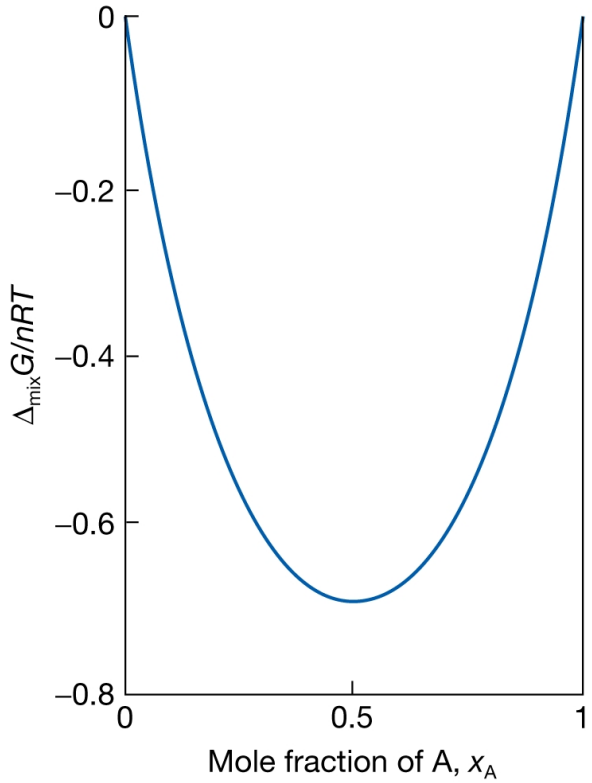
Gibbs energy of mixing of perfect gases



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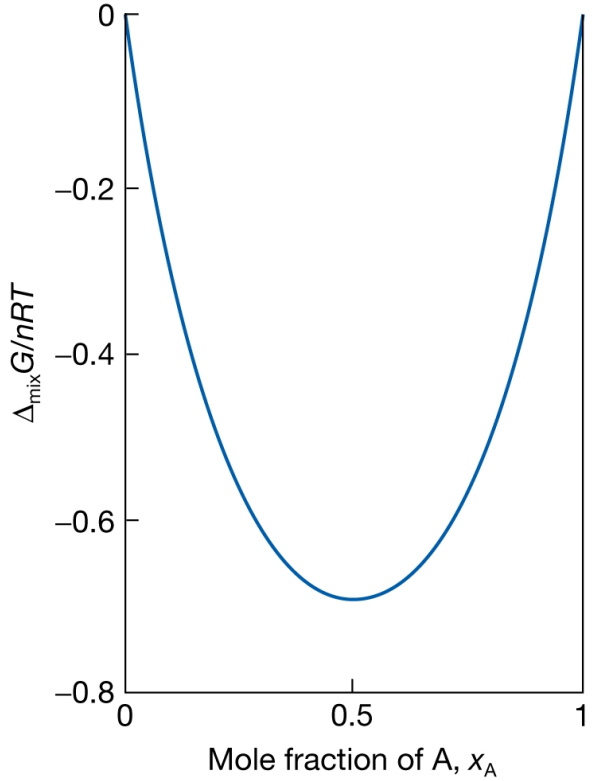

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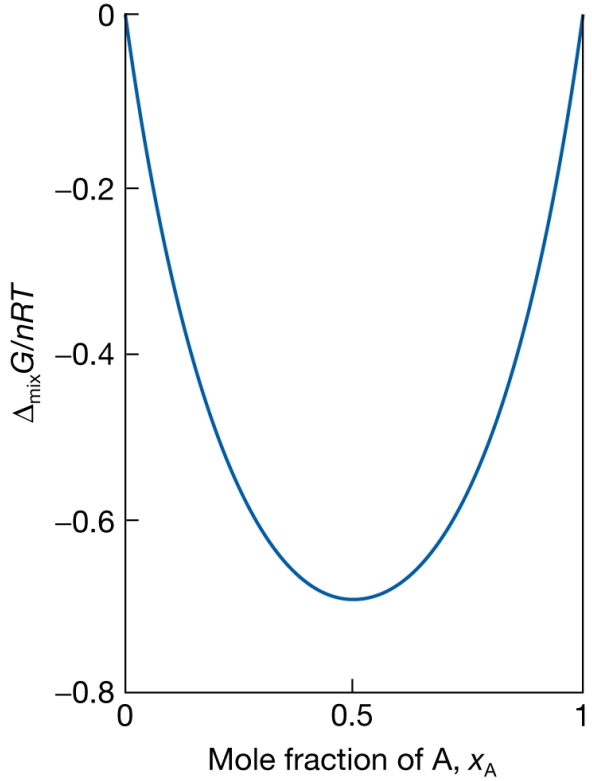

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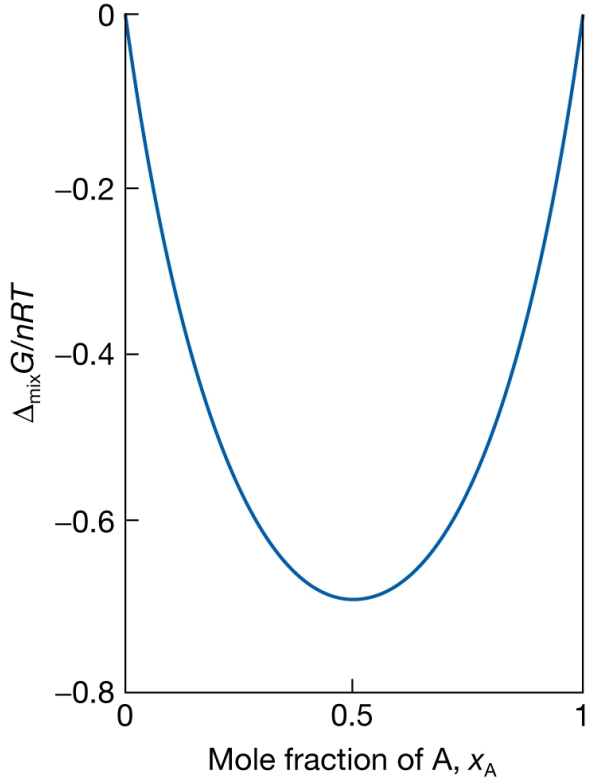

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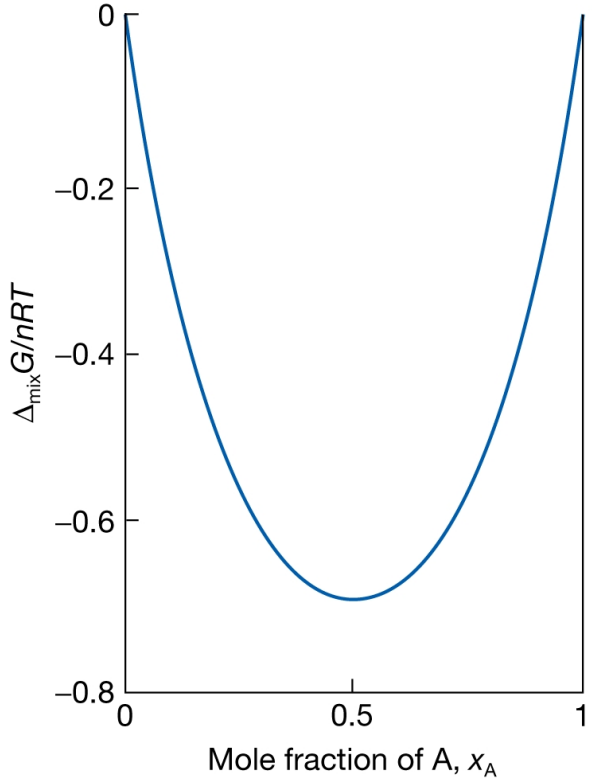

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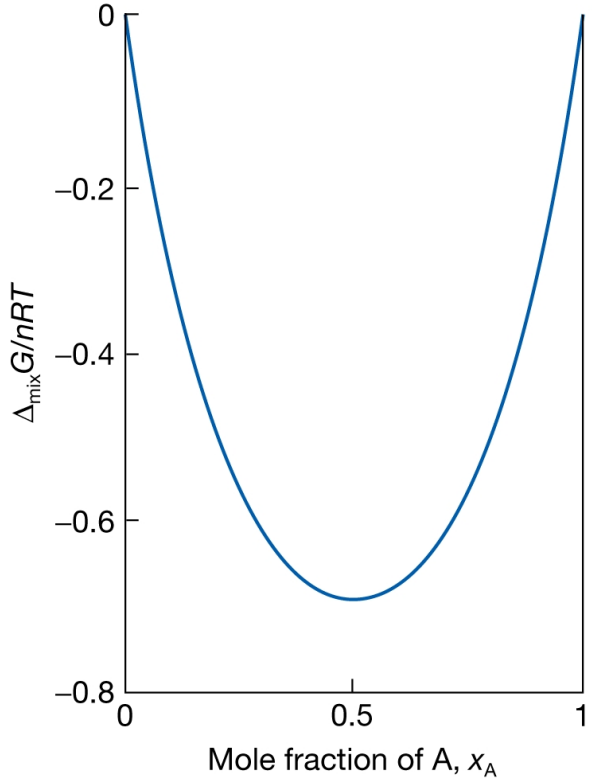

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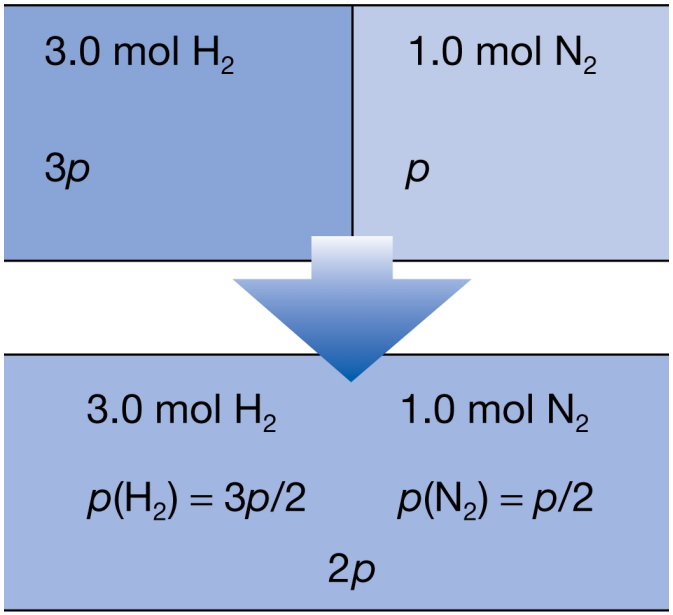
$$= nRT\left(x_A \ln x_A + x_B \ln x_B\right)$$

Ex. : initial pressures not the same :



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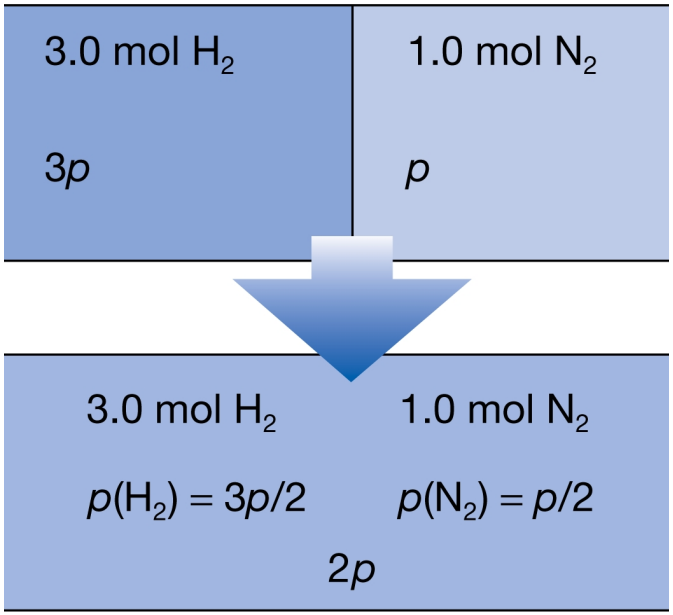

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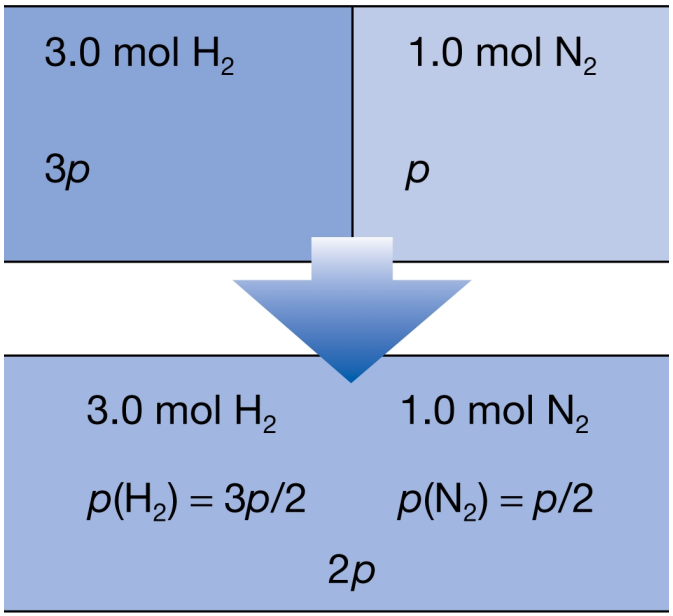

$$G_i = 3\left(\mu^{\ominus}_{H_2} + RT \ln 3p\right) + 1\left(\mu^{\ominus}_{N_2} + RT \ln p\right)$$

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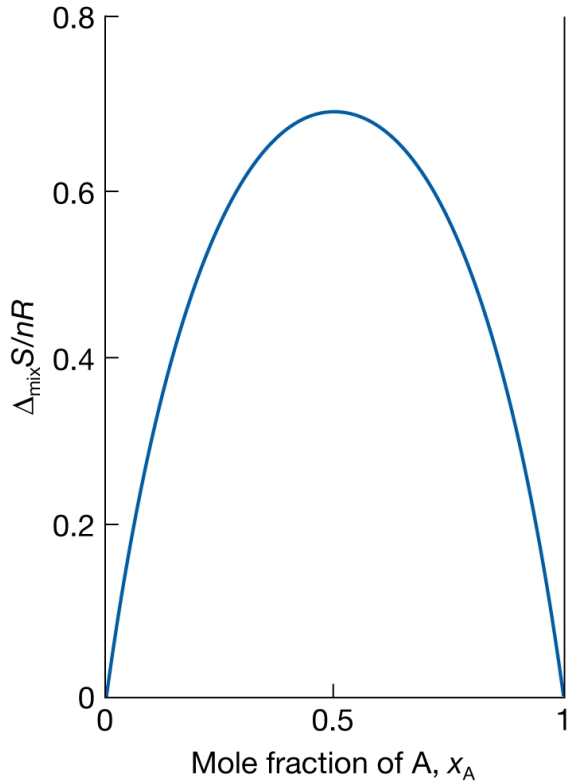
$$\therefore \Delta_{\text{mix}} G = G_f - G_i$$

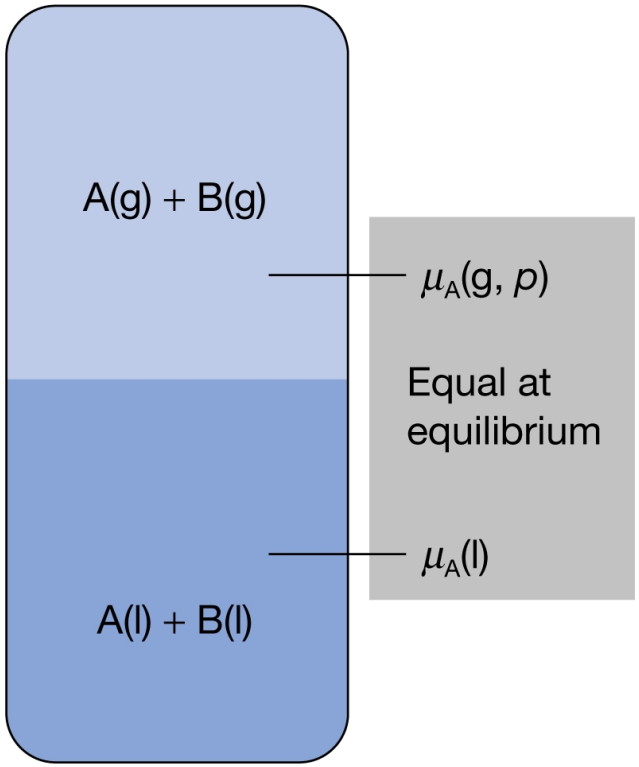
$$= -4RT \ln 2 \overset{T=298}{=} -6.9\text{kJ}$$

for a mixture of perfect gases initially at the same pressure,

$$\Delta_{\mathrm{mix}} S = -\left(\frac{\partial \Delta_{\mathbf{mix}} G}{\partial T}\right)_{p,n_{\boldsymbol{A}},n_{\boldsymbol{B}}} = -nR\left(x_A \ln x_A + x_B \ln x_B\right)$$



Ideal solutions



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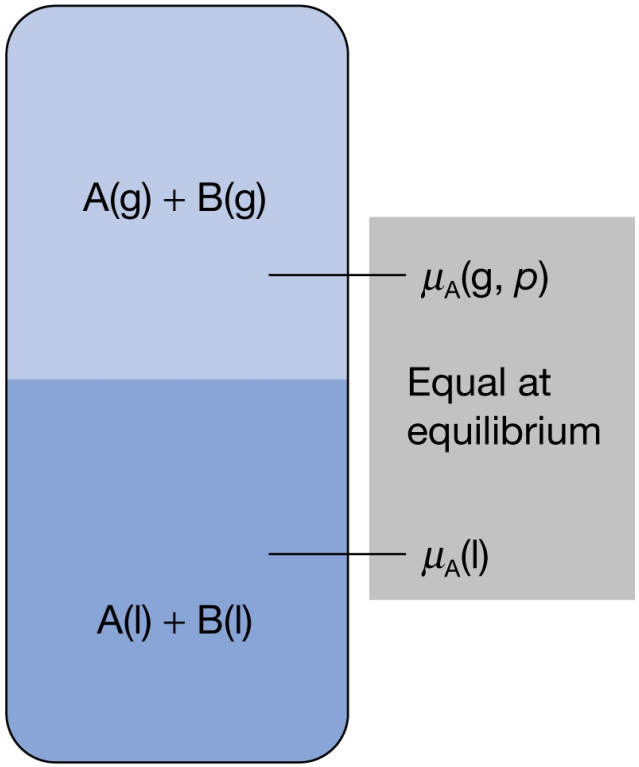

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μ_A^* = chemical potential of pure A

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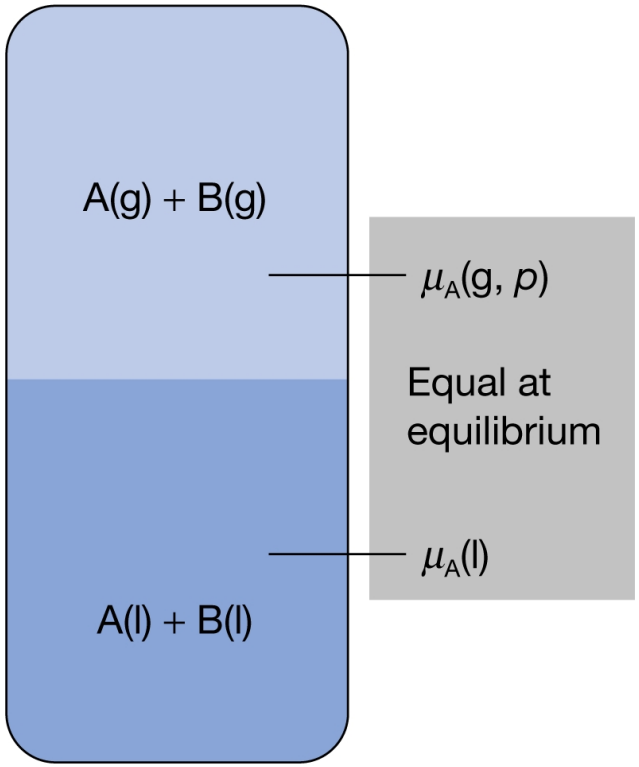

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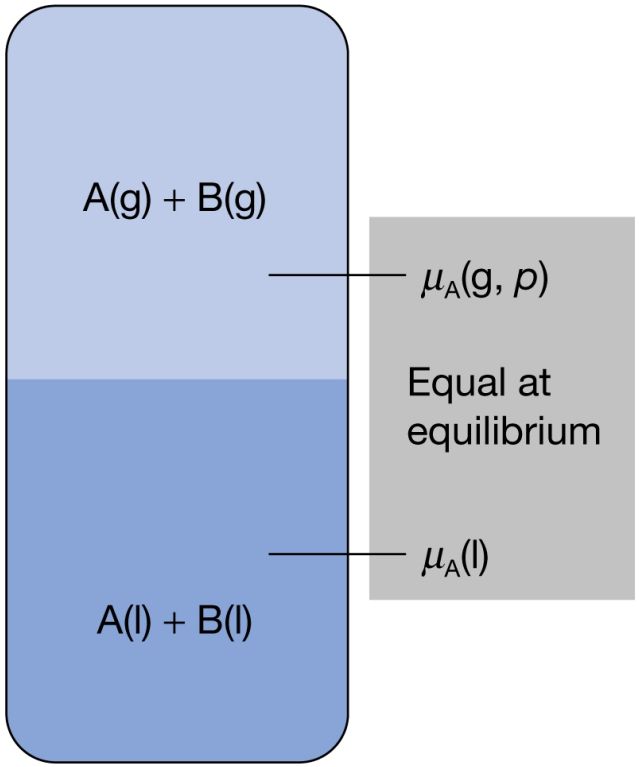

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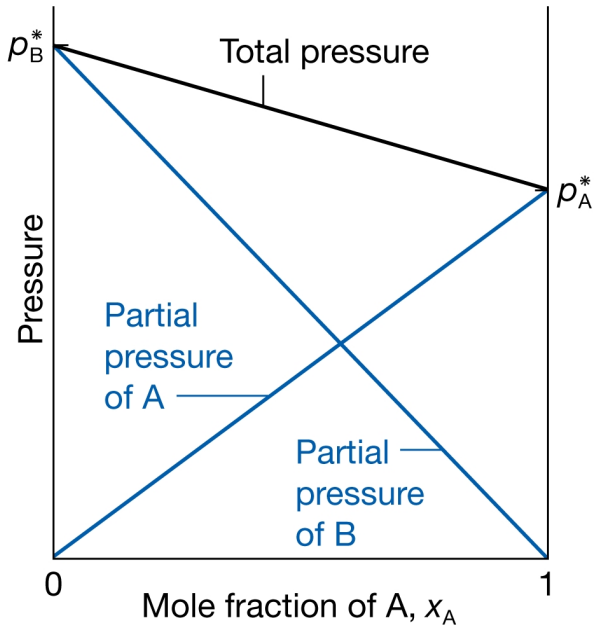
soln. : $\mu_A = \mu_A^{\ominus} + RT \ln p_A$

or, $\mu_A = \mu_A^* + RT \ln \frac{p_A}{p_A^*}$

Ideal solutions - Raoult's law: $p_A = x_A p_A^* \Longrightarrow \mu_A = \mu_A^* + RT \ln x_A$



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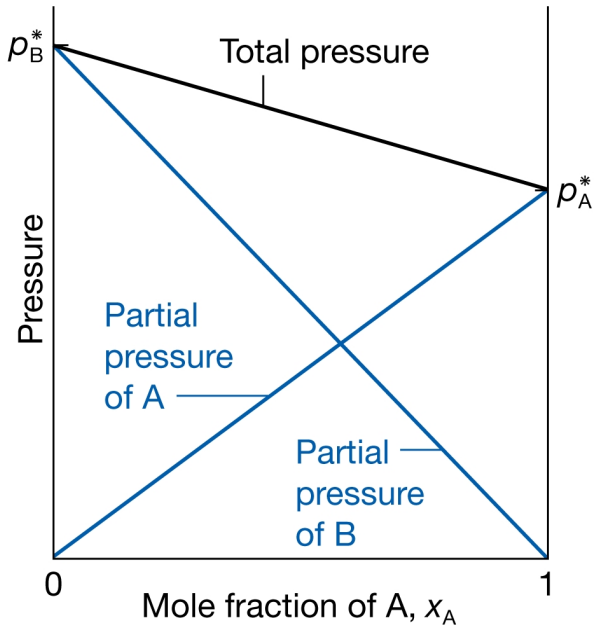
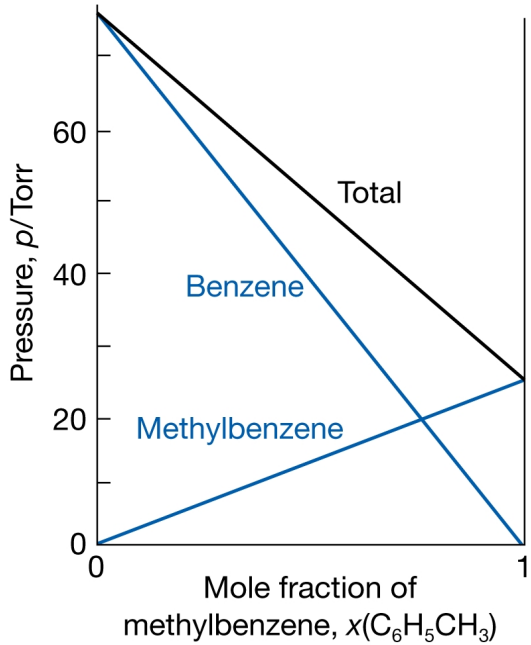


Some mixtures obey Raoult's law very well especially when the components are structurally similar



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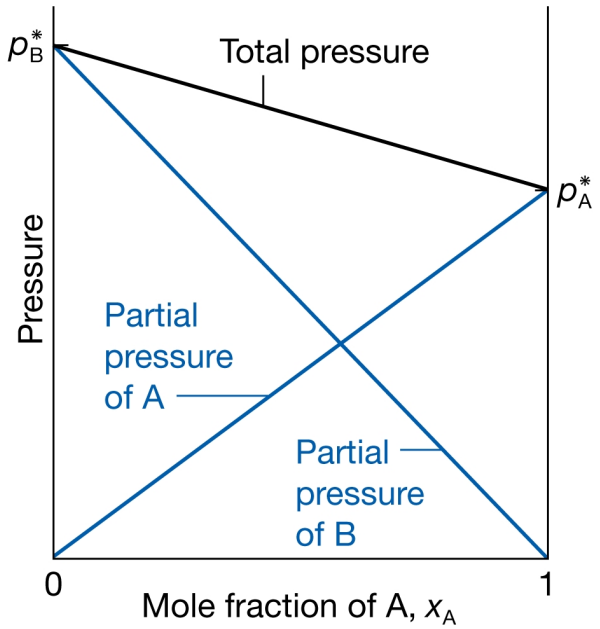

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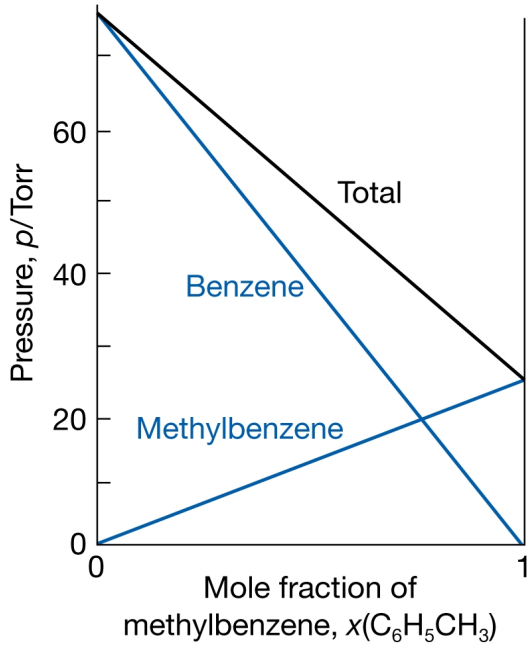

Mixtures that obey the law throughout from pure A to pure B are called

ideal solutions

molecular origin of Raoult's law :

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- $\therefore$ vapour pressure of solvent in solution $<$ that of pure solvent

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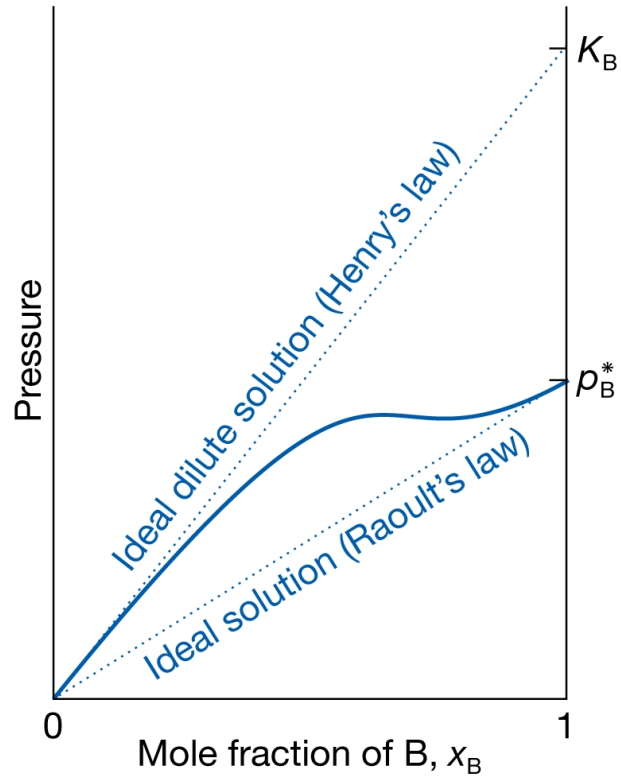
For practical applications, expressed in terms of molality, b,

$$p_B = b_B K_B$$



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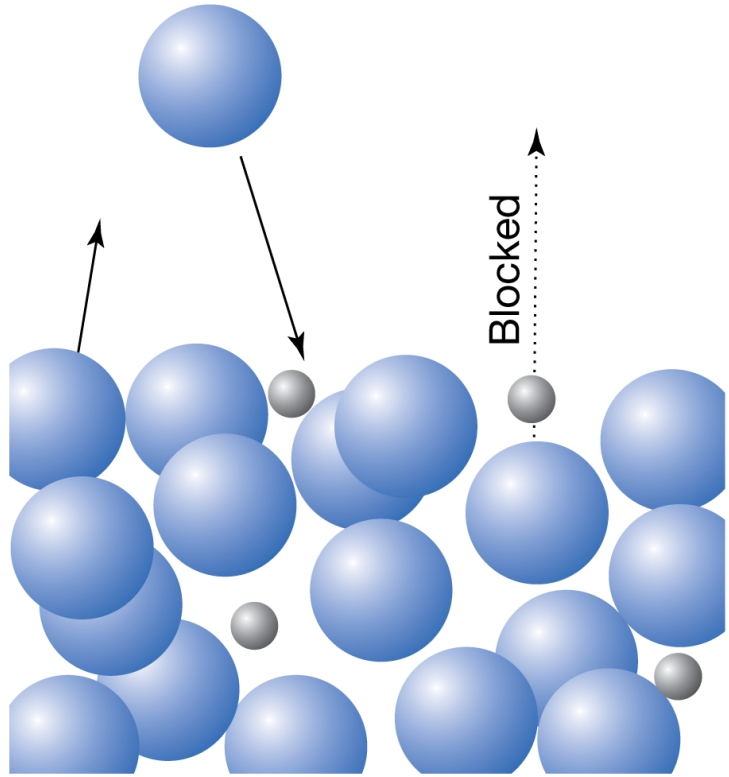
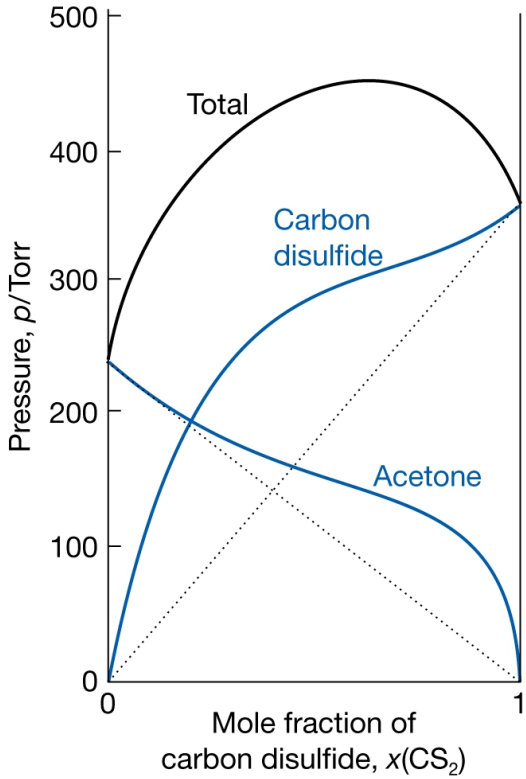
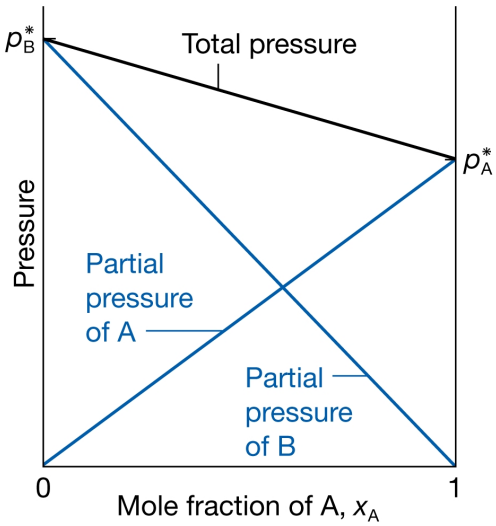
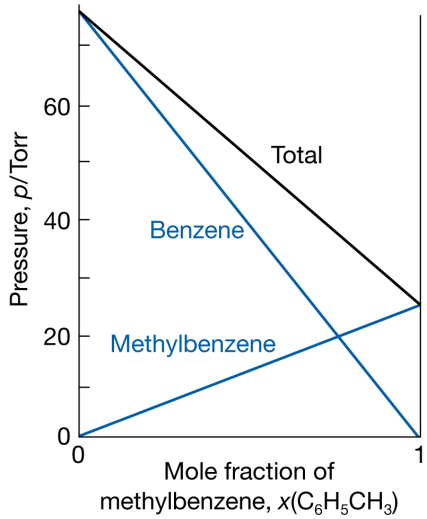
solute molecules are surrounded by solvent molecules, which is entirely different from their environment when pure

solvent behaves like a slightly modified pure liquid, but the solute behaves entirely differently from its pure state unless the solvent and solute molecules happen to be very similar

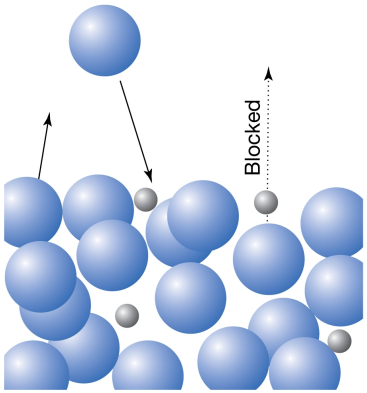


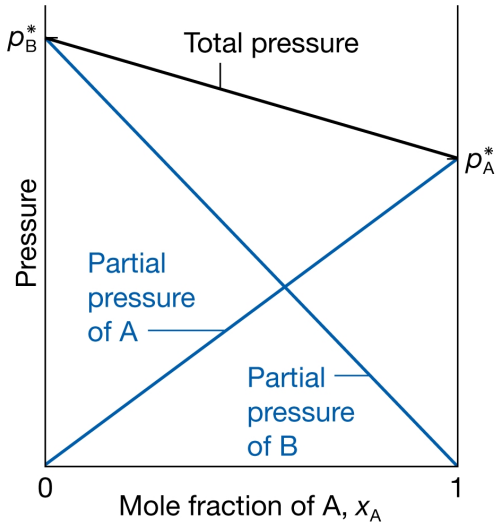

500
400
300
200
100
0
Pressure, p/Torr
Total
Carbon
disulfide
Acetone
0
1
Mole fraction of
carbon disulfide, x(CS2)

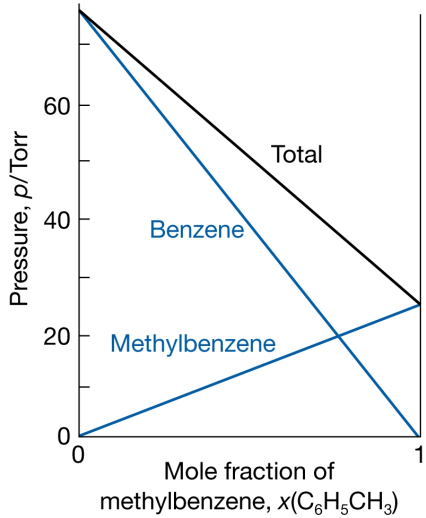




vaporisation (blocked by solute)
& condensation (not hindered)







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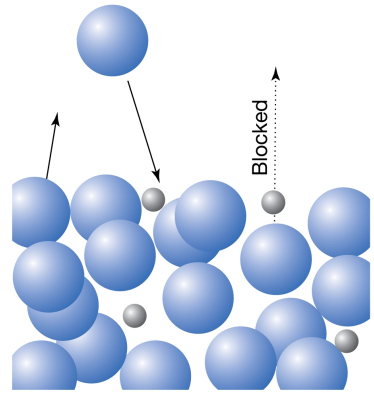

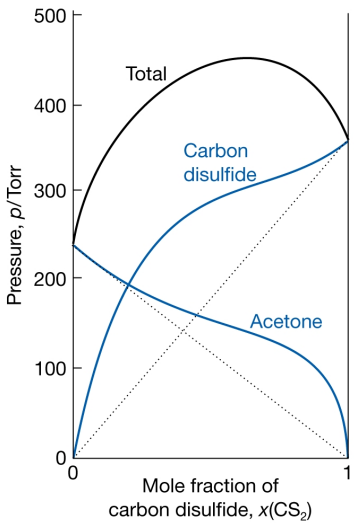

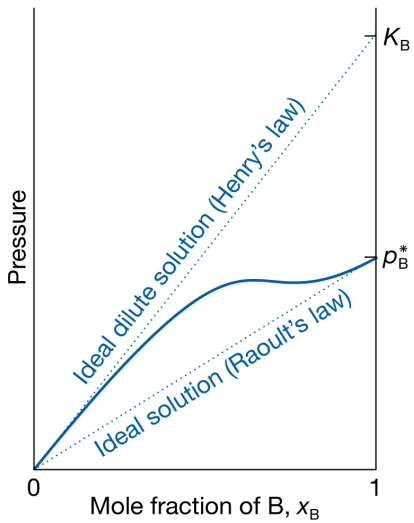

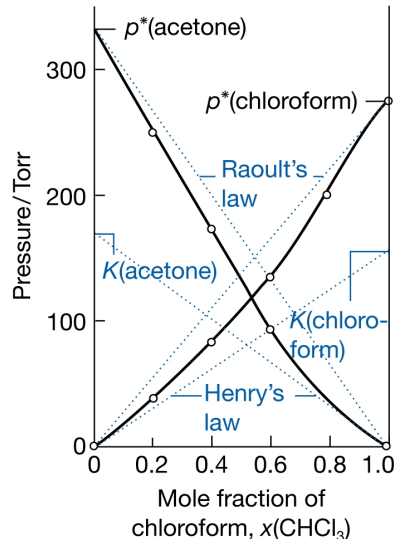

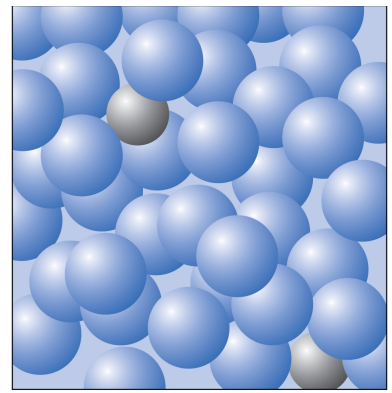

dilute solution
solvent mols - similar environ as pure liq.
solute mols - very different environ