Physical Chemistry (Chem 132A)

Lecture 12
Friday, October 27

Homework #4 will be due October 28

Midterm Exam #1, Oct. 25 (Wednesday)

Grading should be complete by Monday

MIXTURES

Start by discussing binary mixtures
$x_A + x_B = 1$ x_i = mole fraction of component i.

Remember definitions of Molarity (moles/liter) and Molality (moles of solute per kilogram of solvent

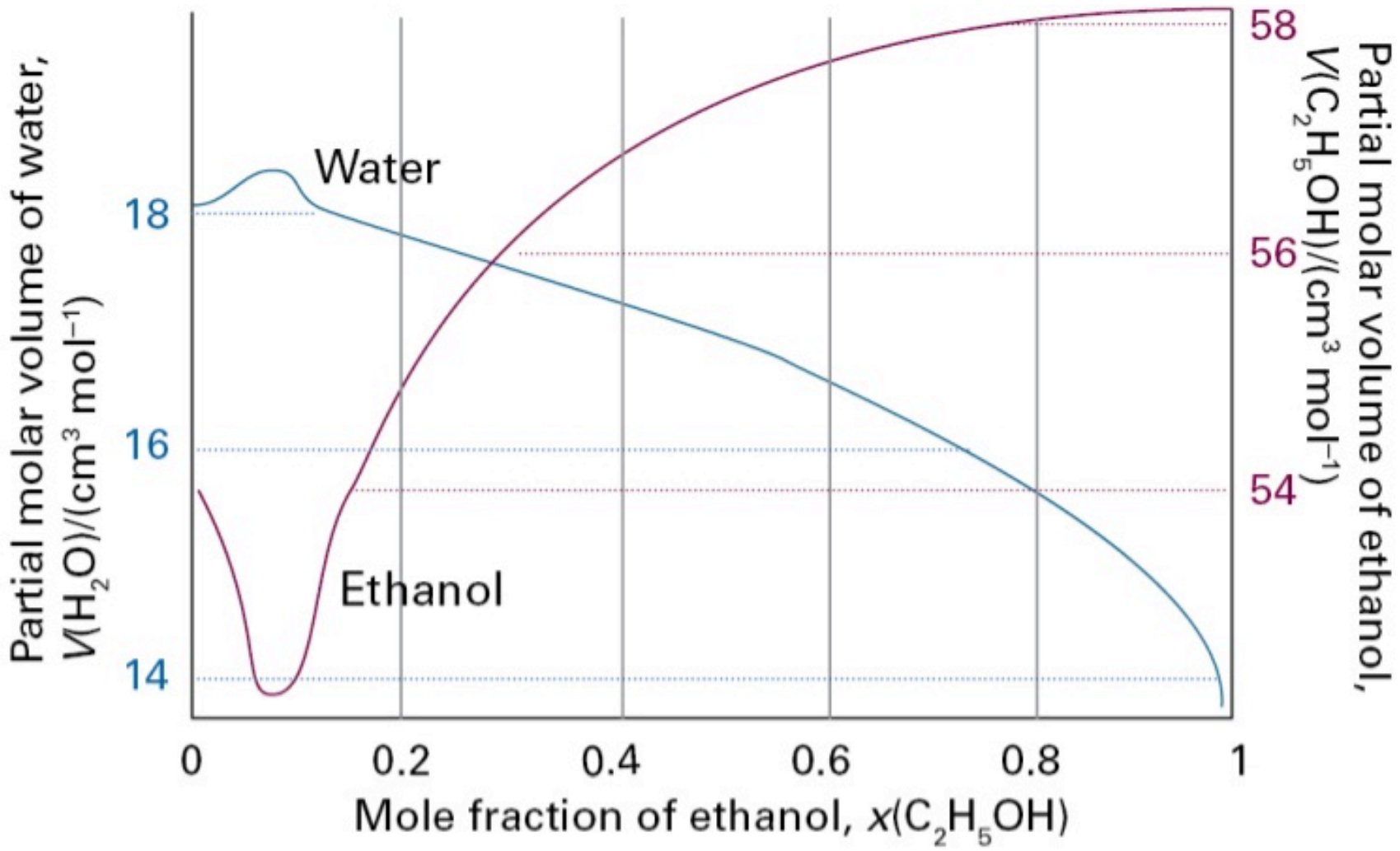
It is useful to talk about "partial molar quantities"

e.g. Partial molar volume

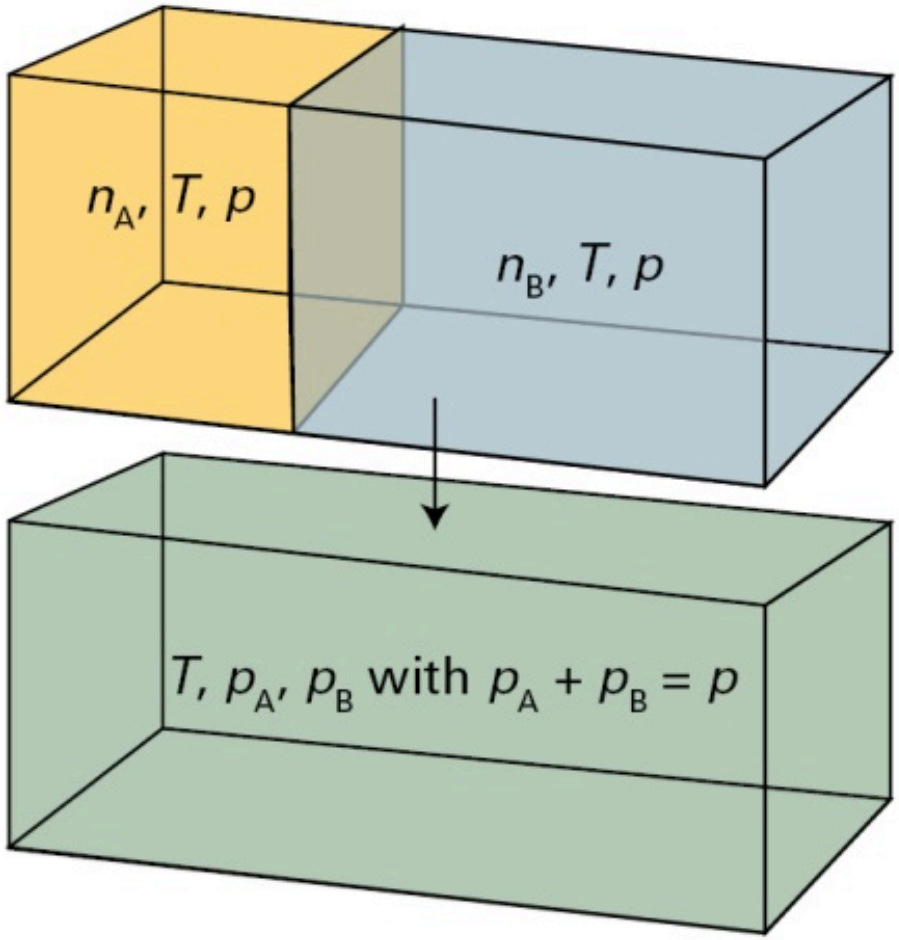
$$V_j = \left(\frac{\partial V}{\partial n_j} \right)_{p,T,n'}$$

$$d\mu_B = -\frac{n_A}{n_B} d\mu_A$$ **Gibbs-Duhem Equation**

Water/Ethanol mixtures (miscible)

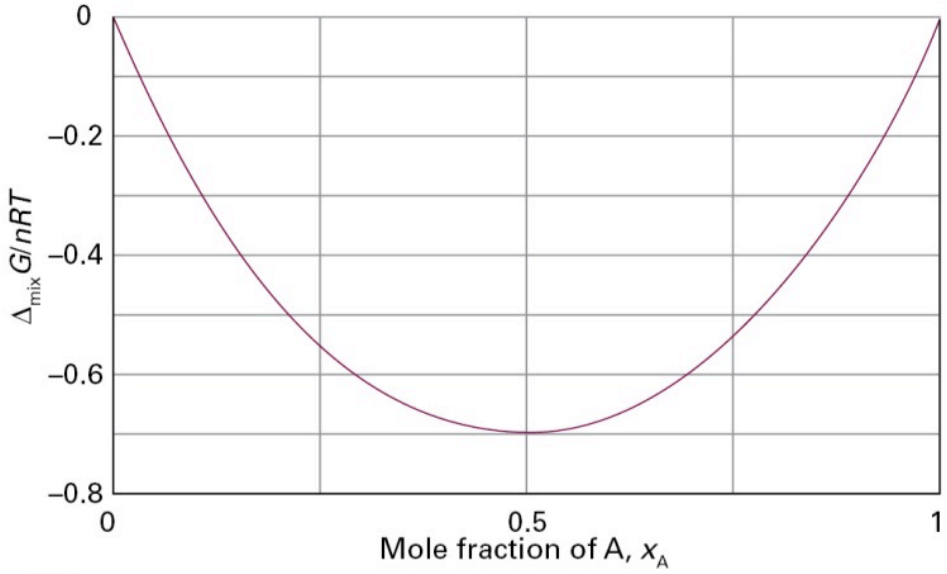


MIXING

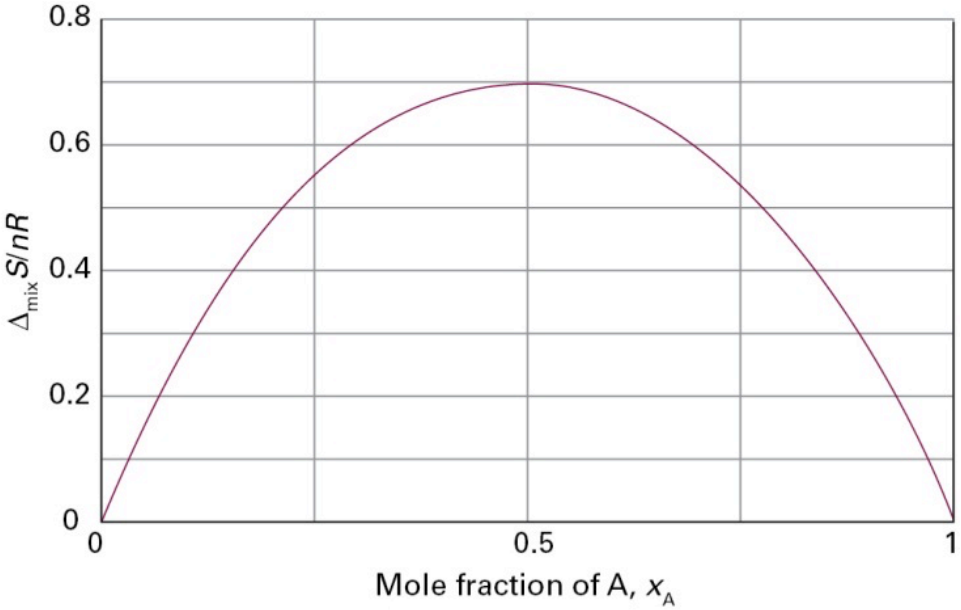


WHAT HAPPENS TO G AND S?

$\Delta_{mix}G$ and $\Delta_{mix}S$??



$\Delta_{mix}G$



$\Delta_{mix}S$

Mixing for Solutions

Behavior is similar as for gases

$\Delta_{mix}G$ is negative

and $\Delta_{mix}S$ is positive

Ideal solution definition: $\mu_j = \mu_j^* + RT \ln(x_j)$

Pressure above a mixed solution

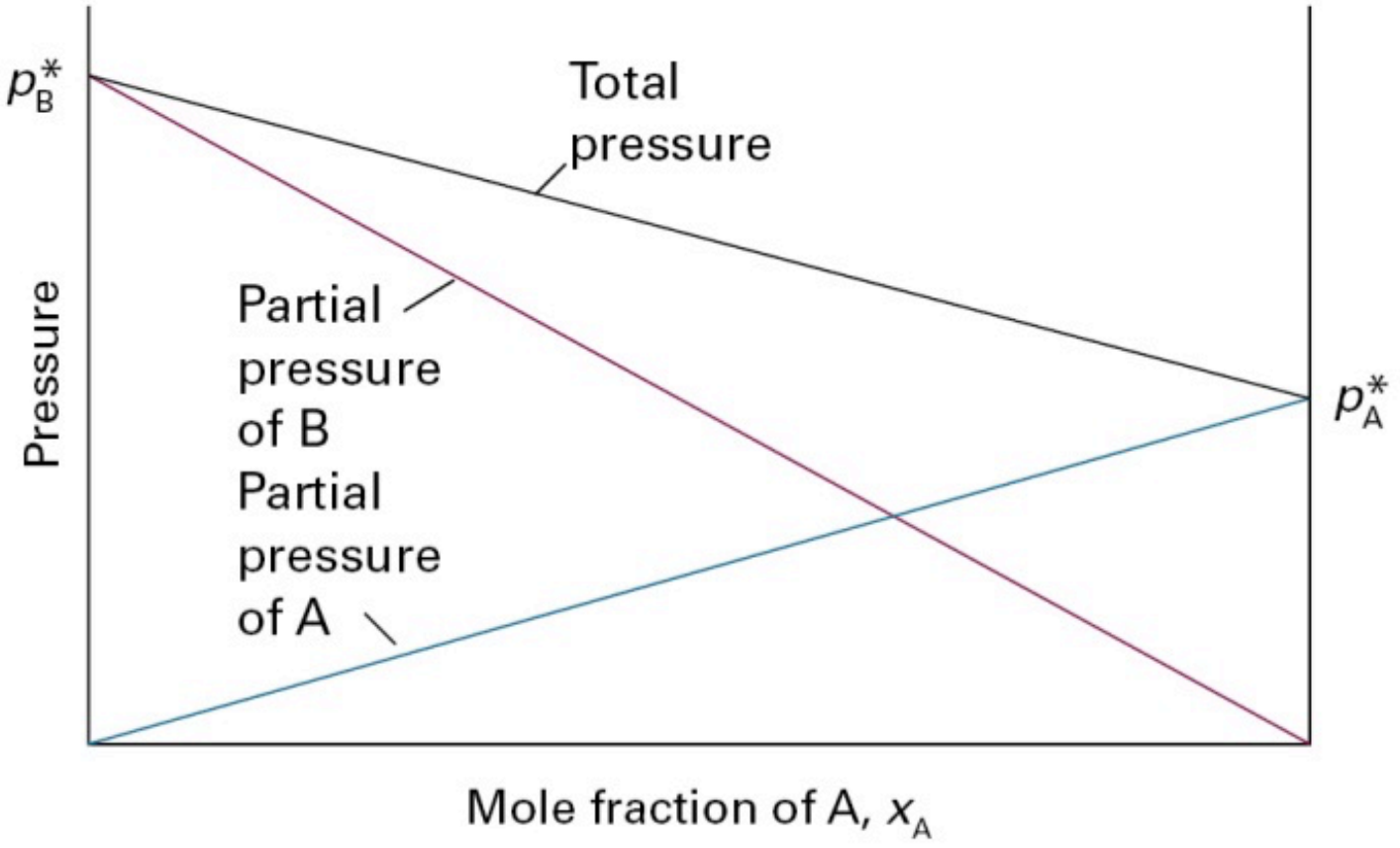
$p_a = x_a p$ note: p = total pressure

Definition of partial pressure.

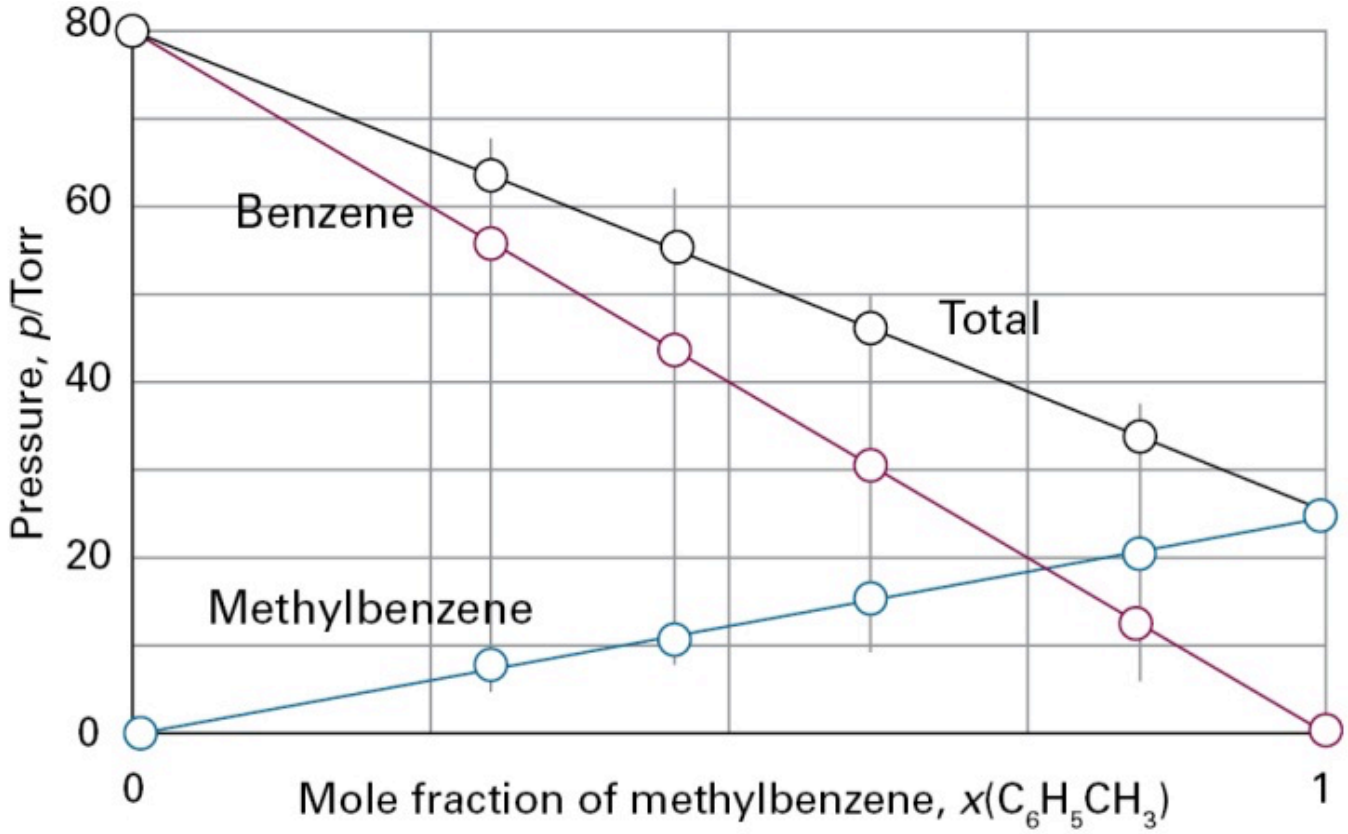
Empirically: $p_a = x_a\, p_a^*$
Where p_a^* is the vapor pressure of pure A

Roult's law

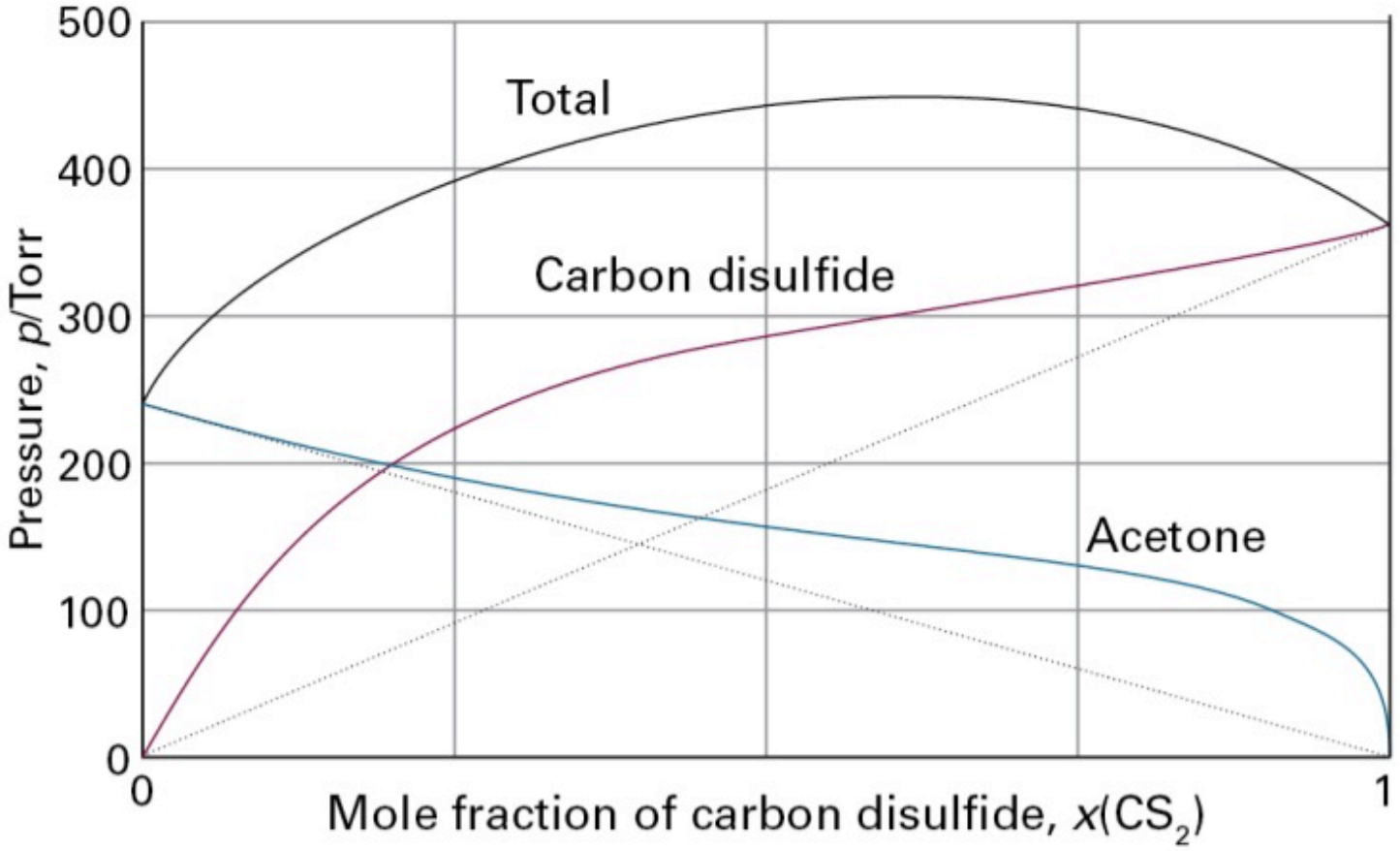
Roult's Law


p_B^*
Total pressure
Partial pressure of B
Partial pressure of A
p_A^*
Pressure
Mole fraction of A, x_A

Example of solution that obeys Roult's Law



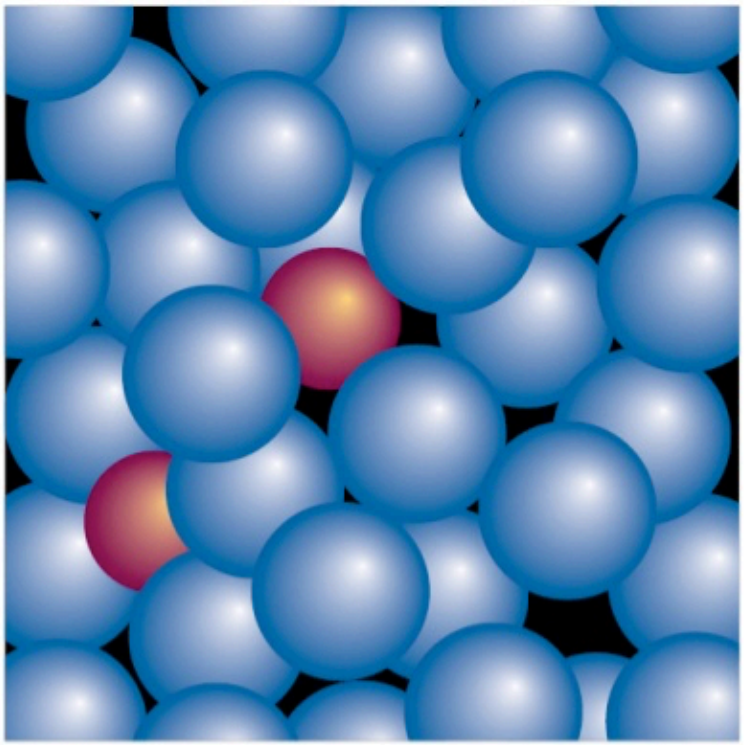
Non-Ideal Solution



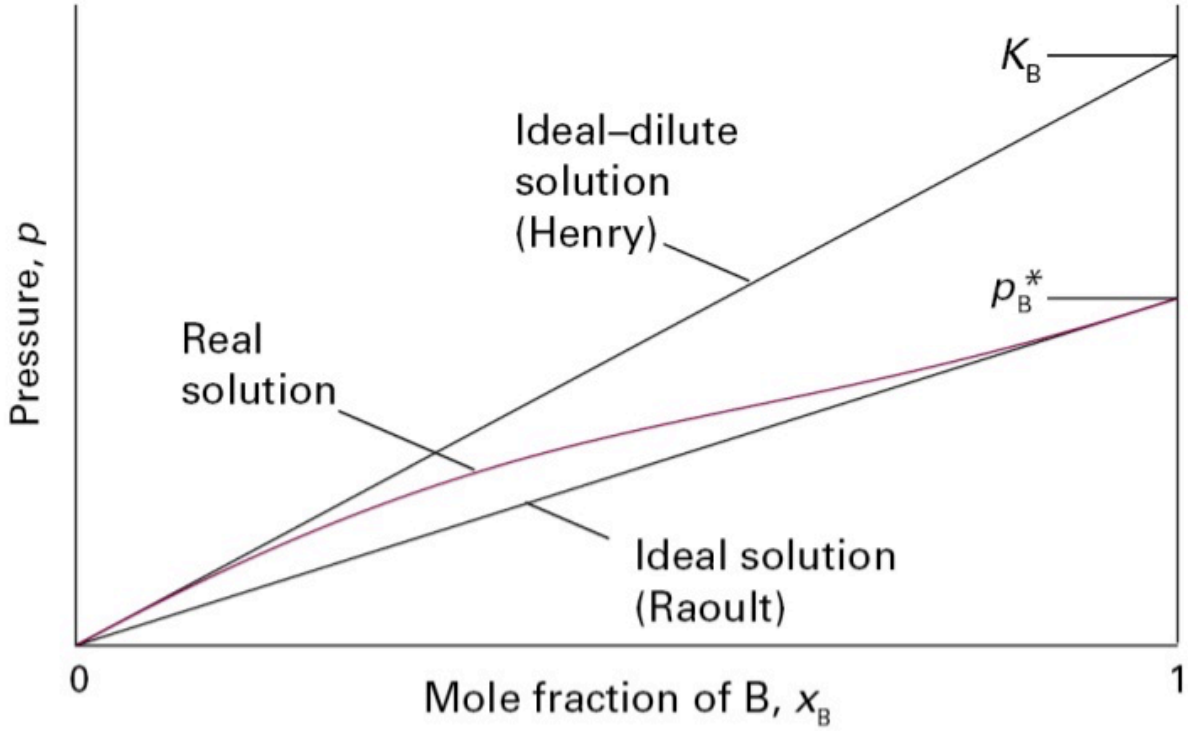
Dilute Solutions that don't obey Roult's Law

$p_B = x_B K_B$ Henry's Law---Dilute solutions

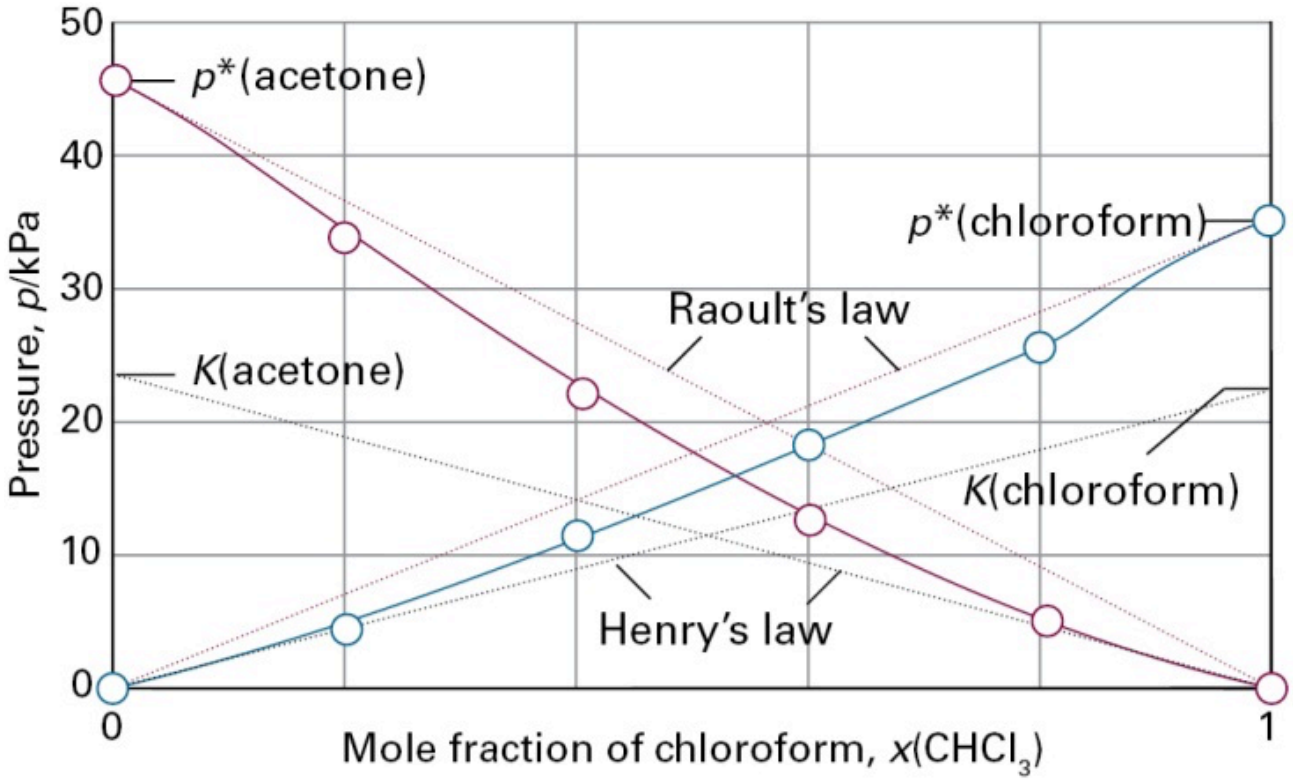
Note: K_B is not the pure solute vapor pressure.



Henry's Law (Dilute solution)



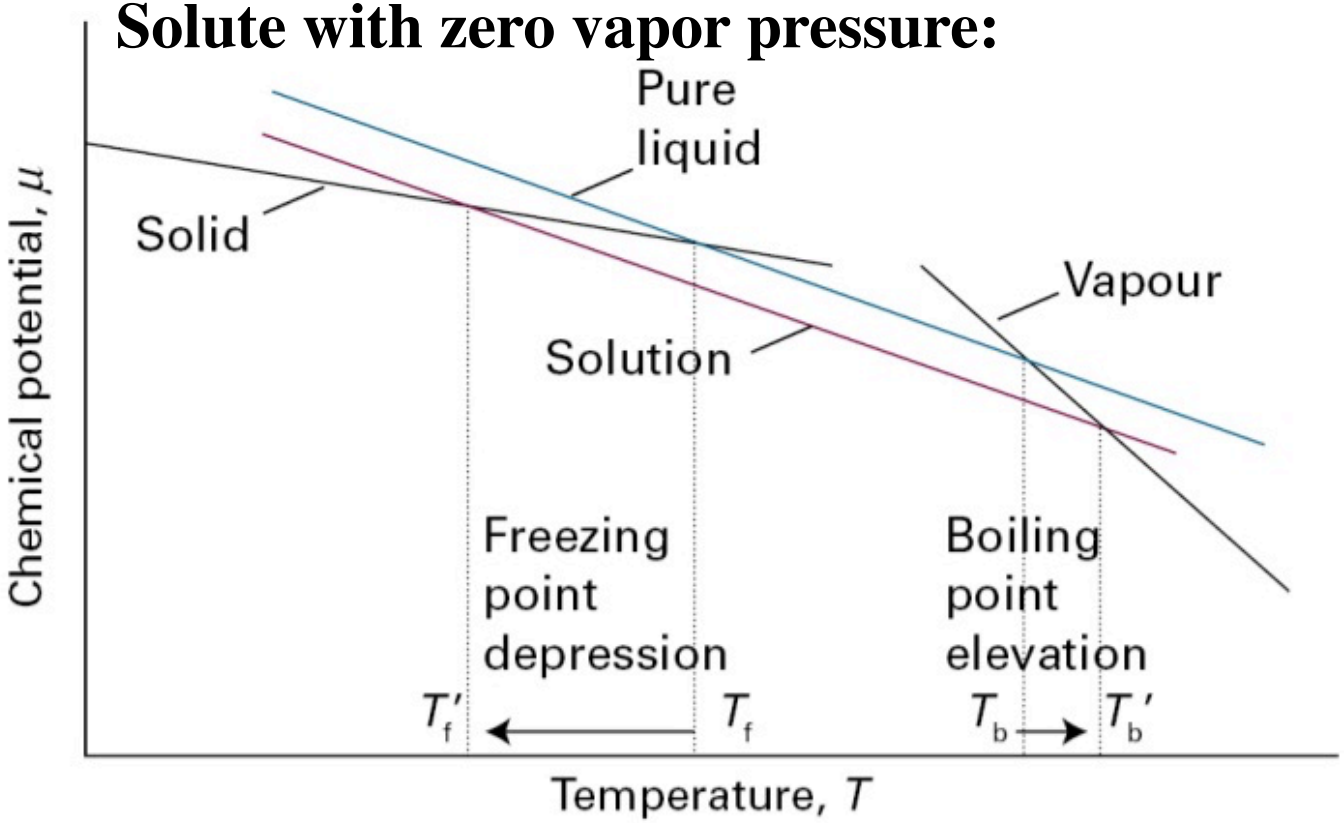
Mixture of acetone and chloroform ($CHCl_3$)



Colligative Properties

For an ideal solution: $\Delta H_{mix} = 0$
Driving force for freezing pt depreession and boiling point elevation is entropy!

Solute with zero vapor pressure:



Colligative Properties

Boiling point elevation: $\Delta T_b = K_b b = K_b m$

Note: b subscript refers to "boiling point"

b (non-subscript) is the molality of the solution

Freezing point depression: $\Delta T_f = K_f b$

Note: These are empirical relationships valid for low concentrations.

THE END

SEE YOU MONDAY