

Chapter 9 - Chemical Equilibrium

- Know how to WRITE the **mass action expression** — same as equilibrium equation
How does this expression change and the value of K when a reaction is "flipped", doubled, halved?
When is this expression equal to Q ? When is it equal to K ?
- What is thermodynamic K ? How does that relate to K_p and K_c ?
- How does K_p (generally just K in our book) relate to K_c ? When would they be equal?
- What is the relationship between ΔG_{rxn} and Q ? between ΔG^0_{rxn} and K ? (read section 9.3)
- What are the units for an equilibrium constant? There are NO units. Why?
- Calculations involving the equilibrium constant, K
 - Know how to calculate the equilibrium constant if given equilibrium amounts of reactants and products. This is where you are given the entire bottom row (final equilibrium concentrations) of the equilibrium table that we use.
 - Know how to calculate the equilibrium constant if given initial concentrations and ONE final concentration at equilibrium. This is where you are given only ONE of the bottom row concentrations of your equilibrium table.
 - Know how to calculate final (equilibrium) concentrations if given initial concentrations and the value of K_c . This is the typical type problem where you must set up and solve the equilibrium expression for x . Your entire bottom row will be lots of concentration formulas containing x .
- Know how to predict the direction of a reaction if given concentrations and a value for K . (hint: compare Q to K)
- Know how to predict how equilibrium shifts (L, R, NC) when a system is stressed (see p. 348-355)
concentration changes, pressure changes, temperature changes (ΔH is needed), and addition of a catalyst (p. 355).
This is all a complete understanding of **LeChatelier's Principle** !!!
- What does a catalyst do for a given reaction? (p. 355)
- How does K change with temperature? Van't Hoff Equation! See page 354.

Chapter 10 - Acid and Base Equilibria (Type 1 problems)

- Know difference in a strong, weak, and non-electrolytes. (p. F62)
- Know your 3 Acid/Base Theories and their definitions. (first check out Chapter J, then p. 365-369)
- Know how to calculate concentrations of ions for strong electrolyte solutions (strong acids and bases fit this criteria, see Example 10.2 on page 371).
- Memorize the 7 Strong Acids and 8 Strong Bases listed on page F70 or from my help sheet on our web site.
- Know the autoionization of water. How is it shown? What is the ion product for water?
Memorize the value of K_w at 25°C — 1.0×10^{-14}
- Know how to calculate ANY "p" function — **pH, pOH, pK_a, pK_b, pK_w**, and in general, pX.
Of course know how to do the opposite too. Given pH, what is the H⁺ or H₃O⁺ concentration?
- What's the definition of a neutral solution? What is an acidic pH? basic? neutral?
- Know acid/base strength trends.
- Know how to write and use the mass action expressions for weak acids (**K_a**) and weak bases (**K_b**).
This also includes the conjugates of each type which would be
 - salts of a weak acid/strong base (Generic: NaA)
 - salts of a weak base/strong acid (Generic: BHCl)
- Be able to calculate the pH of a solution if only given the percent ionization of the acid or base.
 - Also be able to then calculate what the value of K_a or K_b is from the percent ionization and concentration information.
- Be able to write the appropriate stepwise reactions for polyprotic acids and bases. Know how to calculate the concentrations of various deprotonated species for polyprotic acids and bases.
 - Know what the dominant species are at various pH's for any acid or base (mono- or polyprotic). Yes, you do have to know the K_a 's or K_b 's, but those would be given.
- Know how to calculate the pH (and pOH) for any solution. You should refer to my Acid/Base pdf's that are available on our web page. There are a total of 6 versions of 2 Types of problems...
Chapter 10 problems are "Type 1" problems (EXAM 2) – ONE species put into solution.
Type 1 : only HA in solution (plain neutral acid, Example 10.7 & 10.8, p. 384-385)
Type 1 : only B in solution (plain neutral base, Example 10.9, p. 386)
Type 1 : only A⁻ put in solution (the SALT of a weak acid - works the same as B in solution, Example 10.11)
Type 1 : only BH⁺ put in solution (the SALT of a weak base - works the same as HA in solution, Example 10.10)

NOTE: Chapter 11 problems are "Type 2" problems (EXAM 3) – TWO species put into solution (Buffers).

These are listed as a point of reference only. Buffers will be on Exam 3, not Exam 2.

Type 2 : both HA and A⁻ put in solution (acidic buffer)

Type 2 : both B and BH⁺ put in solution (basic buffer)

- Know when TO USE and when NOT TO USE the approximation for solving quadratics in acid/base equilibria.
What is a reasonable concentration?
 - Know what happens with salts that contain small, highly charged cations (section 10.13, p 387-388)
Hint: treat these EXACTLY like you do any weak acid, HA.
However, do know HOW/WHY these things behave this way.
- Remember** the numbering for polyprotic acids and their conjugates are wrong in the book on page 392. The pK_{b1} should be listed as pK_{b2} and K_{b1} should be K_{b2} . Why? The first proton off an acid (K_{a1}) is always the LAST proton going ON to the corresponding conjugate base.

For a triprotic: $H_3A \rightleftharpoons H^+ + H_2A^-$ matches up with K_{a1}

The conjugate reaction is $H_2A^- + H_2O \rightleftharpoons H_3A + OH^-$ and matches up with K_{b3} .

The relationship between the two is $K_{a1} \cdot K_{b3} = K_w$.