# Unit 6 - Equilibrium Applications

This is a continuation of the last unit (Equilibrium). Because many of the concepts here build on past material, you should be familiar with the last unit. For example, you should know how to a) set up an equilibrium law, b) solve equilibrium problems (using a RICE chart), c) use Le Chatelier's principle, d) determine the charge on ions when an ionic solid dissolves in water.

Background (3.3, 4.6)

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| What is the molar mass of $H_2O$? | Molar mass is in units of g/mol. It is calculated from atomic weights. Molar mass of $H_2O$ = 2 x H + O = 2 x 1 + 16 = 18 g/mol. |
| How many moles are in 18 g of NaCl? | Factor label method: $\#mol = g \times \frac{mol}{g} = 18\ g \times \frac{1\ mol}{58.5\ g} = 0.3\ mol$ (For NaCl, molar mass = 23 + 35.5) |
| How many g of $CaCl_2$ need to be added to 2 L of water to make a 3 M solution? | First determine the number of moles required: #mol= 2L x 3mol/L = 6 mol. Next, convert mol to g using the molar mass of $CaCl_2$ (40.1 + 2 x 35.5 = 111.1 g/mol): #g = 6mol x 111.1g/mol = 667 g. |
| What is the molar concentration of $K^+$ when 2 L of 1.5 M KCl is mixed with 1 L of 3 M $K_2SO_4$? | [ ] = mol/L, thus we need to find total # mol and total # L.<br># mol = (2 L x 1.5 mol/L) + (1 L x 3 mol/L x **2**) = 9 mol.<br>(Notice $K_2SO_4 \rightarrow \underline{\mathbf{2}}K^+ + SO_4^{2-}$).<br># L = 2 L + 1 L = 3 L. [ ] = 9 mol/3 L = 3 M $K^+$. |

11.4

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| How can the solubility of compounds be predicted? | The series of solubility rules outlined on pg. 399. You do not have to remember these, but you should be able to use them to solve problems (see examples 11.2, 11.3 on pg. 400). |
| How were the solubility rules determined? | By experiment. They are rules of thumb that summarize many experiments. Thus they are based on experience, not on an understanding of why and/or how molecules dissolve. |
| What should be remembered about the terms "soluble" and "insoluble"? | These are relative terms. When a compound is "insoluble" it means that only a minute amount of it dissolves. |

14.9

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| How can equilibrium laws that include solids or liquids be simplified? | The solids and/or liquids can be ignored. Only gases and/or ions need to be considered. |
| > Why can this simplification be made? | Because concentrations of solids and liquids do not change (recall that concentration is in mol/L. If we divide a solid in half, both #mol and #L will be cut in half, but the mol/L will not change). |
| Write the equilibrium law for $aA(g) + bB(s) \leftrightarrow xX(g) + yY(g)$. | $Kc = \frac{[X]^x[Y]^y}{[A]^a}$ (B is excluded because it is a solid) |
| Write the equilibrium law for $2C(s) + O_2(g) \leftrightarrow 2CO(g)$ | $Kc = \frac{[CO]^2}{[O_2]}$ |

14.10

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| Ksp refers to what kind of reaction? | A solid dissolving in water. i.e. $AB(s) \leftrightarrow A^+(aq) + B^-(aq)$ |
| What name is given to Ksp? | Solubility product constant. |
| Write the equilibrium law for $CaCl_2$ when it is dissolved in water. | First write the correct reaction: $CaCl_2(s) \leftrightarrow Ca^{2+}(aq) + 2Cl^-(aq)$<br>Next write the equilibrium law: $Ksp = [Ca^{2+}][Cl^-]^2$ |
| How are Ksp and Kc different? How are they similar? | Ksp is a specific type of Kc. "Ksp" is used when the reactant is a solid and the products are ions. In both cases the rules for setting up the equation are the same and all terms have units of mol/L. |
| If Ksp and Kc are essentially the same, why have two different terms? | It allows us to identify the type of equilibrium. Also, the value of Kc is different from Ksp. Ksp is Kc (a constant) multiplied by the concentration of the solid reactant (another constant). |
| Define molar solubility. | The maximum number of moles that can be dissolved in one liter (i.e. the highest concentration before a precipitate forms). |