Chemistry 311

Physical Chemistry

Homework Assignment # 2

Due: Monday, September 27, 2004

1. Kinetic molecular theory establishes that the temperature of a gas is proportional to the speed with which the atoms/molecules move. Since perfectly elastic collisions in which no energy is gained or lost are rare, it would seem that molecules of a gas in a container would eventually lose energy due to collisions with the walls and cool down. However, our experience is that a gas in a container remains at a constant temperature unless it is heated or cooled by external factors. How would you reconcile these apparently conflicting statements?

2. Methane is heated from 298 K to 500 K at constant pressure. Find (a) ΔH and (b) ΔU for the process. $C_{P,m} = 23.64 + 47.86\times10^{-3}\ T - 1.92\times10^{5}/T^{2}$.

3. A gas obeys the equation of state $P(V-nb) = nRT$.
   (a) Derive the expression for w_{rev} for an isothermal reversible expansion involving the gas.
   (b) What is the value of w_{rev} for one mole of this gas with $b = 0.0304$ L mol^{-1} for a reversible isothermal expansion from 3.0 L to 6.0 L at 300 K?
   (c) What will be the value of w for the same expansion against a constant external pressure, where the external pressure is the same as the final pressure of the gas?

4. One mole of ideal gas initially at 20 bar and 300 K is allowed to instantaneously ($P_{ext} = 0$!) expand to 2 bar pressure in an irreversible process that lowers the temperature of the system to 283.2 K.
   (a) Sketch at least four different reversible paths in P-V space (more, if you can think of them) that connect the initial state to the final state.
   (b) Find ΔU and ΔH for each step and the total process.