Salt Lake Community College, Chemistry Department

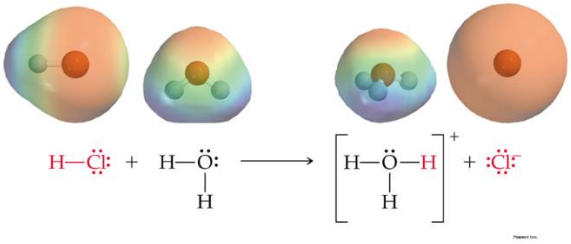
Chem 1110 Workshop 11

Topic: Acids and Bases Part I

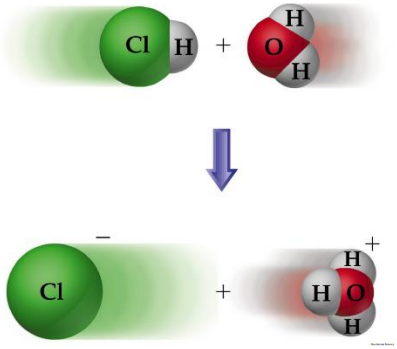
Objective:

- **Acids and Bases Definitions and Strengths**
- **To be able to use the pH scale and relate it to [H_3O^+]**

Arrhenius definition of an acid:



Bronsted Lowry Acid and Base:



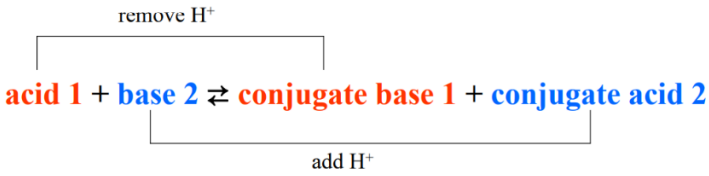
- Brønsted-Lowry: acid donates H^+ and base accepts H^+.
- Brønsted-Lowry base does not need to contain OH^-.
- Water can behave as either an acid or a base.

Acid and Bases Strength:

Table 10.2 Relative Strengths of Acids and Conjugate Bases

		Acid		Conjugate base		
Increasing acid strength	Strong acids: 100% dissociated	Perchloric acid	$HClO_4$	ClO_4^-	Perchlorate ion	Increasing base strength
		Sulfuric acid	H_2SO_4	HSO_4^-	Hydrogen sulfate ion	Little or no reaction as bases
		Hydriodic acid	HI	I^-	Iodide ion	
		Hydrobromic acid	HBr	Br^-	Bromide ion	
		Hydrochloric acid	HCl	Cl^-	Chloride ion	
		Nitric acid	HNO_3	NO_3^-	Nitrate ion	
		Hydronium ion	H_3O^+	H_2O	**Water**	
	Weak acids	Hydrogen sulfate ion	HSO_4^-	SO_4^{2-}	Sulfate ion	
		Phosphoric acid	H_3PO_4	$H_2PO_4^-$	Dihydrogen phosphate ion	Very weak bases
		Nitrous acid	HNO_2	NO_2^-	Nitrite ion	
		Hydrofluoric acid	HF	F^-	Fluoride ion	
		Acetic acid	CH_3COOH	CH_3COO^-	Acetate ion	
	Very weak acids	Carbonic acid	H_2CO_3	HCO_3^-	Bicarbonate ion	
		Dihydrogen phosphate ion	$H_2PO_4^-$	HPO_4^{2-}	Hydrogen phosphate ion	
		Ammonium ion	NH_4^+	NH_3	Ammonia	Weak bases
		Hydrocyanic acid	HCN	CN^-	Cyanide ion	
		Bicarbonate ion	HCO_3^-	CO_3^{2-}	Carbonate ion	
		Hydrogen phosphate ion	HPO_4^{2-}	PO_4^{3-}	Phosphate ion	
		Water	H_2O	OH^-	**Hydroxide ion**	Strong base

Conjugate Acid-Base Pairs:



$$\underset{\text{acid 1}}{HCl} + \underset{\text{base 2}}{NH_3} \rightleftarrows \underset{\text{base 1}}{Cl^-} + \underset{\text{acid 2}}{NH_4^+}$$

Practice Problems:

1. When acids and bases react the product other than water is a
   a) hydrogen ion.
   b) hydroxide ion.
   c) hydronium ion.
   d) metal.
   e) salt.

2. A Brønsted-Lowry acid is a substance which
   a) produces hydrogen ions in aqueous solution.
   b) produces hydroxide ions in aqueous solution.
   c) donates protons to other substances.
   d) accepts protons from other substances.
   e) accepts hydronium ions from other substances.

3. A Brønsted-Lowry base is a substance which
   a) produces hydrogen ions in aqueous solution.
   b) produces hydroxide ions in aqueous solution.
   c) donates protons to other substances.
   d) accepts protons from other substances.
   e) accepts hydronium ions from other substances.

4. Which of the following **cannot** act as a Brønsted base?
   a) HCO_3^-
   b) CO_3^{2-}
   c) NH_3
   d) NH_2^-
   e) NH_4^+

5. Classify each of these solutions as Brønsted-Lowry acid or base.

CN^-	
$HClO_4$	
PO_4^{3-}	
HBr	

6. Give the formula of:

(a) the conjugate base of this acid $C_2H_5NH_3^+$: _____.

(b) the conjugate acid of this base $H_2PO_4^-$: _____.

7. What is the pH of a 0.01 *M* solution of HCl?

8. Find $[H^+]$ in a solution with pH 5.43.

9. What is the pH of a 0.0032 *M* solution of NaOH?

10. A cleaning solution is found to have $[OH^-]$ of 1×10^{-3} *M*. What pH is this?