/2015

FOR ALL PROBLEMS: Think about the answers you obtain. Do they seem reasonable? If yes, then you have nothing more to do. If not, try to find any mistakes you may have made; if you can’t find anything wrong, comment on why you think your answer is unreasonable.

• 8.9

• Extra problem 1. (a) Use the Maxwell speed distribution to show that the root-mean-square speed \( v_{\text{rms}} \) is given by

\[
     v_{\text{rms}} = \sqrt{\frac{3kT}{m}}.
\]

(b) Use the result from (a) to deduce the equation for the average (kinetic) energy of the particles of average mass \( m \) in a gas in thermal equilibrium at temperature \( T \).

Note: In part (a) you should clearly and neatly show all the steps required to simplify your result. Refer to appendix B1 in Tipler for help with the integral.

• Extra problem 2. The most abundant molecule in air is the nitrogen molecule, \( \text{N}_2 \). Produce a plot of \( n(v)/N \) (the probability of a molecule having a speed \( v \)) for air (\( \text{N}_2 \)) at two different temperatures: room temperature and the freezing point of water. Plot both graphs on the same axes. Compare and contrast the two graphs in words, and also label the positions of \( v_{\text{mp}} \), \( \langle v \rangle \), and \( v_{\text{rms}} \) for each distribution.

You must use a computer to generate the plot, and it must have an appropriate title and axis labels.

• Extra problem 3. Repeat Extra Problem 2, but now for two different gases at the same temperature (room temperature): \( \text{N}_2 \) and \( \text{H}_2 \) at room temperature. Both graphs should be plotted on the same axes. Label the same special speeds that you did in Extra Problem 2.