

There is one rule; you don't talk about fight club,
 The second rule is you don't talk about fight club,
 The third rule is $\mu_A = \mu_A^* + RT \ln(P_A/P_A^*)$

<u>Solute</u>	<u>What</u>	<u>Solvent</u>
$\mu_A = \mu_A^* + RT \ln(P_A/P_A^*)$	Nature	$\mu_B = \mu_B^* + RT \ln(P_B/P_B^*)$
$\mu_A = \mu_A^* + RT \ln(\chi_A)$ ←	Raoult's Law $P_A = \chi_A \cdot P_A^*$ $P_B = \chi_B \cdot P_B^*$	→ $\mu_B = \mu_B^* + RT \ln(\chi_B)$
Ideal Solutions		
$\mu_A = \mu_A^* + RT \ln(\chi_A \cdot K/P_A^*)$ ←	Henry's Law $P_A = K \cdot \chi_A$	
$\mu_A = \mu_A^* + RT \ln(\chi_A \cdot K/P_A^*)$ ←	Ideal-Dilute Solutions	→ $\mu_B = \mu_B^* + RT \ln(\chi_B)$
Activity (using Gibbs energy)		
$a_A = P_A/P_A^* = \gamma_A \cdot \chi_A$ $G_A = G_A^* + n_A RT \cdot \ln(a_A)$ or $G_A = G_A^* + nRT \{ \chi_A \cdot \ln(\chi_A) + \chi_A \cdot \ln(\gamma_A) \}$		$a_B = P_B/P_B^* = \gamma_B \cdot \chi_B$ $G_B = G_B^* + n_B RT \cdot \ln(a_B)$ or $G_B = G_B^* + nRT \{ \chi_B \cdot \ln(\chi_B) + \chi_B \cdot \ln(\gamma_B) \}$

Therefore $\Delta_{mix}G = nRT \{ \chi_A \cdot \ln(\chi_A) + \chi_B \cdot \ln(\chi_B) + \chi_A \cdot \ln(\gamma_A) + \chi_B \cdot \ln(\gamma_B) \}$

For the phenomenological Hamiltonian $\Delta_{mix}H = \beta \cdot nRT \cdot \chi_A \cdot \chi_B$
 $G = G_A^* + G_B^* + nRT \{ \chi_A \cdot \ln(\chi_A) + \chi_B \cdot \ln(\chi_B) + \beta \cdot \chi_A \cdot \chi_B \}$
 which is equal to:
 $G = G_A^* + G_B^* + nRT \{ \chi_A \cdot \ln(\chi_A) + \chi_B \cdot \ln(\chi_B) + \chi_A \cdot \beta \cdot \chi_B^2 + \chi_B \cdot \beta \cdot \chi_A^2 \}$ when compared to:
 $G = G_A^* + G_B^* + nRT \{ \chi_A \cdot \ln(\chi_A) + \chi_B \cdot \ln(\chi_B) + \chi_A \cdot \ln(\gamma_A) + \chi_B \cdot \ln(\gamma_B) \}$ makes the following true:

<u>Solute</u>	<u>Solvent</u>
$a_A = P_A/P_A^* = \chi_A \cdot e^{\beta(1-\chi_A)^2}$ $P_A = P_A^* \cdot \chi_A \cdot e^{\beta(1-\chi_A)^2}$ As $\chi_A \rightarrow 0$ $P_A = P_A^* \cdot \chi_A \cdot e^A$ and therefore $K = P_A^* \cdot e^\beta$ (Henry's Law) As $\beta \rightarrow 0$ $P_A = P_A^* \cdot \chi_A$ (Raoult's Law)	$a_B = P_B/P_B^* = \chi_B \cdot e^{\beta(1-\chi_B)^2}$ $P_B = P_B^* \cdot \chi_B \cdot e^{\beta(1-\chi_B)^2}$ As $\chi_B \rightarrow 1$ and / or $\beta \rightarrow 0$ therefore $P_B = P_B^* \cdot \chi_B$ (Raoult's Law)

In the limiting cases of solvent purity and solute dilution, with no excess interaction, Raoult's Law is preserved.

