I.

for the α liquid phase:

$$\ln \gamma_H^\alpha = \frac{8163\,(.0908)^2}{(8.314)(348)}$$

$$\gamma_H^\alpha = 10.3331$$

$$\ln \gamma_E^\alpha = \frac{8163\,(.0902)^2}{(8.314)(348)}$$

$$\gamma_E^\alpha = 1.0236$$

for the gas phase, assuming $\phi_i = 1$

$$P_H = y_H P = \gamma_H x_H P_H^S$$
$$P_E = y_E P = \gamma_E x_E P_E^S$$

$$P_H = (10.3331)(.0902)(1.202) = 1.120 \text{ atm}$$
$$P_E = (1.0236)(.9098)(0.8714) = 0.8115 \text{ atm}$$

b) $\boxed{P = P_H + P_E = 1.932 \text{ atm}}$

c) $\boxed{\begin{aligned} y_H &= 1.120/1.932 = 0.5799 \\ y_E &= 0.8115/1.932 = 0.4201 \end{aligned}}$

for β liquid phase:

$$(\gamma_E x_E)^\alpha = (\gamma_E x_E)^\beta$$

$$(1.0236)(.9098) = \exp\left[\frac{8163\,(1-x_E^\beta)^2}{(8.314)(348)}\right] x_E^\beta$$

~~$0.9313 = (2.821)(1 - 2x_E^\beta + (x_E^\beta)^2) x_E^\beta$~~

$$0.9313 = \exp\left[2.821(1-x_E^{\beta})^2\right] x_E^{\beta}$$

$$\ln(.9313) = 2.821(1-x_E^{\beta})^2 + \ln x_E^{\beta}$$

$$-.0712 = 2.821(1-x_E^{\beta})^2 + \ln x_E^{\beta}$$

But, we know that from regular soln, the liquids should be symmetric.

a) $\therefore$ try $x_E^{\beta} = 0.0902$

$$-.0712 \stackrel{?}{=} 2.821(.9098)^2 + \ln(.0902)$$

$$-.07120 \stackrel{?}{=} -.0704 \quad \text{close enough}$$

II. (a.)

at the azeotrope, assuming $\phi_{is} = 1$

$$\gamma_i x_i P_i^s = y_i P$$

$$\gamma_i = P/P_i^s$$

$\gamma_1 = 1/.8018$ $\quad \ln\gamma_1 = 0.22090$

$\gamma_2 = 1/.3430$ $\quad \ln\gamma_2 = 1.07002$

$$0.22090 = [A + 2(.67993B - A)(.57991)][.17647]$$

$$1.07002 = [B + 2(1.4707A - B)(.42009)](.33630)$$

Margules

$$1.25177 = A - 1.15982A + 0.78860B$$

$$3.18174 = B - .84018B + 1.23565A$$

$$1.25177 = -0.15982A + 0.78860B$$

$$3.18174 = 1.23565A + 0.15982B$$

$$A = 2.3091$$

$$B = 2.0553$$

(b) at $x_1 = 0.2$, $x_2 = 0.8$

$$\ln\gamma_1 = [2.3091 + 2(1.3975 - 2.3091)(.14528)](.7305)$$

$$\ln\gamma_2 = [2.0553 + 2(3.396 - 2.0553)(.85471)](.02111)$$

$\gamma_1 = 4.452$

$\gamma_2 = 1.0961$

$y_1 P = (4.452)(.2)(.8018) = .7139$

$y_2 P = (1.0961)(.8)(.3430) = .30027$

$P = 1.015$

$y_1 = 0.7036$

$y_2 = 0.2964$