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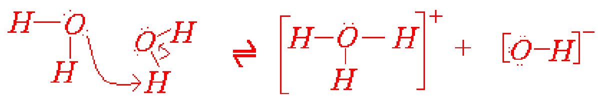
Autoionization of Water

1. Because water is an amphoteric substance, meaning it can be both acidic and basic; thus it is able to autoionize.

2. What is autoionization?



Don't work about the mechanics of what you see above. Just take notice of the fact that both reactants are water. One molecule is taking an H^+ (behaving like a base) and the other is losing the H^+ (behaving like an acid). Essentially water is able to react with itself. For every one hydronium formed there is also a hydroxide – hence water being a neutral (pH=7) substance.

$$2H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + {}^-OH_{(aq)}$$

The above is the reaction written in equation format. Just as with acids however, the reaction is simplified to

$$H_2O_{(l)} \rightleftharpoons H^+_{(aq)} + {}^-OH_{(aq)}$$

3. What is K_w?

K_w is the equilibrium constant for the autoionization of water.

$$K_w = [H_3O^+]\ [^-OH] = [H^+]\ [^-OH]$$

$$\text{at } 25^\circ C$$

$$[H^+] = 1.0 \times 10^{-7}\ M = [^-OH]$$

$$K_w = (1.0 \times 10^{-7})\ (1.0 \times 10^{-7}) = 1.0 \times 10^{-14}$$

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Thus, in any aqueous sol'n at 25°C, regardless of what it contains, the proceeding relationship must hold

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

4. Given that the K_w of pure water at 40°C is 2.29×10^{-14}.
Calculate the $[H^+]$.

Because we are looking at pure water we know that $[H^+] = [^-OH] = x$, where x is equal to the concentration value of H^+ and ^-OH.
We also know that for all aqueous solutions $[H^+][^-OH] = K_w$
If we combine these facts we get the following equation:

$$(x)(x) = 2.29 \times 10^{-14} = x^2$$

Solving for x we get:

$$[H^+] = x = 1.51 \times 10^{-7}\ M$$