PHYS 6107, Homework 2, Due Friday, 01/30/09 at 5pm

1. One mole of an ideal gas is expanded adiabatically from (P_1, V_1) to (P_2, V_2). It is then compressed isobarically to (P_2, V_1). Finally the pressure is raised from P_2 to P_1 at constant volume V_1. Find the efficiency of this cycle.

2. An isolated container has two chambers separated by an adiabatic, movable wall. Each chamber contains N molecules of the same ideal gas but at different temperatures and volume T_A , V_A and T_B, V_B. The wall is removed. What is the final temperature of the system, once equilibrium is established? Calculate the total entropy change; show that this is positive change, meaning the process is irreversible.
3. a) How much heat is required to raise temperature of 1000 grams of nitrogen from −20°C to 100°C at constant pressure.
   b) How much has the internal energy of nitrogen increased.
   c) How much external work was done.
   d) How much heat is required if volume is constant.
   Note: you can assume Nitrogen is ideal diatomic gas so molar specific heat is c_v = 5R/2 with the gas constant R = $N_A k_B$, N_A is the Avogadro number.

4. For discrete random variable x with possible outcome $\{x_1, x_2, x_3, \ldots, x_n\}$, the mean value is given by
   $$\langle x \rangle = \sum_{i=1}^{n} x_i P(x_i) ,$$
   where $P(x_i)$ is the probability that x has the value x_i. Calculate the mean, second moment and variance for the value of a dice after a throw.

5. (We want to calculate, on average, how many dice throws before a "6" appears:) What is the probability $P(m)$ that a "6" appears for the first time after m throws? What is $\langle m \rangle$?
   You should get $\langle m \rangle$=6, which is what one would guess intuitively.

6. A random variable x has probability density $P(x)$. $f(x)$ and $g(x)$ are two functions of x. Show that $\langle f(x)+g(x) \rangle = \langle f(x) \rangle + \langle g(x) \rangle$.

7. Calculate the mean $\langle n \rangle$ and the variance $\sigma^2 = \langle n^2 \rangle - \langle n \rangle^2$ for binomial distribution.

8. Read textbook example 3.1 and section 3.3 (mass action law), redo exercises 3.2, 3.4.