16.6 Weak Acids

Most acid substances are weak acids
↳ partially ionize

$$HA_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + A^-_{(aq)}$$

or $$HA_{(aq)} \rightleftharpoons H^+_{(aq)} + A^-_{(aq)}$$

$$K_c = \frac{[H^+][A^-]}{[HA]} = K_a \leftarrow$$ acid-dissociation constant

The larger the value for K_a → the stronger the acid

Calculating K_a from pH

A student prepared a .10 M solution of HCOOH and found its pH @ 25°C to be 2.38

Calculate K_a

$$HCOOH_{(aq)} \rightleftharpoons H^+_{(aq)} + HCOO^-_{(aq)}$$

$$K_a = \frac{[H^+][HCOO^-]}{[HCOOH]}$$

$$pH = -\log[H^+]$$
$$2.38 = -\log[H^+]$$
$$[H^+] = 10^{-2.38} = 4.2 \times 10^{-3}\ M$$

$HCOOH$	$\rightleftharpoons$	H^+	+	$HCOO^-$
.10		0		0
-4.2×10^{-3}		$+4.2\times10^{-3}$		$+4.2\times10^{-3}$
.10 M		4.2×10^{-3}		4.2×10^{-3}

$$K_a = \frac{(4.2\times10^{-3})(4.2\times10^{-3})}{.10} = 1.8\times10^{-4}$$

Percent Ionization:

$$\% \text{ ionization} = \frac{\text{concentration ionized}}{\text{original ionized}} \times 100\%$$

$$= \frac{[H^+]_{equilibrium}}{[HA]_{initial}} \times 100\%$$

Using K_a to calculate pH

1. write ionization equilibrium:

$$CH_3COOH_{(aq)} \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$$

2. write equil exp & find the value in a table

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} = 1.8 \times 10^{-5}$$

3. Use I.C.E. table:

	CH_3COOH $\rightleftharpoons$	H^+ +	CH_3COO^-
$[\,]_o$	.30	0	0
$\Delta[\,]$	$-x$	$+x$	$+x$
$[\,]_f$	$.30-x$	x	x

4. Substitute and solve for x:

$$1.8 \times 10^{-5} = \frac{x \cdot x}{.30 - x}$$

assume x is small so $.30 - x \approx .30$

$$1.8 \times 10^{-5} = \frac{x^2}{.30}$$

$$x = 2.3 \times 10^{-3} = [H^+]$$

$$pH = -\log 2.3 \times 10^{-3} = 2.64$$

✓ using % ionization $= \frac{.0023}{.030} \times 100\% = .77\%$

if % ionization > 5% use quadratic formula.

Polyprotic Acids

↳ acids with more than one ionizable H^+

H_2SO_3, H_2CO_3

$H_2SO_3 \rightleftharpoons H^+ + HSO_3^-$ $\quad K_{a_1} = 1.7 \times 10^{-2}$

$HSO_3^- \rightleftharpoons H^+ + SO_3^{2-}$ $\quad K_{a_2} = 6.4 \times 10^{-8}$

↑ removal of 2nd proton

Note: Always easier
to remove the first proton

16.7 Weak Bases

$$B_{(aq)} + H_2O_{(l)} \rightleftharpoons HB^+_{(aq)} + OH^-_{(aq)}$$

$$K_b = \frac{[HB^+][OH^-]}{[B]}$$ (base-dissociation constant)

Types of Bases:

1 Neutral substance with a non-bonding pair of electrons that can accept a proton
(Amines → nitrogen atom with non-bonding pair)

2. Anions of weak acids

16.8 Relationship between K_a & K_b

$K_a \times K_b = K_w$ $\qquad pK_a + pK_b = pK_w = 14.00$

Calculate K_b for F^-

$HF \rightarrow K_a = 6.8 \times 10^{-4}$

so $K_b = \frac{K_w}{K_a} = \frac{1.0 \times 10^{-14}}{6.8 \times 10^{-4}} = 1.5 \times 10^{-11}$

Try Practice Exercise
on 681