Ocean Notes

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Chapter 1

Acids & Bases

Liquid water partially dissociates into H^+ and OH^- ions:

$$H_2O\,(l) \xrightleftharpoons{K_w} H^+\,(aq) + OH^-\,(aq)$$

At equilibrium, the molar concentrations (denoted by square brackets) of these ions are related to the auto-ionization constant K_w:

$$K_w = [H^+]\,[OH^-] = 10^{-14}\,M^2 \tag{1.1}$$

In neutral water, the concentration of each species is balanced:

$$[H^+] = [OH^-] = 10^{-7}M \tag{1.2}$$

Acids and bases disrupt (1.2) such that $[H^+] \neq [OH^-]$ by donating or accepting protons, respectively. However, they do not ultimately alter the equilibrium relation (1.1). This is important because it means $[H^+]$ and $[OH-]$ are totally dependent on one another; the entire system can be characterized by only one variable. pH is the most commonly used parameter:

$$pH = -\log\,[H^+]$$

1.1 Conjugate Pairs

Acids and bases come in *conjugate pairs.* After an acid donates a proton, the remaining species is a conjugate base. After a base accepts a proton, it becomes a conjugate acid.

1.2 Strong & Weak Species

Strong acids and bases participate in proton exchange more readily than weak ones. The strength of conjugate pairs is inverse, i.e., a strong acid has a weak conjugate base and vice versa. For example, nitric acid is a strong acid which readily donates its proton into solution, setting up an unbalanced equilibrium:

$$HNO_3 \rightleftharpoons H^+ + {NO_3}^-$$

Since nitric acid is so effective at donating its proton, the conjugate base ${NO_3}^-$ is very weak and does not act as an effective base. By contrast, weak species like carbonic acid set up more balanced equilibria:

$$H_2CO_3 \rightleftharpoons H^+ + {HCO_3}^-$$

The conjugate base ${HCO_3}^-$ is strong enough participate in proton exchange and thus qualifies as a base. The distinction between strong and weak species allows us to proceed with a definition of Alkalinity.