

solution

A) (15)

$$K_a = K_\phi K_y P^{\sum \nu_i} = (1) \frac{y_{\text{meth}}}{y_B y_P} P^{-1} = \frac{0.780}{(0.110)(0.110)} \left(\frac{1}{10}\right)$$

$$K_{a,298} = 6.446$$

$$\Delta G_{R,298}^\circ = -RT \ln K_a = (-8.314)(298) \ln(6.446)$$

$$\Delta G_{R,298}^\circ = -4616.9 \text{ J/mol}$$

B) (15)

$$\Delta G_{R,298}^\circ = \sum \nu_i \Delta G_{f,i,298}^\circ$$

$$= \Delta G_{f,\text{meth}}^\circ - \Delta G_{f,B}^\circ - \Delta G_{f,P}^\circ$$

$$-4616.9 \text{ J/mol} = \Delta G_{f,\text{meth}}^\circ - (-149795) - (-62205)$$

$$\Delta G_{f,298,\text{meth}}^\circ = 207388.1 \text{ J/mol}$$

C) (10)

$$K_{af} = K_\phi K_y P^{\sum \nu_i} = \frac{\phi_{\text{meth}}}{\phi_B \phi_P} \frac{y_{\text{meth}}}{y_B y_P} P^{-1}$$

$$K_{ar} = \frac{\phi_B \phi_P}{\phi_{\text{meth}}} \frac{y_B y_P}{y_{\text{meth}}} P$$

$$K_{ar} = 1/K_{af}$$

d) (20)

$$K_{a,308} = \frac{0.640}{(0.180)(0.180)} (10)^{-1}$$

$$K_{a,308} = 1.975$$

$$\ln \left(\frac{K_1}{K_2} \right) = \frac{-\Delta H^\circ}{R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$\ln \left(\frac{6.446}{1.975} \right) = \frac{-\Delta H^\circ}{8.314} \left(\frac{1}{298} - \frac{1}{308} \right)$$

$$1.183 = \frac{-\Delta H^0}{8.314} \left(0.008109 \right)$$

$$\Delta H_{298}^0 = -90265.52 \text{ J/m}$$

$$\begin{aligned} e) \textcircled{473} \Delta H_{R, 200^\circ\text{C}}^0 &= -90265.52 + \int_{303}^{473} \sum n_i c_{p,i} dT \\ &= -90265.52 + \int_{303}^{473} (c_{p,\text{NH}_3} - c_{p,\text{B}} - c_{p,\text{P}}) dT \\ &= -90265.52 + (116.4 - 89.13 - 64.78)(473 - 303) \\ &= -90265.52 + (-37.51)(170) \\ &= -90265.52 - 6376.7 = -96642 \text{ J/m} \end{aligned}$$

- use avg of 298 & 303

$$\Delta H_{R, 200^\circ\text{C}}^0 = -96642 \text{ J/m}$$

$$\begin{aligned} \Delta G_{R, 298}^0 &= \Delta H_{R, 298}^0 - T \Delta S_{R, 298}^0 \\ -4616.9 &= -90265.52 - 298 (\Delta S_{R, 298}^0) \\ \frac{-4616.9 + 90265.52}{-298} &= \Delta S_{R, 298}^0 \end{aligned}$$

$$\Delta S_{R, 298}^0 = -287.411 \text{ J/m-K}$$

$$\Delta S_{R, 473}^0 = \int_{298}^{473} (-37.51) \frac{dT}{T} - 287.411$$

$$= -37.51 \ln \frac{473}{298} - 287.411$$

$$\Delta S_{R, 473}^0 = -304.74 \text{ J/m-K}$$

$$\Delta G_{R, 473}^0 = -96642 - 473(-304.74) = 47500 \text{ J/m}$$