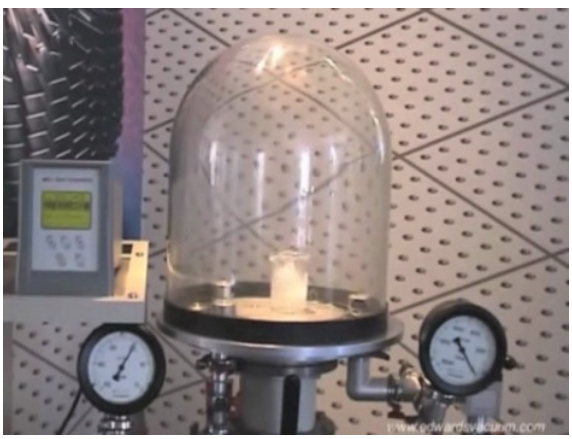
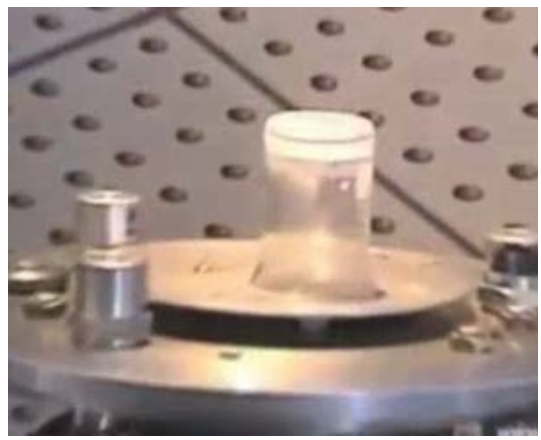
9 January 2020
To: ChE 312 Class
From: Professor Koretsky
Subject: Homework #2

Below is the second homework assignment of the quarter. Please conform to the format described in the class syllabus. This assignment is due on 16 January 2020 at1 PM on Gradescope. If you have any questions, feel free to see me or one of the other instructors during office hours or by appointment.

1. In the video from class, we watched approximately 200 ml of liquid water as it was placed in vacuum. Immediately after vacuum was achieved, the water started to boil (figure left, below). By the end of the process, some of that water turned to ice as shown below right.





The enthalpy of vaporization and the enthalpy of fusion for water are

$$\Delta h_{vap} = 40.65 \left[\frac{\text{kJ}}{\text{mol}}\right] \quad \text{and} \quad \Delta \hat{h}_{fus} = -333.55 \left[\frac{\text{J}}{\text{g}}\right]$$

Estimate the mass of water that turned to ice.

A. Develop a schematic for a conceptual model that you can use to answer this question. Show the initial state and the final state.
B. State any assumptions that you used to estimate the mass of ice.
C. Calculate an estimated value for the mass of ice

2. Consider the use of CF_2Cl_2 as a dispersing agent for aerosol spray cans. Estimate the pressure a can has to withhold at 40 ^{o}C. Its enthalpy of vaporization at its normal boiling point (244 K) is $\Delta h_{vap} = 20.25\left[\frac{\text{kJ}}{\text{mol}}\right]$. State your assumptions.

3. A rigid container contains 10 mol of pure species 1 at 1 bar and 200 K. Under those conditions, species 1 is in vapor-liquid equilibrium and contains 20% vapor by mass. You wish to increase the pressure to 5 bar by heating it. After heating, there are also both liquid and vapor phases present in equilibrium. The enthalpy of vaporization at 200 K, and heat capacities in the vapor and liquid for species 1 are given by:

$$\Delta h_{vap,200\text{ K}} = 14\ \frac{\text{kJ}}{\text{mol}};\ c_P^v = 25\left[\frac{\text{J}}{\text{mol K}}\right];\ \text{and}\ c_P^l = 50\left[\frac{\text{J}}{\text{mol K}}\right]$$

Answer the following:

A. Draw a schematic of the process labeling state 1 and state 2. Include all the information you know about the process in your schematic.
B. Estimate the number of moles of 1 that changes phase. State any assumptions that you make
C. Solve for the total amount of heat that is transferred. State any assumptions that you make.