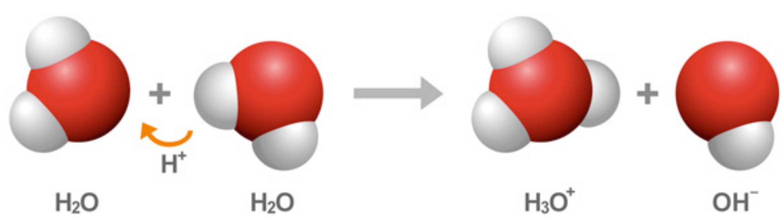
Name ____ Date ____________ Period __________

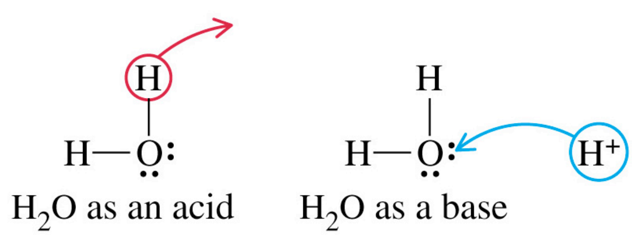
[H^+] vs. [OH^-] and Water Equilibrium

Like pH and pOH, there is a relationship between the [H^+] ion and the [OH^-] ion as well. We discussed that as pH or pOH fluctuated, so did the other. This is also true for the [H^+] ion and the [OH^-] ion. Remember that pH and pOH measure these ions, so if pH and pOH are changing so is the [H^+] and the [OH^-] ions.

When solutions of acids and bases are made, they are usually dissolved in water. This makes the solutions “aqueous” solutions. Acids and bases act like salts in water, meaning they dissociate or break apart into their ions. This is how the pH or pOH is measured, by looking at how many of these ions are in solutions. The more [H^+] ions that are in solution, the more acidic the solution is. The more [OH^-] ions in solution, the more basic the solution is.

There is a special property of water that makes it act like an acid or base, depending on what is dissolved in it. **Remember that the definition of an acid is that is DONATES its proton, and a base ACCEPTS a proton.** Because water has two hydrogen ions on it, and a highly negative other of end of it’s molecule because of the oxygen atom, it can behave like an acid or a base. Look at the picture below:





Notice that between the two water molecules on the reactant side, one water molecule **DONATES** its proton, and the other **ACCEPTS** the donated proton. What is produced on the other side is a protonated water molecule, H_3O^+ and the other is a de-protonated water molecule, OH^-. It’s important to understand that this behavior happens ever so slightly in water, but it is measurable in fact.

Water’s pH is measured by looking at how many [H_3O^+] ions and [OH^-] ions are in solution. Remember that purified water is **neutral**, meaning that the concentration of [H_3O^+] (same thing as a proton) and [OH^-] are equal. This allows us to use a constant, called the equilibrium constant of water, to be able to measure the [H+] or [OH-] ion is one or the other is known. That constant is below:

$$K_w = [H^+][OH^-] = (1.0 \times 10^7)(1.0 \times 10^7) = K_w = 1.0 \times 10^{14}$$

Because of the behavior of water, the relationship between $[H^+]/[H_3O^+]$ and $[OH^-]$ is derived from the equilibrium constant of water:

$$[H^+] = \frac{1.0 \times 10^{14}}{[OH^-]} \text{ and } [OH^-] = \frac{1.0 \times 10^{14}}{[H^+]}$$

Calculations

1. **What is the $[H^+]$ concentration if the $[OH^-]$ concentration is 2.3×10^{-9}?**

2. **What is the $[OH^-]$ concentration if the $[H^+]$ concentration is 1.5×10^{-2}?**

3. **What is the $[H^+]$ ion concentration if the pOH of a NaOH solution is 0.60?** *(HINT: there are TWO ways to set-up this calculation)*

4. **What is the $[OH^-]$ ion concentration of a 1.35M HCl solution?** *HINT: there are TWO ways to set-up this calculation)*