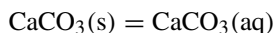
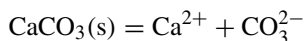


## Chapter 2

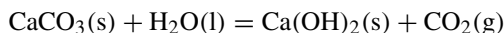
- A2.1 Because the reference or standard state of gases in the tables is the ideal gas. In other words, all the properties are those the gas would have if it were ideal. From Appendix A, the molar volume of an ideal gas at 273.15 K, 1 bar is  $0.02241410 \text{ m}^3 \text{ mol}^{-1}$ . By the ideal gas law, the volume at 298.15 K is  $0.02241410 \times 298.15/273.15 = 0.0244656 \text{ m}^3 \text{ mol}^{-1}$ , or  $24465.6 \text{ cm}^3 \text{ mol}^{-1}$ .
- A2.2  $\Delta_r V^\circ = 17.3 + 0 - 17.3 = 0 \text{ cm}^3$ . The properties of individual ions such as  $\text{Cl}^-$  cannot be measured. In order to have properties for them, the properties of the hydrogen ion  $\text{H}^+$  are defined as zero, and so the properties of  $\text{Cl}^-$  become the same as the properties of  $\text{HCl(aq)}$ , which can be measured. Now that the properties of  $\text{Cl}^-$  are known, measuring the properties of  $\text{NaCl(aq)}$  in the reaction  $\text{NaCl} = \text{Na}^+ + \text{Cl}^-$  allows calculation of the properties of  $\text{Na}^+$ , and similarly for other ions in other reactions.
- A2.3 Has no answer without specifying what reaction or process is being considered. Apart from having thermal and mechanical equilibrium but not chemical equilibrium (in a practical sense, ignoring the caveats in Section 2.3.4) the reaction must be specified. If the reaction is



there is one component. If the reaction is



there is also one component. If the reaction is



there are two components. Only if  $\text{H}_2\text{O}$  is in the reaction is it a component. This might be happening in a complex environment like a soil with many other compounds present. It makes no difference, except to the activity coefficients.

## Chapter 3

- A3.1  $12.782/1500 = 0.00852$  days, or about 12 minutes. Unfortunately, humans cannot digest corundum.
- A3.2  $\Delta_r H^\circ = H_{\text{water}}^\circ - H_{\text{ice}}^\circ = 6008 \text{ J mol}^{-1}$ .  
 $\Delta_r C_P^\circ = C_{P\text{water}}^\circ - C_{P\text{ice}}^\circ = 76.1 - 36.5 = 39.6 \text{ J mol}^{-1} \text{ K}^{-1}$ .

$$\frac{d\Delta H}{dT} = \Delta C_P$$

$$\Delta H_{T_2} - \Delta H_{T_1} = \Delta C_P(T_2 - T_1) \quad \text{if } \Delta C_P \text{ is constant.}$$

$$\begin{aligned} \Delta H_{263.15} - \Delta H_{273.15} &= 39.6(263.15 - 273.15) \\ &= -396 \text{ J mol}^{-1} \text{ K}^{-1} \end{aligned}$$

so  $H_{\text{water}}^\circ - H_{\text{ice}}^\circ$  is  $-396 \text{ J mol}^{-1}$  less at  $-10^\circ\text{C}$  than it is at  $0^\circ\text{C}$ , or  $6008 - 396 = 5612 \text{ J mol}^{-1}$ .