Acids and Bases

Arrhenius acids and bases- Acids are substances that produce hydrogen ions in solution. Bases are substances that produce hydroxide ions in solution.

Brønsted-Lowry acids and bases- Acids are proton donors, bases are proton acceptors.

$$\mathrm{HA}_{(aq)} + \mathrm{H_2O}_{(l)} \iff \mathrm{H_3O^+}_{(aq)} + \mathrm{A^-}_{(aq)}$$

$$\mathrm{HA}_{(aq)} \iff \mathrm{H^+}_{(aq)} + \mathrm{A^-}_{(aq)}$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} = \frac{[H^+][A^-]}{[HA]}$$

Acids Strength

Strong acids are acids with very large Ka values. The equilibrium lies far to the right. Weak acids have Ka values that are far less than one and the equilibrium lies far to the left. Acids with multiple acidic hydrogens will have multiple Ka values.

$$\mathrm{H_2SO_4}_{(aq)} \iff \mathrm{H^+}_{(aq)} + \mathrm{HSO_4^-}_{(aq)}$$

$$\mathrm{HSO_4^-}_{(aq)} \iff \mathrm{H^+}_{(aq)} + \mathrm{SO_4^{-2}}_{(aq)}$$

Amphoteric substances are chemicals that can function as both acids and bases. Water is one of the most important amphoteric substance.

$$2\ \mathrm{H_2O}_{(l)} \iff \mathrm{H_3O^+}_{(aq)} + \mathrm{OH^-}_{(aq)}$$

$$\mathrm{H_2O}_{(l)} \iff \mathrm{H^+}_{(aq)} + \mathrm{OH^-}_{(aq)}$$

$$K_w = [H_3O^+][OH^-] = [H^+][OH^-] = 1.0 \cdot 10^{-14}$$

pH

The pH scale provides a way to represent a wide range of values.

$$\mathrm{pH} = -\log[\mathrm{H}^+] \qquad \mathrm{pOH} = -\log[\mathrm{OH}^-]$$

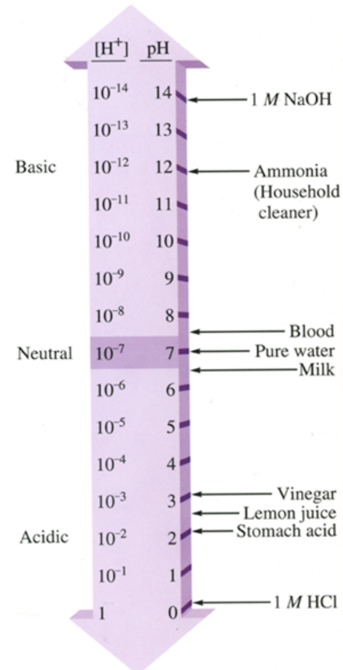
$$\mathrm{pK} = -\log[\mathrm{K}]$$

We can take the the p of the K_w expression.

$$\mathrm{pK_w} = -\log(1.0 \cdot 10^{-14}) = 14$$

$$\mathrm{pH} + \mathrm{pOH} = 14$$

Calculating the pH of a strong acid is trivial, weak acids are equilibrium systems and need to be treated as such.



pH and Weak Acids

When calculating the pH of a solution the first step is to identify the major species in the solution.

Ex: Find the pH of a 1.0M solution of HF.(K_a=7.2e-4). In this example there are two major species that can produce hydrogen ions hydrofluoric acid and water.

$$\mathrm{HF}_{(aq)} \iff \mathrm{H^+}_{(aq)} + \mathrm{F^-}_{(aq)} \qquad K_a = 7.2 \cdot 10^{-4}$$
$$\mathrm{H_2O}_{(l)} \iff \mathrm{H^+}_{(aq)} + \mathrm{OH^-}_{(aq)} \qquad K_w = 1.0 \cdot 10^{-14}$$

Because K_w is so much smaller than K_a we can assume that it has no measurable impact on the hydrogen ion concentration. We need only worry about the hydrofluoric acid. Now this is a standard ICE diagram problem, we can use the 5% rule to simplify the math, and we can find the concentration of hydrogen to be:

Ex: