$\gamma_\text{w}=1$ $\gamma_\text{n}=1$

a) Assuming that each liquid phase behaves ideally with respect to the concentrated species (that is, w 1, in the water-rich phase and n 1 in the nitrobenzene-rich phase), calculate the activity coefficient of each component at infinite dilution.
b) Show that if boiling occurs under constant pressure, the boiling temperature must remain constant until one of the two-liquid phases completely evaporates.
c) 100 mol of the water-rich phase are mixed with 100 mol of the nitrobenzene-rich phase at 100 °C and the pressure is adjusted until boiling starts. What is the pressure?
d) Calculate the composition of the vapor phase in the previous part.
e) If boiling continues indefinitely, which liquid phase will disappear first?
f) Draw a qualitative Pxy graph for this system at 100 °C. Show all the important features on the graph. The saturation pressure of nitrobenzene at 100 °C is 21 Torr.

Problem 13.14: The activity coefficients for the system hexane/ethanol at 85 °C are given by

$$\ln\gamma_1 = 2.8x_2^2, \quad \ln\gamma_2 = 2.8x_1^2.$$

a) Construct the Pxy graph for this system at 85 °C.
b) Determine the bubble pressure of a mixture with the overall composition $x_{hex} = 0.5$ and report the composition of all the phases present.
Additional data: The saturation pressures of the pure components are

$$P^{\text{sat}}_{\text{hex}} = 1.64 \text{ bar}, \quad P^{\text{sat}}_{\text{ethanol}} = 1.31 \text{ bar}.$$

Problem 13.15: Benzene and water are essentially immiscible in each other. Consider a liquid produced by mixing 25 moles of benzene with 75 moles of water at 1 bar, 25 °C:
a) At what temperature does the liquid begin to boil?
b) What is the composition of the first bubble?
c) Which phase boils off first?
d) What is the temperature when the first liquid boils off?
e) At what temperature does the second liquid phase disappear?
f) What is the composition of the vapor at that point?
Additional data: The Antoine equations for the two components are given below (temperature in K, pressure in Torr):

$$\ln P^{\text{sat}}_W(\text{Torr}) = 18.3036 - \frac{3816.44}{T(K) - 46.13},$$

$$\ln P^{\text{sat}}_B(\text{Torr}) = 15.9080 - \frac{2788.51}{T(K) - 52.36}.$$