Molar volume of H_2O at 25°C — 18 ml / mol

in EtOH ⟶ 14 ml / mol

Partial molar volume of H_2O in pure EtOH
= 14 ml / mol

$$V_J = \left(\frac{\partial V}{\partial n_J}\right)_{P, T, n'}$$

$$dV = \left(\frac{\partial V}{\partial n_A}\right)_{P, T, n_B} dn_A + \left(\frac{\partial V}{\partial n_B}\right)_{P, T, n_A} dn_B$$

$$dV = V_A\, dn_A + V_B\, dn_B$$

$$V = V_A\, n_A + V_B\, n_B$$

Partial molar Gibbs Free Energy

$$\mu_J = \left(\frac{\partial G}{\partial n_J}\right)_{P,T,n'}$$

Chemical potential

$$dG = \mu_A\, dn_A + \mu_B\, dn_B$$

$$G = n_A \mu_A + n_B \mu_B$$

$$dG = -SdT + Vdp + \mu_A dn_A + \mu_B dn_B + \dots$$

$$dG_{p,T} = dw_{add,max} = \mu_A dn_A + \mu_B dn_B + \dots$$

$$dG_{p,T} \leq 0$$

$$U = -pV + TS + G$$

$$dU = -pdV - \cancel{Vdp} + TdS + \cancel{SdT} - \cancel{SdT} + \cancel{Vdp} + \mu_A dn_A + \mu_B dn_B + \dots$$

$$dU = TdS - pdV + \mu_A dn_A + \mu_B dn_B + \dots$$

$$\left(\frac{\partial U}{\partial n_J}\right)_{S,V,n'} = \mu_J = \left(\frac{\partial H}{\partial n_J}\right)_{S,p,n'} = \left(\frac{\partial A}{\partial n_J}\right)_{T,V,n'}$$

$$dA = -SdT - pdV + \sum_J \mu_J dn_J$$

$$dA_{T,V} \leq 0 \qquad dA_{T,V} = \sum_J \mu_J dn_J$$

$$dG_{T,P} = \sum_J \mu_J dn_J$$

$$dU_{S,V} = \sum_J \mu_J dn_J = dH_{S,P}$$

Gibb's Duhem Eqn.

$$n_B \, d\mu_B = -n_A \, d\mu_A$$

Two component systems

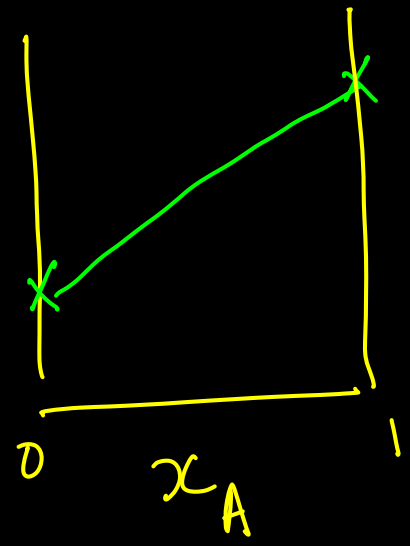
Raoult's Law $P_A = x_A P_A^*$

$P_B = x_B P_B^*$

P_B: partial vap. pr. of B; x_B: mol. fraction; P_B^*: vap pr of pure B

$P = P_A + P_B = x_A P_A^* + x_B P_B^*$

$$P = P_B^* + (P_A^* - P_B^*) x_A$$



$$y_A = \frac{P_A}{P} \quad ; \quad y_B = \frac{P_B}{P}$$

$$y_A = \frac{x_A P_A^*}{P_B^* + \left(P_A^* - P_B^*\right) x_A} \qquad y_B = 1 - y_A$$

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

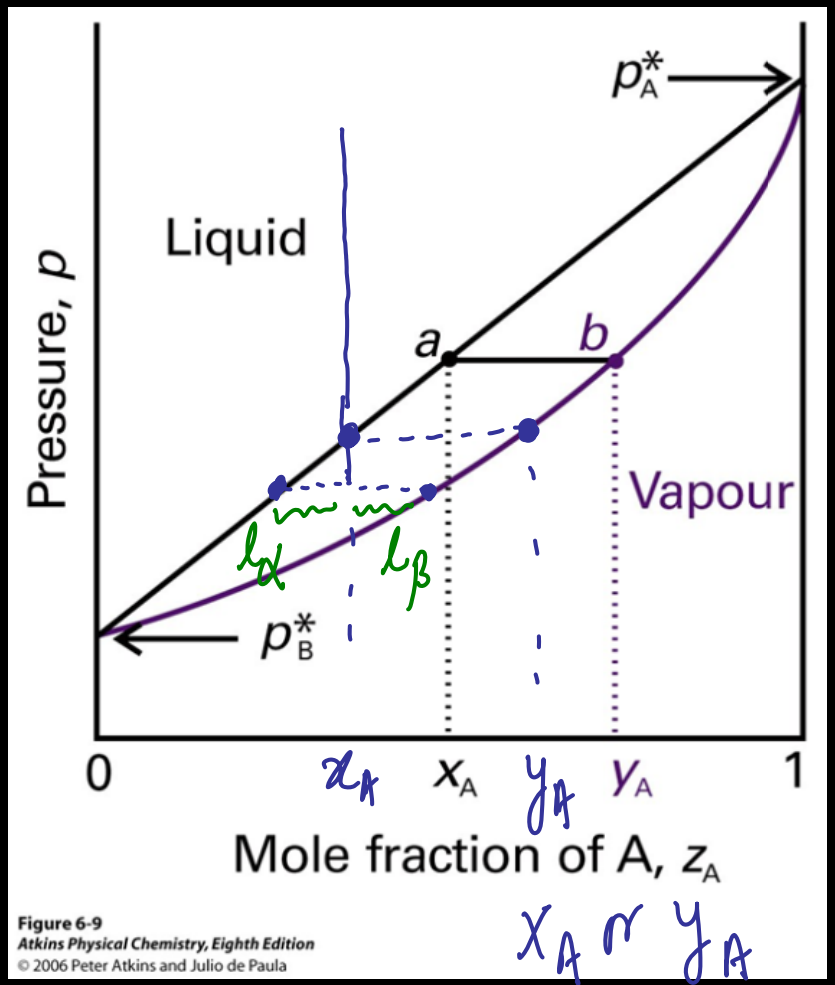


Figure 6-9
Atkins Physical Chemistry, Eighth Edition

x_A or y_A

tie line

lever rule

$n_\alpha l_\alpha = n_\beta l_\beta$

Azeotrope