$$2H_2O(l) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$$

$$K_w = [H_3O^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25^\circ C$$

	$[H_2O]$	$[H_3O^+]$	$[OH^-]$
I	—	0	0
C	—	$+x$	$+x$
E	—	x	x

$$K_w = [H_3O^+][OH^-]$$
$$= (x) \cdot (x)$$
$$= x^2 = 1.0 \times 10^{-14} \text{ at } 25^\circ C$$

$$x = 1.0 \times 10^{-7}$$

$$[H_3O^+] = [OH^-] = 0.0000001 \frac{mol}{L}$$

$$pH = -\log[H_3O^+]$$

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

$$p\,anything = -\log(anything)$$

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

$$\log K_w = \log([H_3O^+][OH^-])$$

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

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

$$pK_w = pH + pOH$$

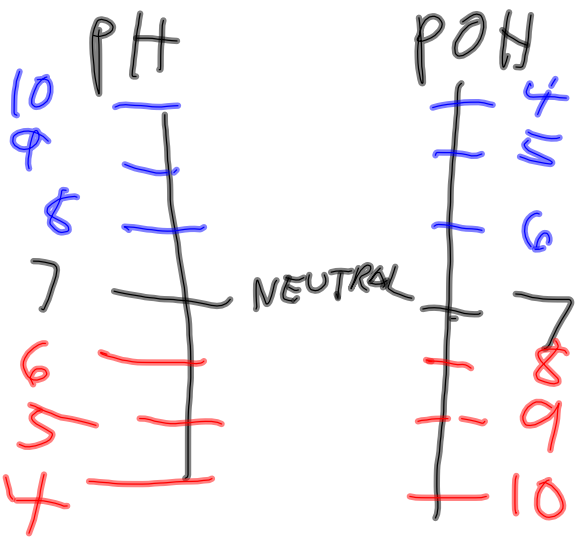
At 25°C $K_w = 1.0 \times 10^{-14}$

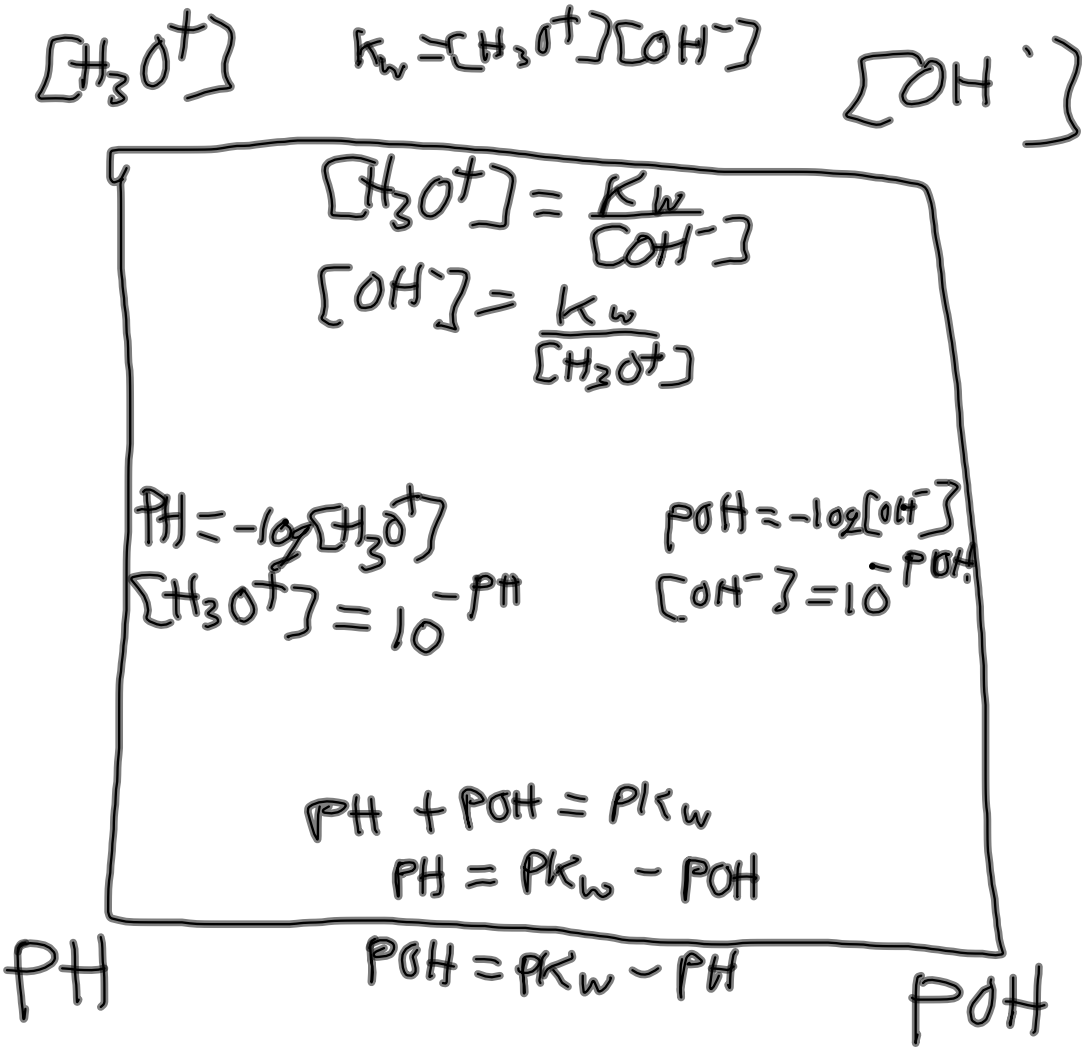
At 25°C $pK_w = -\log(1.0 \times 10^{-14})$

$$= -(-14.00)$$

$$= +14.00$$

At 25°C $pH + pOH = 14.00$




[H3O+]
Kw=[H3O+][OH-]
[OH-]
[H3O+] = Kw / [OH-]
[OH-] = Kw / [H3O+]
pH = -log[H3O+]
[H3O+] = 10^-pH
pOH = -log[OH-]
[OH-] = 10^-pOH
pH + pOH = pKw
pH = pKw - pOH
pOH = pKw - pH
pH
pOH

What is the $[H_3O^+]$, $[OH^-]$ pH, pOH of 0.015 M HCl solution. Note that HCl is a strong acid.

$$HCl(aq) + H_2O \xrightarrow{100\%} H_3O^+(aq) + Cl^-(aq)$$

I	0.015	—	~0	0
C	-0.015	—	+0.015	+0.015
E	0	—	0.015	0.015

$$[H_3O^+] = 0.015\ M$$

$$[OH^-] = \frac{K_w}{[H_3O^+]} = \frac{1.0 \times 10^{-14}}{0.015} = 6.7 \times 10^{-13}\ M$$

$$pH = -\log[H_3O^+] = -\log(0.015) = 1.82$$

$$pOH = pK_w - pH = 14.00 - 1.82 = 12.18$$

What is the $[H_3O^+]$, $[OH^-]$, pH, pOH of 2.55 M $HC_2H_3O_2$ solution?
(acetic acid)

Note that K_a for this acid is 1.8×10^{-5}

$$HC_2H_3O_2(aq) + H_2O(l) \rightleftharpoons H_3O^+(aq) + C_2H_3O_2^-(aq)$$

	$HC_2H_3O_2$	H_2O	H_3O^+	$C_2H_3O_2^-$
I	2.55	—	~0	0
C	$-X$	—	$+X$	$+X$
E	$2.55-X$	—	X	X

$$K_a = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]} = 1.8 \times 10^{-5}$$

$$K_a = \frac{(X)(X)}{2.55-X} = \frac{X^2}{2.55-X} = 1.8 \times 10^{-5}$$