Chapter 16: Acid-Base Equilibria

- List some properties of acids and bases.
- Define acid and base according to the Arrhenius Theory.
- What are the limitations of the Arrhenius Theory of acids and bases?
- Define acid and base according to the Bronsted-Lowrey Theory.
- Write a general equation for the reaction of an acid with water.
- Write a general equation for the reaction of a base with water.
- What happens to a hydrogen ion in an acid-base neutralization reaction?
- What are conjugate acid-base pairs in a reaction? Identify them from the 2 reactions you wrote above (of an acid and base reacting with water).
- Write the reaction of $H_2PO_4^{2-}$ reacting with water and identify the conjugate acid-base pairs.
- What is amphoterism? Give 2 examples of amphoteric substances.
- Define polyprotic acids. Give 2 examples.
- Are all H atoms acidic in molecules?
- What is the difference between a strong acid and a weak acid?
- If two acids react (one strong and one weak), which one will act as the acid and which as the base?
- Any acid that is stronger than what substance will dissociate completely to form $H_2O^-$?
- What is the leveling effect of a solvent?
- Which side of the reaction is favored when a weak base reacts with water?
- How can you use the table listing acids and bases to determine which substance in a reaction will be the strong acid and the weak acid?
- In the reaction of $HSO_4^-$ with $F^-$, which one is the weak acid?
- What is autoionization?
- What is $K_a$? (Both numerically and equation.)
- If the $H^+$ concentration is 0.10 M, what is the concentration of $OH^-$?
- What is the pH of a 1.5 M $H^+$ solution?
- How are pH and pOH related? How do they relate to $pK_a$?
- What happens to pH as a solution of HCl is diluted?
- What are the common strong acids?
- How is the pH of a strong acid solution calculated?
- What is the pH of a 0.200 M solution of HCl?
- What are some strong bases?
- Do all bases contain an $OH^-$ ion?
- How is the pOH of a basic solution calculated? Does the stoichiometry of the dissociation affect pOH?
- What is the $Ka$ expression for a weak acid solution written?
- What does a large value of $Ka$ indicate about the acid?
- How is the pH of a weak acid solution calculated?
- What is the $pH$ of a 0.100 M HF solution? $K_a = 7.0 \times 10^{-4}$
- If the $pH$ of 0.25 M HA is 2.34, what is the $K_a$?
- What is the expression of $K_b$ for a weak base? Write the equation for the dissociation of a weak base in water.
- What is the relationship between $K_a$ and $K_b$?
- What is $K_w$?
- How are $pK_a$ and $pK_b$ related?
- What is hydrolysis?
- What happens when Fe($H_2O)_6^{3+}$ is dissolved in water?
- How do salts change the pH of water?
- For what cations is hydrolysis not observed? Anions?
- For what cations is hydrolysis observed? (What charges and sizes?)
- How will the pH of a solution change if the following salts are added?
  - NaCl
  - LiCN
  - NH₄Cl
  - NH₄CN
- Does $NH_4^+$ produce an acidic or basic solution when hydrolyzed? Will $K_a$ be calculated to give $K_d$ or $K_b$?
- Does $CN^-$ produce an acidic or basic solution when hydrolyzed? Will $K_b$ be calculated to give $K_a$ or $K_d$?
- Is a solution of $NH_4F$ acidic or basic?
- What factors affect the strength of an acid?
- How does bonding affect the strength of an acid?
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- How does structure affect the strength of an acid?
- In oxoacids, how does the strength of an acid change with increasing numbers of oxygen?
- Does a larger electronegativity of an atom make the O-H bond easier or harder to ionize?
- What happens to the value of $K_a$ as successive H ions are pulled away from the neutral molecule?
- What is the anhydride (without water) of an acid?
- What is the anhydride of a base?
- Why are metal oxides bases?
- Does the acid character of an oxide increase or decrease as you move from left to right across the periodic table? As you move from bottom to top?
- Define Lewis acids.
- Define Lewis bases.

Chapter 17: Additional Aspects of Aqueous Equilibria

- What is the common ion effect?
- What happens to a solution’s equilibrium if a conjugate base of a weak acid is added?
- What is a buffered solution?
- What happens to the pH of a buffer if a strong base is added? Which way does equilibrium shift?
- What happens to the pH of a buffer if a strong acid is added? Which way does equilibrium shift?
- What is an example of a buffer solution? What two components are needed?
- What concentrations are changed when a strong acid is added to a buffer solution? Why is the concentration of $H_3O^+$ initial set to 0?
- If 1.00 M HF and 0.5 M NaF are combined and then mixed with 0.10 M HCl, what will the resulting pH be?
- What is the Henderson-Hasselbalch equation?
- If 1.00 M HF and 0.5 M NaF are combined and then mixed with 0.10 M NaOH, what will the resulting pH be?
- If the $K_a$ of HF is $7.0 \times 10^{-4}$ and $[HF] = 1.00 \text{ M}$ and $[F^-] = 0.500$, use the Henderson-Hasselbalch equation to calculate the pH of the buffer solution.
- What is the buffer range relative to $pK_a$?
- How can distribution diagrams be interpreted to determine which species are dominant at any given point?
- What is an equivalence point in titration?
- How is the equivalence point different from the end point?
- What is the difference between the titration of a weak acid with a strong base and that of a strong acid with a strong base?
- How should indicators be chosen for a titration?
- How is the equivalence point identified on a titration curve?
- In a strong acid-strong base titration, how is the pH at the equivalence point calculated?
- How is the pH calculated both before and after the equivalence point?
- What substance is in excess before the equivalence point if base is added to acid? What substance is in excess after the equivalence point?
- How is the pH calculated before any base is added to the acid?
- For a weak acid-strong base titration, when does $pH = pK_a$?
- How is the pH calculated before the equivalence point? Which substance is in excess?
- How is the pH calculated after the equivalence point? Which substance is in excess?
- Why are weak acid-weak base titrations never performed?
- What is the formation constant expression?
- Formation constants generally represent the formation of a Lewis acid-base complex ion.
- What is the general expression for a formation constant?
- For the stepwise formation of a complex, what is the overall equation?
- How is $K_f$ for each reaction related to the overall $K_f$?
- How are solubility equilibria expressions written?
- What is the equation for the dissociation of $Ba(IO_3)_2$ (s)?
- What is the $K_{sp}$ expression for the equation above?
- If the $K_{sp}$ value is $5.12 \times 10^{-4}$, what is the molar solubility of $Ba^{2+}$?
- What are the minimum concentrations needed for a precipitate of $Fe(OH)_3$ to form? $K_{sp} = 1.1 \times 10^{-36}$.
- What happens to a solution of $Ag^+$ and $Cl^-$ as more $Cl^-$ is added?
- If $S = [Ag^+] = [Cl^-] = 1.70 \times 10^{-6}$, what is the $K_{sp}$?
- How does adding an acid affect the solubility of a salt? Will the acid shift the equilibrium to the left or to the right?
- Does the formation of a complex ion increase or decrease solubility?
- Will a precipitate form if $Q_{sp} < K_{sp}$?
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- Will a solution containing $1.0 \times 10^{-6}$ M Cl$^-$ and $1.5 \times 10^{-4}$ Ag$^+$ form a precipitate of AgCl? $K_{sp} = 1.70 \times 10^{-10}$.
- You want to separate 0.10 M Pb$^{2+}$ from 0.10 M Ag$^+$ using Cl$. How much Ag$^-$ is left over when the Pb$^{2+}$ begins to precipitate? $K_{sp}$ of PbCl$_2 = 1.6 \times 10^{-5}$, $K_{sp}$ of AgCl = $1.7 \times 10^{-10}$.

Chapter 20: Electrochemistry

- What is electrochemistry?
- What is oxidation? What is reduction?
- Why can’t you have one without the other?
- How do we decide when metal deposition will be a spontaneous process or not?
- Will Ag displace Ni from a solution of Ni$^{2+}$?
- Which of the following combinations will undergo an oxidation-reduction reaction?
  - Mg + K$^+$
  - Mg + Zn$^{2+}$
  - H$_2$ + Ni$^{2+}$
  - H$_2$ + Cu$^{2+}$
- How can the reaction of Zn (s) + VO$^{2+} \rightarrow$ Zn$^{2+}$ + V$^{3+}$ be balanced using the half-reaction method? Assume it is an acidic solution.
- List the steps used to balance using the half-reaction method.
- Which substance is oxidized? Reduced? Which one is the oxidizing agent? Reducing agent?
- What is the difference in balancing between an acidic and a basic solution?
- Balance Cr$^{3+}$ + MnO$_4^-$ $\rightarrow$ CrO$_4^{2-}$ + Mn$^{2+}$ assuming a basic solution.
- What is a voltaic cell?
- What is needed to produce electricity?
- What reaction occurs at the anode? At the cathode?
- In which direction do anions flow?
- In which direction do cations flow?
- What are the components of a voltaic cell?
- What is EMF? Both the acronym and what it measures?
- What is the cell potential?
- What is the relationship between $E^\circ_{ox}$ and $E^\circ_{red}$?
- What is the reference for $E^\circ$?
- The $E^\circ$ of the hydrogen electrode is defined as 0.00 V. What would be the values of $E^\circ$ for the other half-reactions if these were defined as 1.00 V?
- What would be the overall redox reactions if the reference were defined as 1.00 V?
- If we reverse a reaction, what do we do to $E^\circ$?
- What condition of $E^\circ_{rxn}$ will make a redox reaction spontaneous?
- How is spontaneity determined for two half-reactions?
- What will happen if a piece of Zn and a piece of Cu are placed in a solution that contains a mixture of Zn$^{2+}$ and Cu$^{2+}$?
- Which combination will produce a spontaneous reaction? $E^\circ_{ox}$ of Zn = 0.76; $E^\circ_{ox}$ of Cu = -0.34
- What are disproportionation reactions?
- Will MnO$_4^-$ disproportionate?
- What are the 3 criteria for spontaneity? ($E^\circ$, $\Delta$G, and K)
- How are these criteria related?
- What is the value of F (Faraday constant)?
- What can be added together to give $E^\circ_{cell}$ or $E^\circ_{rxn}$?
- Why can $E^\circ$’s for half-reactions be added together to give an overall reaction but $E^\circ$’s for half-reactions cannot be added together to give a third half-reaction?
- Under what circumstances can $\Delta$G$^\circ$ be added?
- How can Keq be calculated from $E^\circ$?
- How can corrections be made if solutions aren’t all 1 M?
- For what value of Q will E = $E^\circ$?
- What is $E$ of the Zn/Cu$^{2+}$ reaction if [Cu$^{2+}$] = 0.010 M and [Zn$^{2+}$] = 1.99 M?
- What is a battery?
- What components are commercial batteries made of?
- What are the anode and cathode in commercial batteries?
- What is a LeClancache dry cell?
- What is an alkaline dry cell?
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- What is a lead storage battery?
- What is a NiCad cell?
- What is a silver cell?
- What is a fuel cell?
- What happens during corrosion?
- How can the corrosion of iron be prevented?
- What is electrolysis?
- What metals are purified by electrolysis?
- How is aluminum produced?
- How does electrolysis occur?
- Describe the process of electrolysis of NaCl. Of H$_2$O.
- What are the products of electrolysis of VBr$_3$ at pH 7?
- What is Faraday’s Law?
- What is equivalent weight?
- \( F = \text{charge on 1 mol e}^{-} = 96500 \text{ coul/mol} \)
- \( \text{charge} = \text{current} \times \text{time} \)
- 1 coul = 1 A s
- \( \text{moles e}^{-} = \text{charge (coul)} \times 1 \text{ mol/96500 coul} \)
- \( \text{moles e}^{-} = \text{current (A)} \times \text{time (s)} \times 1 \text{ coul/1 A s} \times 1 \text{ mol/96500 coul} \)
- If we electrolyze molten NaCl with a current of 5000 A for 30 min (or 1800 s), what mass of Na is produced?
- How long would we have to electrolyze molten NaCl with a current of 3000 A to produce 150 g of Na?