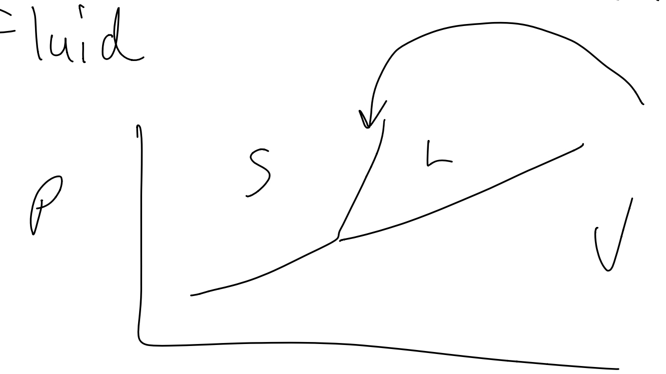
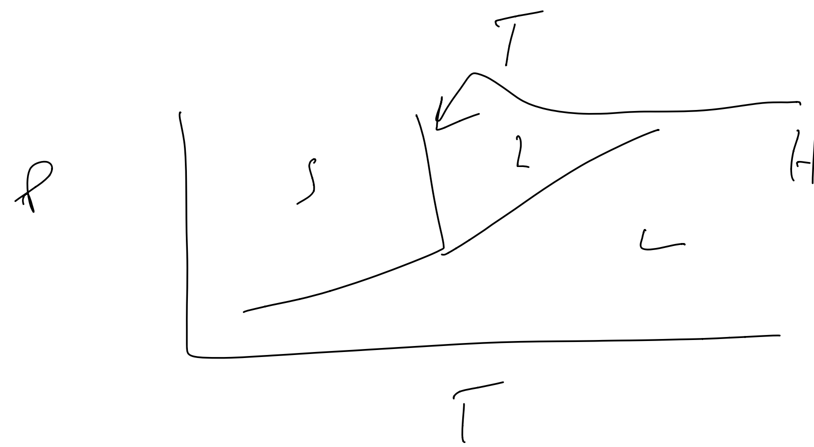
Clausius - Clapeyron $\left(\frac{dP}{dT}\right)_{\text{coexistence}} = \underline{\qquad\qquad}$

Single Fluid



most fluids



H_2O

idea of constraints

$$\begin{cases} \mu^{v}(T,P) = \mu^{l}(T,P) \\ \mu^{\alpha}(T,P) = \mu^{\beta}(T,P) \end{cases}$$

Gibbs Phase "Rule"

c = # components

π = # phases

Net D.O.F. $= C + 2 - \pi$

at equilibrium !!

$C = 2$; 2 components

phase Diagrams for 2-comp systems.

Net. D.o.F = $C + 2 - \pi$

$= 3$

$1 = \pi$

$C = 2$

$C = 1$

$C = 2$

$\pi = 2$ ← 2 phases in equilibrium

2-dimensions

2 D.O.F.

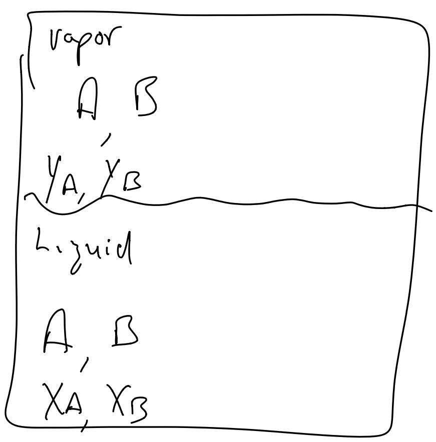
T or P specified

Because, T, P, $\{x_i\}$

→ we'll specify T

→ at Equilibrium we have only
1 D.O.F.

T = constant



A, B volatile liquids

Assume vapor is Ideal Gas

Assume solution is "ideal"

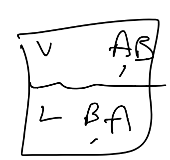
interactions between
A ⟷ B
are equivalent to
A ⟷ A
B ⟷ B

Question : Phase Equilibrium

T = constant

Raoult's "Law"

P_A = partial pressure of A in vapor



$$P_A = X_A \, P_A^*(T)$$

liquid phase composition of A

vapor pressure of pure A at T

$$P_B = X_B P_B^*(T)$$

$$P_B = (1 - X_A) P_B^*(T)$$

Since I. G. $P = P_A + P_B$

$$= X_A P_A^* + X_B P_B^*$$

$$= (1 - X_B) P_A^* + X_B P_B^*$$

are @ T

$$P = (1 - X_B) P_A^* + X_B P_B^*$$

$$\boxed{P = P_A^* + (P_B^* - P_A^*) X_B}$$

TOTAL Pressure

composition of liquid

What About vapor phase.

$$Y_A = \frac{P_A}{P}$$

$$Y_A(X_A)$$

$$X_A = f(Y_A)$$

$$Y_A = \frac{X_A P_A^*}{X_A P_A^* + (1-X_A) P_B^*}$$

$$Y_A\left(X_A P_A^* + (1-X_A) P_B^*\right) = X_A P_A^*$$

$$Y_A X_A P_A^* + Y_A P_B^* - Y_A X_A P_B^* = X_A P_A^*$$

$$X_A\left[Y_A P_A^* - P_A^* - Y_A P_B^*\right] = -Y_A P_B^*$$

$$\boxed{X_A = \frac{-Y_A P_B^*}{Y_A P_A^* - P_A^* - Y_A P_B^*}}$$

$$X_A = f(Y_A)$$

$$Y_A = \frac{P_A}{P} \Rightarrow \boxed{P = \frac{P_A}{Y_A}}$$

$$P = \frac{X_A P_A^*}{Y_A} = \frac{-Y_A P_B^*}{Y_A\left(Y_A P_A^* - P_A^* - Y_A P_B^*\right)}$$

$$P = \frac{-P_B^* P_A^*}{Y_A P_A^* - P_A^* - Y_A P_B^*}$$

$$\boxed{P = \frac{-P_B^* \, P_A^*}{y_A \left(P_A^* - P_B^*\right) - P_A^*}}$$