Chapter 18 "Acids, Bases and Salts"

- Some familiar chemistry….

THW (04/06)

Chapt. 18 OBJECTIVES

- State and use the Arrhenius and Brønsted-Lowry definitions of acids and bases.
- Identify common physical and chemical properties of acids and bases.
- Describe dissociation constants and explain what they indicate about acids and bases.
- Use experimental data to determine dissociation constants.
- Explain what most ‘acidic hydrogen atoms’ have in common.
- Explain wghat most bases have in common.
- Describe nomenclature of acids and bases.

18-1 Defining Acids and Bases

- What are some properties of acids and bases? (Let's derive some.)
  - Taste (Don't do this at home!)
  - Touch (Or this!)
  - Reactions with metals
  - Electrical conductivity
  - Reactions with "Indicators"
  - Neutralization

The Arrhenius Definitions

- **Acid** – a substance that dissociates in water to produce hydrogen ions (H^+).
- **Base** – a substance that dissociates in water to produce hydroxide ions (OH^-).
- See Fig. 18-6 (page 599).
- Arrhenius acids and bases react together (*neutralize*) to form a salt and water.
- Examples

The Brønsted-Lowry Definiton

- Arrhenius definition is restrictive
  - Applies only to water solutions.
  - Does not explain why covalent molecules are acids (HCl, HBr)
  - Does not explain why certain compounds like NH_3 are bases.
- **Brønsted-Lowry Definitions**
  - **Acid: a proton (H^+) donor.**
  - **Base: a proton acceptor.**

The Hydronium Ion

- Protons (H^+) do not really exist in water solutions in this way.
- *Hydronium Ions* (H_3O^+) are a better approximation of what occurs.

Conjugate Acid-Base Pairs

- The difference between an acid and a base *may be as simple as one H^+ ion!*
- To emphasize this relationship, chemists use the terms ‘conjugate acid – conjugate base’ pairs.
  - The term “conjugate” means “joined together.”
- **Conjugate Acid-Base Pair** is two compounds that differ by only one H^+ ion.
- Examples (Fig. 18-12, page 603).

18-2 Determining The Strengths of Acids and Bases

- **Strong and Weak Acids**
  - Strong acids easily lose H^+ ions, so they are strong electrolytes (high degree of dissociation).
  - Weak acids do not dissociate very much.
- **Strong and Weak Bases**
  - Strong bases (such as compounds with OH^-) have high affinity for H^+ ions, and they are strong electrolytes.
  - Weak bases react partially with water to form hydroxide ions.

- Use single arrows (→) to signify strong acids (~100% dissociation). (HCl)
- Use double arrows (↔) to signify weak acids (low amount of dissociation). ($HC_2H_3O_2$)

- **Strength of Conjugate Acid-Base Pairs**
  - The stronger the acid, the weaker its conjugate base.
  - The stronger the base, the weaker its conjugate acid.

The Acid Dissociation Constant

- For the reaction HA (*aq*) + H_2O (*l*) ↔ H_3O^+ (*aq*) + A^- (aq) we may write an equilibrium expression:

$$K_{eq} = [H_3O^+][A^-] / [HA][H_2O]$$

or

$$K_a = [H_3O^+][A^-] / [HA]$$ (Why?)

where K_a is the acid dissociation constant.

The larger the K_a, the stronger the acid.
Example

The Base Dissociation Constant

- For the reaction B (*aq*) + H_2O (*l*) ↔ HB^+ (*aq*) + OH^- (aq) we may write an equilibrium expression:

$$K_{eq} = [HB^+][OH^-] / [B][H_2O]$$

or

$$K_b = [HB^+][OH^-] / [B]$$ (Why?)

where K_b is the base dissociation constant.

The larger the K_b, the stronger the base.
Example

Calculating Dissociation Constants

- This is a very easy task once the concentrations of ions are known.
- Sample problem (p612).

Acid-Base Properties of Salts

- Salts are strong electrolytes, forming cations and anions in water.
- Many of these ions are weak Brønsted-Lowry acids or bases, so they produce H^+ or OH^-.
- This is called a '*salt hydrolysis reaction*.'

Types of Salt Hydrolysis Reactions

- Salts of Strong Acids & Strong Bases
  - Solution is neutral.
- Salts of Strong Acid & Weak Bases
  - Solution is acidic.
- Salts of Weak Acids & Strong Bases
  - Solution is basic (alkaline).
- Salts of Weak Acids & Weak Bases
  - Not easily predicted due to the many complex equilibria involved.

18-3 Naming and Identifying Acids and Bases

- Acids have “acidic hydrogens.”
  - These have a slight positive charge while still part of the molecule.
  - Binary Acids
  - Oxy Acids
  - Carboxylic Acids
- Bases
  - These always contain an unshared pair of electrons.
  - Anions
  - Amines
- Nomenclature (See p619 and prior notes.)

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