Acid Strength vs. Concentration

Jan 21st

Concentration refers to the mol/L of acid used to make a solution and can be determined through titration.

Strength refers to the ability of the acid to dissociate and donate a proton

Q6 is related to this.

$$HB + \underline{X^{1-}} \rightleftharpoons HX + \underline{B^{1-}}$$ - lies right

a) X^{1-} and B^{1-} are the bases competing for products

b) X^{1-} is the stronger base. The equilibrium lies to the right which shows X^{1-} is better and B^{1-} at getting protons

c) HX is the weaker acid *

d) The K-value will have a large value : $K = \frac{[products]}{[reactants]}$

e) $NaB \rightarrow Na^{1+} + B^{1-}$

S - ↑$[B^{1-}]$

R - ↓$[B^{1-}]$

H - use B^{1-}

D - left

* weak acid ↔ strong conjugate base ($CH_3COOH \rightleftharpoons H^{1+} + CH_3COO^{1-}$)

strong acid ↔ weak conjugate base ($HCl \rightarrow H^{1+} + Cl^{1-}$)

Weak Acid Equilibrium Calculation & % dissociation

Jan. 21st

eg. find the pH of 0.5M CH_3COOH * must find $[H^{1+}]$ first!

$$CH_3COOH \rightleftharpoons H^{1+} + CH_3COO^{1-}$$

$k_A = 1.8 \times 10^{-5}$ (from table)

WEAK ACID

non-acidic hydrogens

make this a variable

$[CH_3COO^{1-}] = [H^{1+}]$

$[CH_3COOH] = C^{o}_{A} - [H^{1+}]$

$= 0.5 - [H^{1+}]$

initial concentration of acid, "recipe" to make the acid, (the concentration of acid molecule IF there were 0% dissociation)

okay, so...

$$k_A = \frac{[H^{1+}][CH_3COO^{1-}]}{[CH_3COOH]}$$

* $[CH_3COO^{1-}] = [H^{1+}]$
* $[CH_3COOH] = 0.5 - [H^{1+}]$

$$1.8 \times 10^{-5} = \frac{[H^{1+}]^2}{0.5 - [H^{1+}]}$$

$$[H^{1+}] = \sqrt{1.8 \times 10^{-5}(0.5 - [H^{1+}])}$$

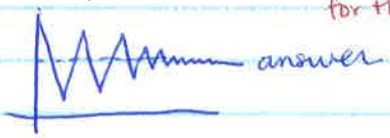
let's guess, to not do quadratic formula
let $[H^{1+}] = 0.05$

$= 0.002846$

$= 0.002991$ → same ∴ $[H^{1+}] = 0.002991$ M

$= 0.002991$

this is an equation that converges using successive approximation - ONLY WORKS for this Q!



$pH = -\log_{10}[H^{1+}]$

$= -\log_{10}[0.002991M]$

$pH = 2.52$

∴ pH is 2.52 and % dissociation is 0.598%.

$$\% \text{ dissociation} = \frac{[H^{1+}]}{C^{o}_{A}} \times 100\%$$

$$= \frac{[0.002991M]}{0.5M} \times 100\%$$

$$= 0.598\%$$

2 More Exam Question Examples

Jan. 22

1. A solution of HF is found to have a pH of 2.473. What is C°_A of HF?

$HF \rightleftharpoons H^+ + F^-$

extra step.

$[H^+] = 10^{-pH}$

$= 10^{-2.473}$

$[H^+] = 3.365 \times 10^{-3}\ M$

$[F^-] = [H^+]$

$= 3.365 \times 10^{-3}\ M$

$[HF] = C^\circ_A - [H^+]$

$= C^\circ_A - 3.365 \times 10^{-3}\ M$

found on table

$k_A = \frac{[H^+][F^-]}{[HF]}$

$6.8 \times 10^{-4} = \frac{(0.00365)^2}{C^\circ_A - 0.00365}$

$C^\circ_A = \frac{(0.00365)^2}{6.8 \times 10^{-4}} + 0.00365$

$\boxed{C_A^\circ = 0.0200 M}$

2. A solution of an unknown weak acid is found to have a pH of 3.761, titration of this monoprotic unknown determines the solution is 1.0M. What is the acid?

$HA \rightleftharpoons H^+ + A^-$ ← unknown acid anion

$[H^+] = 10^{-pH}$

$= 10^{-3.761}$

$[H^+] = 0.000173M$

$[A^-] = [H^+]$

$= 0.000173M$

$[HA] = C^\circ_A - [H^+]$

$= 1.0^M - [0.000173M]$

$= 0.999827\ M$

$k_A = \frac{[H^+][A^-]}{[HA]}$

$= \frac{(0.000173)^2}{0.999827}$

$kA = 3.0907 \times 10^{-8} \rightarrow HClO$ → refer to table to find proper KA.

17 备

* cannot solve stoichometrically

Problems 2-6

Jan22

2. a) $HCN \rightleftharpoons H^+ + CN^-$ $k_A = 4.0\times10^{-10}$

$[CN^-] = [H^+]$

$[HCN] = C^\circ_A - [H^+]$

$= 1.0M - [H^+]$

$$k_A = \frac{[H^+][CN^-]}{[HCN]}$$

$$4.0\times10^{-10} = \frac{[H^+]^2}{1.0-[H^+]}$$

$$[H^+] = \sqrt{4.0\times10^{-10}(1.0-[H^+])}_{0.05}$$

1.949×10^{-5}

1.999×10^{-5}

$[H^+] = 1.999\times10^{-5}$

$pH = -\log_{10}[H^+]$

$= -\log_{10}[0.00001999M]$

$\boxed{pH = 4.699}$ ✓

$$\%\text{ dissociation} = \frac{[H^+]}{C^\circ_A}\times100\%$$

$$= \frac{0.00001999M}{1.0}\times100\%$$

$\boxed{\%\text{ dissociation} = 0.001999\%}$ ✓

[b), c), d), e)]

f) $H_3BO_3 \rightleftharpoons H^+ + H_2BO_3^-$ $k_A = 5.9\times10^{-10}$

$[H_2BO_3^-] = [H^+]$

$[H_3BO_3] = C^\circ_A - [H^+]$

$= 0.5M - [H^+]$

$$k_A = \frac{[H^+][H_2BO_3^-]}{[H_3BO_3]}$$

$$5.9\times10^{-10} = \frac{[H^+]^2}{0.5-[H^+]}$$

$$[H^+] = \sqrt{5.9\times10^{-10}(0.5-[H^+]}$$

$$\rightarrow [H^+] = \sqrt{5.9\times10^{-10}(0.5-[H^+]}_{0.05}$$

1.629×10^{-5}

1.718×10^{-5}

$[H]^+ = 1.718\times10^{-5}$

$pH = -\log_{10}[H^+]$

$= -\log_{10}[0.00001718M]$

$\boxed{pH = 4.77}$ ✓

$$\%\text{ diss} = \frac{[H^+]}{C^\circ_A}\times100\%$$

$$= \frac{0.00001718M}{0.5M}\times100\%$$

$\boxed{\%\text{ diss} = 0.003436\%}$ ✓

3. $HF \rightleftharpoons H^+ + F^-$

$[F^-] = [H^+]$

$[HF] = C_A^\circ - [H^+]$

$$C_A^\circ = \frac{n}{V}$$

$$= \frac{2.0g\left(\frac{1mol}{20g}\right)}{1.0L}$$

$C_A^\circ = 0.1M$

$[H^+] = 10^{-pH}$

$10^{-2.2}$

$[H^+] = 6.31\times10^{-3}M$

$$k_A = \frac{[H^+][F^-]}{[HF]}$$

$$= \frac{[H^+]^2}{C_A^\circ - [H^+]}$$

$$= \frac{(6.31\times10^{-3})^2}{0.1M - 6.31\times10^{-3}}$$

$\boxed{k_A = 4.25\times10^{-4}}$ ✓

* not actually HF?

4. $HX \rightarrow H^+ + X^-$

$[X^-] = [H^+]$

$[HX] = 0.100 - [H^+]$

$$\%\text{ diss} = \frac{[H^+]}{C^\circ_A}\times100$$

$$[H^+] = \frac{(6.0\%)(0.100M)}{100\%}$$

$[H^+] = 0.006M$

$$k_A = \frac{[H^+][X^-]}{[HX]}$$

$$= \frac{[H^+]^2}{0.100-[H^+]}$$

$$= \frac{(0.006)^2}{0.100-0.006}$$

$\boxed{k_A = 3.83\times10^{-4}}$ ✓

5. $HX \rightleftharpoons H^+ + X^-$

$C^\circ_A = 1.0 \times 10^{-3}\ M$

$[H^+] = 0.2 \times 1.0\times10^{-3}$

$= 2.0\times10^{-4}\ M$

$[HX] = C^\circ_A - [H^+]$

a) $pH = -\log_{10}[H^+]$

$= -\log_{10}[0.2\times10^{-4}]$

$pH = 3.70$

b) $[X^-] = [H^+]$

$[Y^-] = 2.0\times10^{-4}\ M$

c) $k_A = \frac{[H^+][X^-]}{[HY]}$

$= \frac{[H^+]^2}{C^\circ_A - [H^+]}$

$= \frac{(2.0\times10^{-4})^2}{1.0\times10^{-3} - 2.0\times10^{-4}}$

$\boxed{k_A = 5.0\times10^{-5}}$ ✓

6. $HBrO \rightarrow H^+ + BrO^-$ $k_A = 2.0\times10^{-9}$, $pH = 4.8$, $C^\circ_A = ?$

$[H^+] = 10^{-pH}$

$= 10^{-4.8}$

$[H^+] = 1.58\times10^{-5}\ M$

$[BrO^-] = [H^+]$

$[HBrO] = C^\circ_A - [H^+]$

$k_A = \frac{[H^+][BrO^-]}{[HBrO]}$

$2.0\times10^{-9} = \frac{[H^+]^2}{C^\circ_A - [H^+]}$

$C^\circ_A = \frac{(1.58\times10^{-5})^2}{2.0\times10^{-9}} + 1.58\times10^{-5}$

$\boxed{C^\circ_A = 0.1248\ M}$ ✓