

## 16.5: Expressing the Activity Coefficient as A Deviation from Henry's Law

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Even if Henry's law is valid only for solute concentrations very close to zero, we can use it to express the activity of the real system as a function of solute concentration. Let us suppose that we have data on the mole fraction of  $A$ ,  $x_A$ , in a gas whose pressure is  $P$  and which is at equilibrium with a solution in which its mole fraction is  $y_A$ . In the preceding section, we find that we can choose the solute's standard state so that its activity in any state is  $\tilde{a}_A = x_A P / \kappa_A$ . Introducing the activity coefficient, defined by  $\tilde{a}_A = y_A \gamma_A$ , we have  $x_A P / \kappa_A = y_A \gamma_A$ . The activity coefficient is

$$\gamma_A = \frac{x_A P}{y_A \kappa_A}$$

(Henry's law activity coefficient)

and the chemical potential is

$$\mu_A = \tilde{\mu}_A^\circ(\text{Hyp } \ell, \kappa_A) + RT \ln y_A \gamma_A$$

Just as when we define the activity coefficient using the deviation from Raoult's law, this development provides a way to recast the available information in a way that makes the solute mole fraction,  $y_A$ , the independent variable in the chemical-potential equation.

In [Section 16.4](#), we note that Raoult's law is the special case of Henry's law in which  $P_A^\bullet = \kappa_A$ . If we make this substitution into the Henry's-law based activity coefficient, we recover the Raoult's-law based activity coefficient.

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