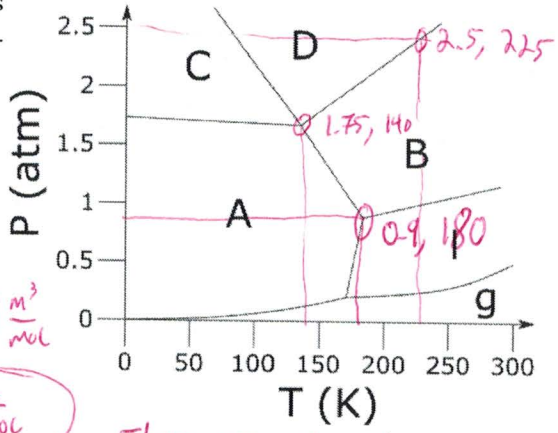
Quiz 4.2 – Phase Boundaries

Name: Key

Use the phase diagram at right to answer the following questions:



- Estimate the slopes of the A-B and the D-B transition lines (These should technically be curves, but the curvature between solid phases is usually small)

A-B: $\frac{-0.89\,atm}{40\,K} = -2254\,\frac{Pa}{K}$ D-B: $\frac{0.75\,atm}{85\,K} = +893.8\,\frac{Pa}{K}$

- If $\Delta H_{A-B} = 2.5\frac{kJ}{mol}$ at $150.0\ K$, find $\Delta V_{m,A-B}$

$\frac{dp}{dT} = \frac{\Delta H}{T\Delta V_m}$ $-2254\,\frac{Pa}{K} = \frac{2506\,\frac{J}{mol}}{150.0K \cdot \Delta V_m}$ → $\Delta V = 0.00739\,\frac{m^3}{mol}$

$\Delta V = 7.39\,\frac{L}{mol}$

- If $\Delta V_{m,D-B} = 2.3\frac{mm^3}{mol}$ at $200.0\ K$, find ΔH_{D-B}

These are obviously unreasonable values... writing these questions was hard.

$\frac{dp}{dT} = \frac{\Delta H}{T \cdot 2.3\cdot 10^{-9}\,\frac{m^3}{mol}}$ $893.8\,\frac{Pa}{K} = \frac{\Delta H}{200.0K \cdot 2.3\cdot 10^{-9}\,\frac{m^3}{mol}}$ ⇒ $\Delta H = 4.11\cdot 10^{-4}\,\frac{J}{mol}$

Gasoline readily evaporates if it spills onto the ground. For gasoline, $\Delta H_{vap} = 39.1\frac{kJ}{mol}$, and gasoline has a normal boiling temperature of $333\ K$. What is the vapor pressure of gasoline at $20^\circ C$?

$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$ → $\ln\left(\frac{P_2}{1\,atm}\right) = \frac{-39{,}100\,J/mol}{8.314\,J/mol\cdot K}\left(\frac{1}{293K} - \frac{1}{333K}\right)$ → $P_2 = 0.145\,atm$

You measure the vapor pressure of an unknown substance at two temperatures. At $260.0\ K$ the vapor pressure is $13.5\,torr$, and at $310.0\ K$ the vapor pressure is $1240\,torr$. Use these data to estimate ΔH_{vap} for this substance.

$\ln\left(\frac{1240\,torr}{13.5\,torr}\right) = \frac{-\Delta H_{vap}}{8.314\,\frac{J}{mol\cdot K}}\left(\frac{1}{310K} - \frac{1}{260K}\right)$ → $\Delta H_{vap} = 60.6\,\frac{kJ}{mol}$

Use today's barometric pressure to estimate the actual boiling temperature of water today in Cedar City, Utah.

0.81 atm $\Delta H_{vap} = 40.65\,kJ/mol$

$\ln\left(\frac{0.81\,atm}{1.00\,atm}\right) = \frac{-40{,}650\,\frac{J}{mol}}{8.314\,\frac{J}{mol\cdot K}}\left(\frac{1}{T_B} - \frac{1}{373K}\right)$ → $T_B = 367.1K = 94.1^\circ C$