Using the above results, the fugacity coefficient of carbon dioxide is

$$\phi_1 = 3.31944 = \phi_1^\infty.$$

Since the calculations was done at $x_1 = 0$, this is the fugacity coefficient at infinite dilution. Henry's law constant is

$$k_1^H = \phi_1^\infty P = (3.31944)(10 \text{ bar}) = 33.2 \text{ bar}.$$

Comments This calculation may be repeated at other pressures and temperatures. Figure 13-11 shows a graph of Henry's law constants for this system calculated by the SRK equation.

Infinite Dilution and Ideal Solution as Reference States

Henry's law was introduced as a way of calculating the fugacity of a component in solution when the component is above its critical temperature at the temperature of the solution. Nonetheless, Henry's law may be used even when the component is below its critical point. There is a certain symmetry between the Lewis-Randall rule, which applies in the limit $x_i \to 1$, and Henry's law, which applies in the limit $x_i \to 0$. The relationship is demonstrated in Figure 13-12, which shows the fugacity of carbon dioxide in n-pentane, plotted as a function of the mol fraction of carbon dioxide at constant temperature. In this case carbon dioxide is below its critical temperature (304.2 K) and forms a liquid solution at all compositions between 0 and 1. The Lewis-Randall rule gives the fugacity of component by the linear relationship

$$f_i = x_i f_i^{\text{pure}} \qquad (x_i \to 1).$$

This is a straight line that is *tangent* to the true fugacity at $x_i = 1$. As a tangent line, it provides a good approximation of the true fugacity over some range of compositions near $x_i = 1$. Beyond this range the linear form diverges from the true fugacity and the Lewis-Randall rule is corrected through the use of the activity coefficient:

$$f_i = \gamma_i x_i f_i^{\text{pure}}.$$

Henry's law gives the fugacity of component by the linear relationship

$$f_i = k_i^H x_i, \qquad (x_i \to 1)$$

change to 0 (zero)

This straight line is tangent to the true fugacity at the opposite corner, at $x_i = 0$. As with the Lewis-Randall rule, it provides a good representation of fugacity within