Physics 111 Homework Set #3

1) Find the rms speed of N_2 molecules under standard conditions. Recall that 1 mole of any gas occupies 22.4 *l* under standard conditions.
2) In a 30 second interval, 500 hailstones strike a glass window of area 0.6 m^2 at an angle of 45° to the window surface. Each hailstone has a mass of 5g and a velocity of 8m/s. If the collisions are assumed to be elastic, find the average force and pressure on the window.
3) Gaseous He is in thermal equilibrium with liquid He at T=4.2K. Determine the most probable speed of an He atom.
4) One mole of an adiabatic gas has a pressure P, and a volume V. By heating the gas its pressure is tripled and its volume is doubled. If the heating process includes two steps, the first at constant pressure and the second at constant volume, determine the amount of heat transferred to the gas.
5) One mole of H_2gas is heated at constant pressure from 300K to 420K. Calculate (a) the heat transferred to the gas, (b) the increase in internal energy of the gas and (c) the work done by the gas.
6) Two moles of an ideal gas (γ=1.4) expand slowly and adiabatically from P=5.00atm and V=12.0*l* to a final volume of 30.0*l*. (a) What is the final pressure of the gas? (b) What are the initial and final temperatures?
7) A room of a well insulated house has V=100m^3 and T=300K. (a) Estimate the energy required to increase T by 1.0°C. (b) If this energy could be used to lift an object of mass m to a height of 2m, calculate the value of m.
8) During the compression stroke of a certain gasoline engine, the pressure increases from 1.00 atm to 20.0 atm. Assuming that the process is adiabatic and reversible and the gas is ideal with (γ=1.4), (a) by what factor does the volume change, and (b) by what factor does the temperature change?
9) At what temperature would the average speed of He atoms equal the escape speed from earth (1.12×10^4m/s) and (b) the escape speed from the moon (2.37×10^3m/s)? ($M_{He}=6.65\times10^{-27}$kg)
10) Show that the mean free path for molecules of an ideal gas is $l = \frac{k_B T}{\sqrt{2}\pi d^2 P}$ where d is the molecular diameter.
11) A mixture of two gasses will diffuse through a filter at rates proportional to v_{rms}. If the molecules of the two gasses have masses m_1 and m_2, show that the ration's of their rms speed (or the ration of their diffusion rations) is $v_{1rms}/v_{2rms} = m_2/m_1$. Note: This process is used to obtain Uranium rich in ^{235}U.