Warm Up $K_w = K_a K_b$ $K_b = K_w / K_a$

Aspirin is a weak acid (HA). If a 1.0 M solution dissociates 1.8%, what is the [H+], pH & Ka of the soln?

$$HA + H_2O \rightleftharpoons H_3O^+ + A^-$$

	HA	H_3O^+	A^-
I	1.0 M	0	0
C	−x	+x	+x
E	≈ 1.0 M	x	x

$$\%\ \text{dissociation} = \frac{[H_3O^+]}{[HA]} \times 100$$

$$1.8\% = \frac{[H_3O^+]}{1.0} \times 100$$

$$0.018\ M = [H_3O^+]$$

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

$$pH = -\log(0.018)$$

$$pH = 1.74$$

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

$$K_a = \frac{(.018)^2}{1.0} = 3.2 \times 10^{-4}$$

Practice with Ka and Kb ICE and polyprotic as well as salts

1. What is the nature of the following salts and if it is not neutral write the B/L dissociation equation for the part that is acidic or basic?

a. $\overset{N}{Na}\overset{B}{CN}$ = Basic

b. $\overset{A}{CH_3NH_3}\overset{N}{Br}$ = Acidic

c. $\overset{N}{K}\overset{B}{ClO_3}$ = Basic

d. $\overset{N}{Cd}\overset{N}{I_2}$ = Neutral

e. $\overset{A}{(NH_4)_2}\overset{N}{SO_4}$ = Acidic

	Acid	Base	Neutral
+	All others	None	SB
−	HSO_4^- $H_2PO_4^-$ HPO_4^{-2}	Most	SA

Practice with Ka and Kb ICE and polyprotic as well as salts

1. What is the nature of the following salts and if it is not neutral write the B/L dissociation equation for the part that is acidic or basic?

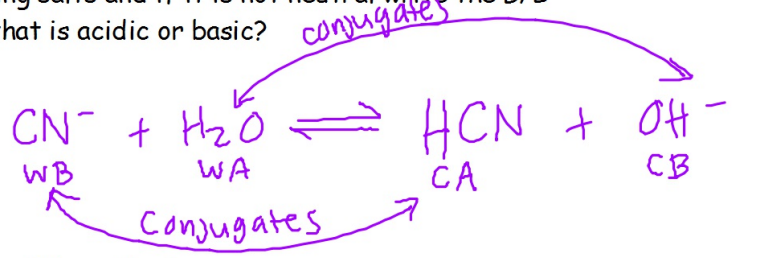
a. $NaCN$ (N \| B) = Basic

b. CH_3NH_3Br (A \| N) = Acidic

c. $KClO_3$ (N \| B) = Basic

d. CdI_2 (N \| N) = Neutral

e. $(NH_4)_2SO_4$ (A \| N) = Acidic



$CH_3NH_3^+$ + H_2O ⇌ CH_3NH_2 + H_3O^+
WA WB CB CA

ClO_3^- + H_2O ⇌ $HClO_3$ + OH^-
WB WA CA CB

NH_4^+ + H_2O ⇌ NH_3 + H_3O^+
WA WB CB CA

Practice with Ka and Kb ICE and polyprotic as well as salts

2. What is the pH of a 3.00 M H_3PO_4 solution if its Ka1 = $7.1 * 10^{-3}$ and its Ka2 = $6.3 * 10^{-8}$ and its Ka3 = $4.3 * 10^{-13}$?

Practice with Ka and Kb ICE and polyprotic as well as salts

2. What is the pH of a 3.00 M H_3PO_4 solution if its Ka1 = 7.1 * 10^{-3} and its Ka2 = 6.3 * 10^{-8} and its Ka3 = 4.3 * 10^{-13}?

$$H_3PO_4 + H_2O \rightleftharpoons H_3O^+ + H_2PO_4^-$$

	H_3PO_4		H_3O^+		$H_2PO_4^-$
I	3.00 M		0		0
C	$-x$		$+x$		$+x$
E	≈ 3.00 M		x		x

$$K_{a_1} = \frac{[H_3O^+][H_2PO_4^-]}{[H_3PO_4]}$$

$$7.1 \times 10^{-3} = \frac{x^2}{3.00}$$

$$X = 0.15\ M = [H_3O^+] = [H_2PO_4^-]$$

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$$H_2PO_4^- + H_2O \rightleftharpoons H_3O^+ + HPO_4^{-2}$$

	$H_2PO_4^-$		H_3O^+		HPO_4^{-2}
I	0.15 M		0.15 M		0
C	$-x$		$+x$		$+x$
E	≈ 0.15 M		≈ 0.15 M		x

$$K_{a_2} = \frac{[H_3O^+][HPO_4^{-2}]}{[H_2PO_4^-]}$$

$$6.3 \times 10^{-8} = \frac{(0.15)(x)}{0.15}$$

$$X = 6.3 \times 10^{-8}\ M = [HPO_4^{-2}]$$

Practice with Ka and Kb ICE and polyprotic as well as salts

2. What is the pH of a 3.00 M H_3PO_4 solution if its Ka1 = 7.1 * 10^{-3} and its Ka2 = 6.3 * 10^{-8} and its Ka3 = 4.3 * 10^{-13}?

$$HPO_4^{-2} + H_2O \rightleftharpoons H_3O^+ + PO_4^{-3}$$

HPO_4^{-2}		H_3O^+	PO_4^{-3}
6.3×10^{-8} M		0.15 M	0
$-x$		$+x$	$+x$
$\approx 6.3 \times 10^{-8}$ M		≈ 0.15 M	x

$$K_{a_3} = \frac{[H_3O^+][PO_4^{-3}]}{[HPO_4^{-2}]}$$

$$4.3 \times 10^{-13} = \frac{(0.15)(x)}{6.3 \times 10^{-8}}$$

$$X = 1.8 \times 10^{-19}\ M = [PO_4^{-3}]$$

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

$$pH = -\log(0.15)$$

$$pH = 0.82$$