Hydronium & the Spontaneous Dissociation of Water, The Mystery of the pH Scale Revealed

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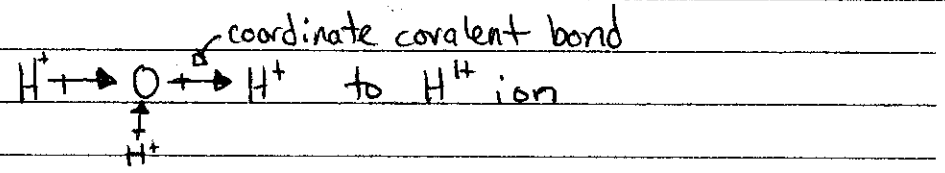
$H^+ \simeq H_3O^+$

acidic — acid with the water molecule carrier included



• Spontaneous Dissociation

good dissociation example! (hint, hint)

$H_2O \rightleftharpoons H^+ + OH^- \rightarrow K_W = [H^+][OH^-]$ ← Both acceptable formats

$1 \times 10^{-7} : 1$

$2H_2O \rightleftharpoons H_3O^+ + OH^- \rightarrow K_W = [H_3O^+][OH^-]$

↑ includes the carrier H_2O molecule

$K_W = 1 \times 10^{-14}$ @ 25°C

↳ Know this number!

If x represents the $[H^+]$

$\therefore [OH^-] = x$

$\therefore K_W = [H^+][OH^-]$

$1 \times 10^{-14} = x^2$

$x = 1 \times 10^{-7}$

$\therefore [H^+] = [OH^-] = 1 \times 10^{-7}$ M in neutral water at 25°C

pH → p ⇒ a p function means "take the -ve log of..."

① $pH = -\log_{10}[H^+]$ * $pH = -\log_{10}(1 \times 10^{-7})$

② $[H^+] = 10^{-pH}$ $pH = 7$ ↳ neutral water $[H^+]$

③ $pOH = -\log_{10}[OH^-]$

④ $[OH^-] = 10^{-pOH}$

⑤ $K_W = [H^+][OH^-]$ $K_W = 1 \times 10^{-14}$

⑥ $K_W = [H^+][OH^-]$

$\log_{10} K_W = \log_{10}[H^+][OH^-]$

$\log_{10} 1 \times 10^{-14} = \log_{10}[H^+] + \log_{10}[OH^-]$

$-14 = \log_{10}[H^+] + \log_{10}[OH^-]$

$\therefore 14 = -\log_{10}[H^+] - \log_{10}[OH^-]$

⑥ $14 = pH + pOH$

• Application to Strong Acid or Base (Non-Equilibrium)

$$\underset{2.0M}{HCl} \rightarrow \underset{2.0M}{H^+} + Cl^-$$

find $[H^+]$, pH, pOH, $[OH^-]$

$\therefore [H^+] = 2.0M$

$pH = -\log[H^+]$
$= -\log(2.0)$
$pH = -0.301$

$[OH^-] = \frac{K_w}{[H^+]}$
$= \frac{1 \times 10^{-14}}{2.0}$
$= 5 \times 10^{-13} M$

$pOH = -\log[OH^-]$
$= -\log(5 \times 10^{-13})$
$= 14.301$