Problem Set J
Due Wednesday, May 1, 2002 in lecture

Problem 33
For the system ethyl ethanoate(1)/n-heptane(2) at 343.15 K, $P_1^{sat} = 79.8$ kPa, $P_2^{sat} = 40.5$ kPa, and $G^E/RT = 0.95\ x_1x_2$. At this temperature,
a) Estimate the bubble pressure and value of y_1 when $x_1 = 0.5$
b) Estimate the dew pressure and value of x_1 when $y_1 = 0.5$
c) What is the azeotrope composition and pressure?
State and justify any assumption you make on the behavior of the vapor and liquid phases.

Problem 34
For the methanol/acetone system, $G^E/RT = 0.64\ x_1\ x_2$ to a good approximation, and the saturation pressures for acetone and methanol can be estimated using the Antoine equation (page 361-2 of your textbook).
a) Generate a P*xy* diagram for acetone(1)/methanol(2) at 50 °C.
b) Write down a procedure for constructing a T*xy* diagram for acetone(1)/methanol(2) at 75 kPa. *While you do not need to generate the Txy diagram, you need to show explicitly how equations can be used to get x_1 and y_1 if given some T (or y_1 and T if given some x_1, etc.)*
c) A gaseous mixture of acetone(1)/methanol(2) with a molar composition $z_1 = 0.75$ is cooled to a temperature T in the two-phase region and flows into a separation chamber at a pressure of 100 kPa. If the composition of the liquid product is to be $x_1 = 0.50$, what is the required T, the value of y_1, and the relative flow rates of the liquid and gaseous output streams?

Problem 35
Aqueous emulsions of perfluorochemicals are being considered as "artificial bloods" because of their high oxygen solubility. At 25 °C and an oxygen pressure of 1 atm, 384 mL of oxygen gas (measured at 25 °C and 1 atm) dissolve in 1 liter of perfluorotributylamine, $[C_4F_9]_3N$, which has a liquid density of 1.883 g/mL.
a) Determine the Henry's Law constant, in units of atmospheres, for oxygen dissolved in perfluorotributylamine. The corresponding value for oxygen in water is 4.38×10^4 atm.
b) The blood substitute Oxypherol is an emulsion of 20% perfluorotributylamine and 80% water by volume. Estimate the volume of oxygen gas (measured at 25 °C and 1 atm) dissolved in a liter of liquid when Oxypherol is equilibrated with air at 25 °C.
c) Compare the result from part b) with the volume of oxygen gas that would be dissolved in a liter of water under the same conditions.

Problem 36
a) If a liquid solution of HCl in water, containing 1 mol of HCl and 3 mol of H_2O, absorbs an additional 1 mol of HCl(g) at the constant temperature of 25 °C, what is the heat effect?
b) What is the heat effect when 175(lb$_m$) of H_2SO_4 is mixed with 400(lb$_m$) of an aqueous solution containing 30-wt% H_2SO_4 in an isothermal process at 120 °F?
c) For a 60-wt% aqueous solution of H_2SO_4 at 100 °F, what is the excess enthalpy H^E in $(Btu)(lb_m)^{-1}$?