Chapter 7 Problems

1. The equation for ΔG_{mix} in Figure 7.4 is

$$\Delta G_{mix} = RT(x_A \ln x_A + x_B \ln x_B).$$

   Use calculus to show that this has a minimum at $x_A = x_B = 0.5$.

2. Calculate ΔG_{mix} for $x_B = 0.4$, and compare with Figure 7.5.

3. If the molality of solute A is 0.05 and its activity coefficient (γ_H) is 0.8, what can you say about the chemical potential of the solute?

4. The composition of the air we breathe is tabulated below.

Gas	Percent by volume
N_2	78.084
O_2	20.946
Ar	0.934
CO_2	0.035
CH_4	0.00017
H_2	0.00005

   Calculate the partial pressure and fugacity of each gas, assuming the atmosphere is an ideal gas. Atomic weights are not required.

5. If a sample of air was compressed to 100 bar, what would be the fugacity of methane in the gas? Assume it behaves as an ideal gas ($\gamma_f = 1.0$).

6. If the fugacity coefficient of methane at 100 bar is actually 0.95, what is its fugacity?

7. The partitioning of gases into a vapor phase separating from a hydrothermal solution is of major importance. It is controlled by the Henry's Law constant for each gas. An article by Henley[1] gives Henry's Law constants for several gases, recalculated from Ellis and Golding (1963), and Glover (1982) (references in Henley article). For CO_2 and H_2S he gives

T°C	CO_2	H_2S
25	1660	551
50	2880	89 9
100	5245	1555
125	6150	1703
150	6670	1829
175	6860	1959
200	6620	2042
250	5340	1934
300	3980	1645

[1] Henley, R.W., Gaseous components in geothermal processes. Chapter 4 *in:* Fluid-Mineral Equilibria in Hydrothermal Systems. Reviews in Economic Geology, Vol. 1, pp. 45–56, Society of Economic Geologists, 1984.

using units of bars/(mole fraction).

(a) Use SUPCRT92 to obtain such constants for CO_2 and H_2S, and compare them with Henley's values. These will be calculated using units of bars/molality, which you should convert to bars/(mole fraction). Excellent experimental data for comparison is provided by Suleimenov, O.M., and Krupp, R.E., 1994, Solubility of hydrogen sulfide in pure water and in NaCl solutions from 20 to 320°C and at saturation pressures. Geochim. Cosmochim. Acta, v. 58, pp. 2433–2444.

(b) If you have any interest in geothermal or related subjects (such as ore transport and deposition) you should read Henley (1984) and complete the other exercises there.