Homework #4

Problem #1

One mole of oxygen slowly expands from V_1 = 1 liter to V_2 = 2 liters. The temperature is constant T = 300 K. Using the Van der Waals equation calculate the work performed by the gas. Compare it with the result of calculations made for ideal gas under the same conditions.

The Vad der Waals equation can be written in two equivalent ways,

$$\left(P + A\frac{N^2}{V^2}\right)(V - NB) = Nk_BT \text{ and } \left(P + \frac{a}{v^2}\right)(v - b) = RT,$$

where v is volume per mole. Oxygen parameters are, $a = 1.38\text{x}10^{-4}\ Jm^3/mole^2$, $b = 3.2\text{x}10^{-5}\ m^3/mole$.

Problem #2

A container with total volume V_0 is separated into three compartments with volumes V_1, V_2 and V_3. ($V_1+V_2+V_3=V_0$). There are total N_0 molecules in the container, they are free to move between the compartments and each molecule can be found with equal probability anywhere within the container. Find the probability of the following configuration: N_1 molecules are in the compartment 1, N_2 molecules are in the compartment 2, N_3 molecules are in the compartment 3.

Problem #3

Problem 1.51 form the textbook

Use data at the back of the textbook to determine ΔH for the combustion of a mole of glucose.

$C_6H_{12}O_6+6O_2 \rightarrow 6CO_2+6H_2O$

This is the (net) reaction that provides most of the energy needs in our body.

(Comments: I copied the table and posted in the course website. The examples of how to deal with the enthalpy we given in the lecture #3)

Problem #4

The piston of mass M, closing a volume of a monoatomic gas at initial pressure P_0 and temperature T_0, moves with velocity u. Find the temperature and the volume of the gas at maximum compression. The system is thermally isolated. The specific heat of the cylinder and the piston can be neglected.