DIPROTIC / POLYPROTIC ACIDS

→ all lose 1 H^+ at a time

$H_3A \rightleftharpoons H^+ + H_2A^-$ $\quad K_{a_1} = \frac{[H^+][H_2A^-]}{[H_3A]}$

$H_2A^- \rightleftharpoons H^+ + HA^{2-}$ $\quad K_{a_2} = \frac{[H^+][HA^{2-}]}{[H_2A^-]}$

$HA^{2-} \rightleftharpoons H^+ + A^{3-}$

$K_{a_1} >> K_{a_2} > K_{a_3}$

- usually, K_{a_1} is sufficient to calculate the pH of the solution
- usually $K_{a_2} = [HA^{2-}]$ conj. base of second ionization

*watch out for

$H_2SO_4 \longrightarrow H^+ + HSO_4^- \rightleftharpoons H^+ + SO_4^{2-}$

$K_a \approx 10^{-2}$

$H_2C_2O_4$ oxalic acid

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example H_2X $Ka_1 = 6.2\times10^{-6}$, $Ka_2 = 5.3\times10^{-10}$

@ eq $[H_2X] > [H^+] \cong [HX^-] >> [X^{2-}]$

What are all the concentrations at EQ? 0.030 M H_2X

(1) $H_2X \rightleftharpoons H^+ + HX^-$

H_2X	H^+	HX^-
0.030	0.0	0.0
$-x$	$+x$	$+x$
$0.030-x$	x	x
≈ 0.030		

$$Ka_1 = 6.2\times10^{-6} = \frac{x^2}{0.030}$$

$x = 4.3\times10^{-4}$ M $= [H^+] = [HX^-]$

(2) $HX^- \rightleftharpoons H^+ + X^{2-}$

HX^-	H^+	X^{2-}
4.3×10^{-4}	4.3×10^{-4}	0
$-y$	$+y$	$+y$
$4.3\times10^{-4}-y$	$4.3\times10^{-4}+y$	y
$\approx 4.3\times10^{-4}$	4.3×10^{-4}	y

$$Ka_2 = 5.3\times10^{-10} = \frac{(4.3\times10^{-4})(y)}{4.3\times10^{-4}}$$

$Ka_2 = 5.3\times10^{-10}$ M $= [X^{2-}]$

$[H_2X] = 0.030$ M

$[H^+] = 4.3\times10^{-4}$ M

$[HX^-] = 4.3\times10^{-4}$ M

$[X^{2-}] = 5.3\times10^{-10}$ M

STRUCTURE + STRENGTH

BINARY ACIDS

HF   HCl   HBr   HI

strongest bond ⟷ weakest bond

weakest acid ⟷ strongest acid

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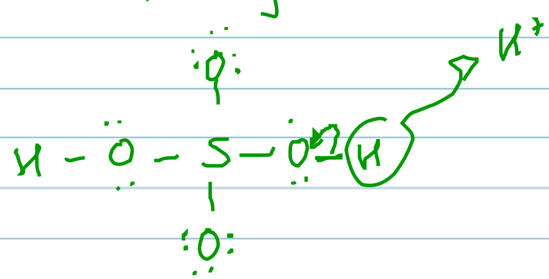
oxoacids $H_x Z O_y$

H_2SO_4



→ the weaker the O-H bond, the stronger the acid

→ ↑ the EN of central atom, the weaker the O-H bond

→ or, the ↑ the ox# of the central atom, the weaker the O-H bond

$\overset{+7}{HMnO_4}$ ✓

$\overset{+3}{HMnO_2}$

① Different central atom from same group (column) AND same # of O's & H's?

$HClO_2 > HBrO_2 > HIO_2$

② Same central atom, different # O's

$HClO_4 > HClO_3 > HClO_2 > HClO$