Strength of Acids & Bases - K_{eq}

- Just like in Chapter 13, we can use the equilibrium constant to decide whether products or reactants are favored in the dissociation of a base or of an acid.
- For an acid the K_{eq} is called the **acid dissociation constant (K_a)**

$$HCl\ (aq) + H_2O\ (l) \leftrightharpoons Cl^-\ (aq) + H_3O^+\ (aq) \qquad K_a = \frac{[H_3O^+][Cl^-]}{[HCl]}$$

- For a base the K_{eq} is called the **base dissociation constant (K_b)**

$$NH_3\ (aq) + H_2O\ (l) \leftrightharpoons NH_4^+\ (aq) + OH^-\ (aq) \qquad K_b = \frac{[OH^-][NH_4^+]}{[NH_3]}$$

Strength of Acids & Bases - K_{eq}

Table 14.5 K_a and K_b Values for Selected Weak Acids and Bases

Acids		
Phosphoric acid	H_3PO_4	7.5×10^{-3}
Hydrofluoric acid	HF	7.2×10^{-4}
Nitrous acid	HNO_2	4.5×10^{-4}
Formic acid	HCOOH	1.8×10^{-4}
Acetic acid	CH_3COOH	1.8×10^{-5}
Carbonic acid	H_2CO_3	4.3×10^{-7}
Dihydrogen phosphate	$H_2PO_4^-$	6.2×10^{-8}
Hydrocyanic acid	HCN	4.9×10^{-10}
Hydrogen phosphate	HPO_4^{2-}	2.2×10^{-13}
Bases		
Carbonate	CO_3^{2-}	2.2×10^{-4}
Ammonia	NH_3	1.8×10^{-5}

- Remember, large K_{eq} means products are favored and vice versa
- What is the strongest acid?
- What is the strongest base?
- What would be the strongest **conjugate** base?

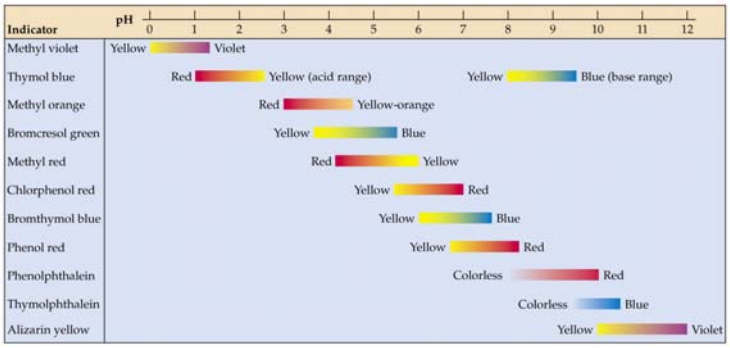
Table 14.6 Characteristics of Acids

Characteristic	Strong Acids	Weak Acids
Equilibrium position	Toward ionized products	Toward reactants
K_a	Large	Small
$[H_3O^+]$ and $[A^-]$	≈100% of [HA]	Small percent of [HA]
Conjugate bases	Weak	Strong

Measuring pH

- The approximate pH of a solution can be determined by using an **acid-base indicator**
- An indicator is a chemical substance that changes color in a specific pH range.

Measuring pH



- Indicators let you determine the pH of your solution within approximately ± 1 pH unit.
- More accurate methods, such as a **pH meter**, are also available in most labs

Acid-Base Properties of Salt Solutions

- Remember, split the salt into a cation and an anion.
- React each ion with water. If you get a strong acid or base as a product, then that reaction **WILL NOT** occur.
- If you get a weak acid or base, then that reaction **WILL** occur. Look and see if the second product is H_3O^+ (acidic solution) or OH^- (basic solution)

Table 14.11 Acid–Base Properties of Some Salt Solutions

Typical Salts	Types of Ions	pH	Solution
NaCl, $MgBr_2$, KNO_3	Cation from a strong base Anion from a strong acid	7.0	Neutral
NaF, $MgCO_3$, KNO_2	Cation from a strong base Anion from a weak acid	>7.0	Basic
NH_4Cl, $FeBr_3$, $Al(NO_3)_3$	Cation from a weak base Anion from a strong acid	<7.0	Acidic

Acid-Base Properties of Salt Solutions

- Predict whether the following solutions will be acidic, basic, or nearly neutral:

NH_4I

$CaCl_2$

$Al(ClO_4)_3$

$NaHSO_4$

NaCN

Calculating the pH of a Buffer

- A buffer is prepared by dissolving 5.25 g of sodium fluoride and 7.25 g of hydrofluoric acid into 250.0 mL of water. If Hydrofluoric acid has a pK_a of 3.14, what is the pH of this buffer solution?
  - **Step 1:** Identify the acid and the base.
  - **Step 2:** Write out the Henderson-Hasselback equation and make sure you have all the information.
  - **Step 3:** Plug your values into the H-H equation and solve for pH.