Acid-Base Calculations

***The Ion-Product Constant for Water, Kw***

Water undergoes ionization to a small extent:

 H20(*l*)  H+(*aq*) + OH–(*aq*)

The equilibrium constant for the reaction is the *ion-product constant for water* *Kw*:

  (1)

This is a key equation in acid-base chemistry. Note that the product of [H+] and [OH–] is a constant at a given temperature (Eq(1) value is for 25oC). Thus as the hydrogen ion concentration of a solution increases, the hydroxide ion concentration decreases (and vice versa).

The pH scale is widely used to report the molar concentration of hydrogen ion H+(*aq*) in aqueous solution. The pH of a solution is defined as

  (2)

Similarly, pOH and p*Kw* are defined as

  (3)

  (4)

If you take the log10 of both sides of Eq(1), multiply the resulting equation by (-1), and use the definitions of pH, pOH and p*Kw* above, the result is the very useful equation

 pH + pOH = p*Kw* = 14.00 (5)

Equations (2) and (3) above may be solved for [H+] and [OH–] respectively to give

  (6)

  (7)

(Here we use the well known rule that if , then .) In practice, the pH scale is only used when [H+(*aq*)] is less than 1.0 M.

Acidic, basic, and neutral solutions can be distinguished as shown below:

|  |  |  |  |
| --- | --- | --- | --- |
| **Type of Solution** | **pH**  | **[H+]** | **Color of litmus** |
| **Acidic** | < 7.00 | >  | pink |
| **Neutral** | = 7.00 | =  | in between |
| **Basic** | > 7.00 | <  | blue |