Problem 1, 10 marks

We can ice skate because the pressure on the ice lowers its freezing temperature creating a thin film of water under the skate blades. Calculate the freezing temperature of ice for a 70 kg person standing on ice skate blades of dimension 0.25 x 12.0 inches.

Data: 1 inch = 2.54 cm; $\rho(H_2O(\ell)) = 0.997 \text{ g/cm}^3$; $\rho(H_2O(s)) = 0.917 \text{ g/cm}^3$; $\Delta H_{fus}(H_2O)$ = 6.01 kJ/mol; $g = 9.8 \text{ m/s}^2$ don't forget to convert

Use chapeyron Equation: integrate assum independent of T $\frac{dP}{dT} = \frac{\Delta H}{T\Delta V} \Rightarrow dP = \frac{\Delta H}{\Delta V} \frac{dT}{T} \Rightarrow \frac{\Delta P}{\Delta V} = \frac{\Delta H}{\Delta V} \ln \left(\frac{T_2}{T_1}\right)$

Use: P = A Area T = 273.15k

and $\Delta V = V_{\ell} - V_{s} \Rightarrow (m) P_{\ell} - (m) P_{s} = answer$

Then, plug back into DP = DH in (Tz) and solve for Tz

* USE Lelvin

to check yourself, make sure all units cancel out except for Lewin.

Looking for 4 things when grading (highlited)

How to derive Clapeyron Equation

https://chem.libretexts.org/Bookshelves/ Physical and Theoretical Chemistry Textbook M aps/Physical Chemistry (LibreTexts)/ 23%3A Phase Equilibria/ 23.03%3A The Chemical Potentials of a Pure S ubstance in Two Phases in Equilibrium

Problem 2, 10 marks

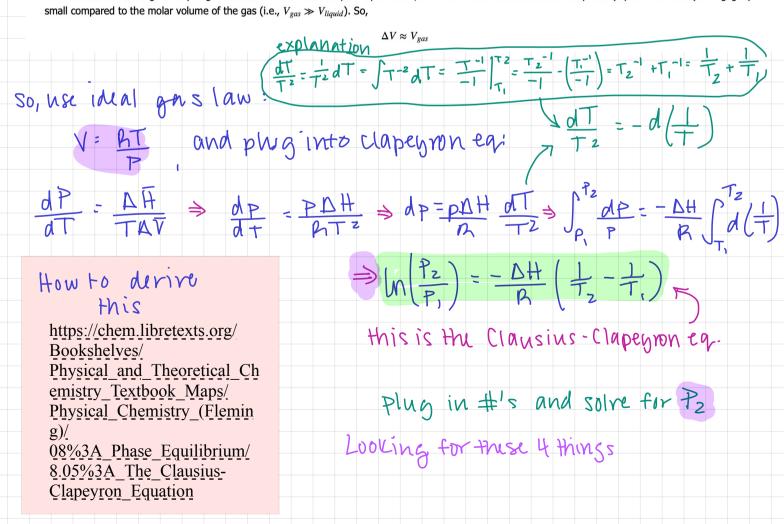
Freeze drying (lyophilization) is a process where water contained in a sample is evaporated into the gas phase at low pressures and temperatures below the freezing temperature of water. What is the maximum pressure at which a sample can be freeze dried if the temperature is not to exceed -10.5 °C?

Data: $\Delta H_{fus}^0 = 6.01 \text{ kJ/mol}$; $\overline{\Delta H_{vap}^0} = 40.65 \text{ kJ/mol}$; the vapor pressure of ice is 611 Pa at 273.15 K.

The Clapeyron equation can be developed further for phase equilibria involving the gas phase as one of the phases. This is the case for either sublimation (solid \rightarrow gas) or vaporization (liquid \rightarrow gas). In the case of vaporization, the change in molar volume can be expressed

$$\Delta V = V_{gas} - V_{liquid}$$

Since substances undergo a very large increase in molar volume upon vaporization, the molar volume of the condensed phase (liquid in this case) is negligibly small compared to the molar volume of the gas (i.e., $V_{gas} \gg V_{liquid}$). So,



Problem 3, 10 marks

convert

The vapor pressure of water at 20 °C is 17.54 torr. Using this data and $\Delta H_{vap}^0 = 40.65$ kJ/mol for water calculate ΔG_{298}^0 for the change $H_2O(\ell) \to H_2O(g)$? (Hint: the form of the van't Hoff equation is identical to the Clausius-Clapeyron equation)

$$\ln\left(\frac{P_z}{P_1}\right) = -\frac{\Delta H}{R}\left(\frac{1}{T_z} - \frac{1}{T_1}\right)$$

Looking for these 2 things