Chapter 8 Answers

1. (a) i. 1.0
   ii. 1.4928
   iii. 1.4933
   iv. $10^{-14.946}$

   (b) i. 1.0
   ii. 1.787
   iii. 5.408
   iv. Estimate a value for f_{ice} at T by any means, such as extrapolating fugacities from lower T.

   (c) i. 0.001
   ii. 0.000472

   (d) i. At system equilibrium.
   ii. When the same standard state is used for both — system equilibrium irrelevant.

   (e) -11533 cal mol^{-1}

   (f) 7.070 (Same as $a^{qtz}_{SiO_2}$ using this standard state).

2. In equation (8.17), the value of μ° varies with T. To use a constant T standard state, you must include a term giving the difference between μ° in this equation and the μ° in the state you have chosen. Nobody does this, because it is not useful.

3. The idea is to change $\Delta_r G^\circ$ for the reaction, knowing the change in $\Delta_f G^\circ$ for NaCl. That is, add $\mu_A^{\circ,old} - \mu_A^{\circ,new}$ to $\mu_A - \mu_A^{\circ,old}$, to get $\mu_A - \mu_A^{\circ,new}$. For component A, it would be

$$\mu_A - \mu_A^{\circ,old} = RT \ln a_A^{old}$$

$$\mu_A^{\circ,old} - \mu_A^{\circ,new}$$

   adding,

$$\mu_A - \mu_A^{\circ,new} = RT \ln a_A^{new}$$

   where in this case

$$\begin{aligned}\mu_A^{\circ,old} - \mu_A^{\circ,new} &= -384138 - (-393133) \\ &= 8995 \text{ J mol}^{-1}\end{aligned}$$

   The nepheline-sodalite reaction is

$$\text{sodalite} = 3\,\text{nepheline} + \text{NaCl}$$

where $\Delta_f G^\circ_{\mathrm{NaCl}}$ is either for halite or for an ideal 1 molal solution, and where $K = a_{\mathrm{NaCl}}$, beacuse sodalite and nepheline have unit activities. Sodalite is not in the SUPCRT92 database, but we calculate $\Delta_r G^\circ$ from the given activity,

$$\begin{aligned} \log a_{\mathrm{NaCl}(\textit{halite std. state})} &= -4.786 \\ \Delta_r G^\circ &= -2.30259\, RT \times (-4.786) \\ &= 27318.7\,\mathrm{J\,mol^{-1}} \end{aligned}$$

The new $\Delta_r G^\circ$ is then $27318.7 + 8995 = 36313.7\,\mathrm{J\,mol^{-1}}$, and the new activity is

$$\begin{aligned} \log a_{\mathrm{NaCl}(\textit{1m std. state})} &= -36313.7/(2.30259\, RT) \\ &= -6.36 \end{aligned}$$