Autoionization of water

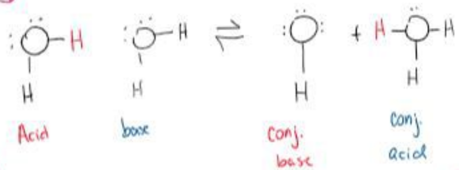
↳ in pure water, a few molecules act as bases and a few as acids

↳ this is **AUTOIONIZATION**

$$H_2O(l) + H_2O(l) \rightleftharpoons OH^-(aq) + H_3O^+(aq)$$

$$K_w = K_c = [H_3O^+][OH^-] = 10^{-14}$$

↳ very small amount of product in water



note that this is just $10^{-14} \div 2$

$$[H^+] = [OH] = 10^{-7} M \text{ (in this case)}$$

$$pH = -\log[H^+]$$ (how to find pH level based on $[H^+]$)

$$pH = -\log(10^{-7}) = \boxed{7}$$

↳ note that if we increase $[H^+]$ the pH decreases (more acidic)

↳ if we decrease $[H^+]$, the pH will increase (more basic)

$$pOH = -\log[OH^-]$$

$$= -\log[10^{-7}] = \boxed{7}$$

$$[H_3O^+][OH^-] = 10^{-14}$$

$$-\log[H_3O^+] + -\log[OH^-] = 14$$

$$pH + pOH = 14$$

Increase H^+ $10^{-4} \Rightarrow pH = 4$ $K_w = 10^{-14} = [H^+][OH^-]$ $[OH^-] = \frac{10^{-14}}{10^{-4}} = 10^{-10}$

$\boxed{pOH = 10}$

Decrease H^+ $10^{-10} \Rightarrow pH = 10$ $K_w = 10^{-14} = [H^+][OH^-]$ $[OH^-] = \frac{10^{-14}}{10^{-10}} = 10^{-4}$

$\boxed{pOH = 4}$

Ex: $pH = 11.70$

$[H_3O^+] = 10^{-11.70} = 2 \times 10^{-12}\ M$

$pOH = 14 - 11.70 = 2.3$

$[OH^-] = 10^{-2.3} = 5 \times 10^{-3}\ M$

- We measure pH $\bar{w}$ indicators
  - ↳ Color change indicators
    - ↳ some only change in presence of ACID or BASE
  - ↳ also there natural indicators
    - → hydrangea flower
      - ↳ their color varies based on pH of soil
    - → cabbage juice

Ex: pH of strong acid

↳ Calc. $[H_3O^+]$ and pH for 0.100M soln of $HClO_4$

$$H_2O + HClO_4 \rightleftharpoons H_3O^+ + ClO_4^-$$

	$HClO_4$	H_3O^+	ClO_4^-
I	0.100M	0	0
C	−0.100M	+0.100	0.100
E	0	+0.100	+0.100

$[H_3O^+] = 0.100$ M

$pH = -\log(\underset{10^{-1}}{0.100}) = 1$

0.100M strong base (NaOH)

$[OH^-] = 0.100$M

pOH = 1   pH = 13

• Strong acids COMPLETELY disassociates into its ions

↳ hence why its stoich. is so easy

• But weak acids/base don't completely disassociate

↳ only partially disassociate

$$HNO_2\,(aq) + H_2O\,(l) \rightleftharpoons H_3O^+\,(aq) + NO_2^-\,(aq)$$

acid dissociation constant

$$K_a = \frac{[H_3O^+][NO_2^-]}{[HNO_2]}$$

→ the stronger the acid, the greater amount of product

↳ ∴ K_a is big

$= 4.5 \times 10^{-4}$

↳ Kinda large K_a

Now we can create a general form:

$$\boxed{\begin{gathered} HA\,(aq) + H_2O\,(l) \rightleftharpoons H_3O^+\,(aq) + A^-\,(aq) \\ K_a = \frac{[H_3O^+][A^-]}{[HA]} \end{gathered}}$$

Ex: $HA\,(aq) + H_2O \rightleftharpoons H_3O^+ + A^-$

	HA	H_3O^+	A^-
I	$0.020M$	0	0
C	$-5.5\times10^{-4}M$	$+5.5\times10^{-4}M$	$5.5\times10^{-4}M$
E	$0.01945M$	$5.5\times10^{-4}M$	$5.5\times10^{-4}M$

pH = 3.26

$[H_3O^+] = 10^{-3.26} = 5.5\times10^{-4}M$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]} = \frac{(5.5\times10^{-4})^2}{0.01945} = 1.6\times10^{-5}$$