Unit 4 Chemical Systems and Equilibrium

7.1 Dynamic Equilibrium in Chemical Systems

- Many chemical reactions do not go to completion.
- A balance is reached when the reactants form products at the same rate the products react to reform the reactants.
- Unlike you learned in the past, many reactions are reversible.
  E.g. $H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$

Terms to Know

- Closed System: a system that may exchange energy but not matter with its surroundings.
- Equilibrium: a balance between forward and reverse processes occurring at the same rate.
- Forward Reaction: in an equilibrium equation, the left to right reaction.
- Reverse Reaction: in an equilibrium equation, the right to left reaction.

Solubility Equilibrium

- a dynamic equilibrium between a solute and a solvent in a saturated solution in a closed system.
- Both dissolving and crystallizing processes take place at the same rate with no observable changes.
- E.g. page 426 figure 2 and page 427 figure 3

Phase Equilibrium

- dynamic equilibrium between different physical states of a pure substance in a closed system.
- Phase changes occur at the same rate in both directions.
- E.g. At 0°C water will both melt and freeze at the same rate.

Chemical Reaction Equilibrium

- a dynamic equilibrium between reactant and products of a chemical reaction in a closed system.
- The most complex type of equilibrium.

- Not all reactions go to completion and sometimes the system is modified to force the reaction one direction.
- E.g. Cement production at high temperatures:

  $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ open system

  $CaCO_{3(s)} \leftrightarrow CaO_{(s)} + CO_{2(g)}$ closed system
- See figure 6 and 7 on page 430

Percent Reaction at Chemical Equilibrium

- A value that is constant for a particular set of parameters.
- E.g. $H_{2(g)} + I_{2(g)} \leftrightarrow 2HI_{(g)}$ at 448°C with always react to give 78% product.
- See table 4 on page 433 and examples of problems
- Percent reaction values provide clues to the equilibrium scenario
- Any value between 1% and 99% describes a scenario where some reactants AND some products are BOTH still present
- Maybe you are not supposed to get 100% yields in your reactions

Solving Equilibrium Problems

- ICE Tables
- Use stoichiometry in regards to the mole ratio
- Values of reactants or products will be in mol/L
- All chemicals will be in solutions or gases occupying a defined volume
- Equilibrium deals with how concentrations change and will not include solids or liquids

Ex.

	A +	2B ➔	3C +	D
INITIAL	5	5	0	0
CHANGE	-x	-2x	+3x	+x
EQUILIBRIUM	5-x	5-2x	0+3x	0+x

Comparing final values of reaction to theoretical values and will help determine the equilibrium constant for the reaction

Homework

- Practice 1,2,3,4,6,7
- Questions 1,2,3,4,5,7,8,9