CH353 – Physical Chemistry I
Spring 2013, Unique 52575

Homework, Week 1

1. What pressure is exerted by 250 g of CO_2 gas at 25˚C in a container 1.5 dm^3 in volume if it behaves as a perfect gas? What pressure would it exert if it behaves as a van der Waals gas? Comment on any differences.

2. In a van der Waals gas, there is a temperature at which the attractive and repulsive intermolecular forces balance each other, and the behavior of the gas approaches that of an ideal gas. Find an expression for this temperature, in terms of *a*, *b*, and any other variables you need.

3. Use the van der Waals equation to plot the compressibility factor against pressure for methane gas at 180 K and 250 K. Comment on any differences.

4. When boarding an airplane in Austin, where the external air pressure is 1.0 atm and the temperature of the airport is 25˚C, you are given a balloon filled with helium. Using the string to which it is tied, you measure the circumference of the balloon to be 40 cm. When you plane reaches and altitude of 36,000 ft, the temperature in the cabin has decreased to 21˚C and the circumference of the balloon has increased to 45.5 cm. What is the air pressure of the cabin? Assume a spherical balloon, and that the helium is behaving as an ideal gas.

5. A 4 L container with rigid walls is divided in half into two compartments separated by a rigid wall. One compartment is filled with 1.5 mol of an ideal gas, and the other is evacuated (i.e. pumped down to a vacuum of $P \sim 0$). The wall is removed and the gas expands to fill the entire vessel, while an external heater keeps the system at 25˚C.

   a) Draw the initial and final states, and define the path by which the system moves between them.

   b) Determine *P*, *V*, *T*, and *n* of the initial and final states.

   c) Was the external heater necessary to maintain the system at this temperature? Why or why not? (We might not yet be able to answer this question by the end of Friday's class, but please think about it.)

6. a) A sealed vessel containing an ideal gas at a pressure of 0.5 atm is opened in a room at approximately atmospheric pressure (1.0 atm). What happens?

   b) A sealed vessel containing an ideal gas at a pressure of 1.5 atm is opened in the same room. What happens?

   c) The pressure of a poisonous gas inside a sealed vessel is 1.47 atm at 20˚C. If the atmospheric pressure is 1.0 atm, to what temperature must the container and its contents be cooled so that the container can be opened with no risk for gas escaping?