Lecture 11.2 Weak acids and percent ionization

Note Title 9/30/2011

$CH_3COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$ $K_a = 1.76\times10^{-5}$ four reactants

	CH_3COOH	H_2O	H_3O^+	CH_3COO^-
i	1.00 M	~	0 M	0 M
c	$-x$		$+x$	$+x$
e	$1.00-x$		x	x

1 M.A.

$$1.76\times10^{-5} \approx \frac{x^2}{(1.00-x)} \quad \Big| \quad x = 0.004195\ M$$

$1.00 - x \approx 1.00$

$x = [H_3O^+]_e = 0.004195\ M$

5% rule $\frac{x}{(1.00)}\cdot 100 = 0.420\% < 5\%$ ☺

$pH = -\log[H_3O^+] = -\log(0.004195) = 2.377$ (3 S.F.) acid pH.

% ionization $= \frac{[H_3O^+]_e}{[CH_3COOH]_i}\cdot 100 = \frac{(0.004195)}{(1.00\ M)}100 = 0.420\%$ ionization

Least conc. → Conc. increasing → Most conc.

	0.0100 M	0.0500 M	0.100 M	0.250 M	0.500 M	1.00 M
	? Conductivity					
$[H_3O^+]_e$	0.0004195 M	0.0009380 M	0.0013266 M	0.0020976 M	0.0029666 M	0.004195 M
			$[H_3O^+]$ increasing →			
pH	3.378	3.028	2.878	2.678	2.528	2.377
			pH decreasing →			
% ionization	5%: 4.195% ☺	1.88%	1.326%	0.839%	0.593%	0.420%
			% ionization decreases →			

Example: • What is the pH of a 0.500 M weak acid solution that is 2.34% ionized?

⊙ What is K_a for this acid?

• $\%\text{ ionization} = \frac{[H_3O^+]_e}{[HA]_i} \cdot 100$ } $2.34\% = \frac{[H_3O^+]_e}{0.500\,M} \cdot 100$

→ $[H_3O^+] = 0.0117\,M$

→ $pH = -\log(0.0117\,M) = 1.932$ acidic!

⊙

	HA	+ H_2O	⇌	H_3O^+	+	A^-
i	0.500 M	~		0 M		0 M
c	$-x$			$+x$		$+x$
e	$(0.500-x)$			x		x

$x = [H_3O^+] = [A^-]$

$x = 0.0117\,M$

$K_a = \frac{[H_3O^+]_e[A^-]_e}{[HA]_e}$

$K_a = \frac{(0.0117\,M)(0.0117\,M)}{(0.500 - 0.0117\,M)}$

$K_a = 2.80 \times 10^{-4}$