Calculations Involving Acidic Solutions

Chapter 8.4

Strong Acids

- Since strong acids almost completely ionize in water, we can assume that the concentration of hydrogen ions is equal to the concentration of the acid.
- Ex: A solution of hydrochloric acid has a concentration of 0.1mol/L. Calculate:

a) $[H^+]$

b) $[OH^-]$

c) pH

d) pOH

Weak Acids and Percent Ionization

- Percentage ionization is the percentage of a solute that ionizes when it dissolves in a solvent

$$\text{percentage ionization} = \frac{\text{concentration of ionized acid}}{\text{initial concentration of acid}} \times 100\ \%$$

$$HA(aq) \rightleftharpoons H^+(aq) + A^-(aq)$$

$$\text{percentage ionization} = \frac{[H^+(aq)]}{[HA(aq)]} \times 100\ \%$$

OR

$$[H^+(aq)] = \frac{\text{percentage ionization}}{100\ \%} \times [HA(aq)]$$

Example

- Calculate the K_a of hydrofluoric acid, $HF_{(aq)}$, if a 0.100mol/L solution at equilibrium has a percent ionization of 7.8%.

Using K_a to find pH

- Calculate the pH of a 0.10mol/Lacetic acid solution. K_a for acetic acid is $1.8x10^{-5}$.

Using pH to find K_a

- A student prepares a 0.20mol/L aqueous solution of ascorbic acid, and measures its pH as 2.40. Based on this evidence, what is the K_a of ascorbic acid?

Polyprotic Acids

- A **monoprotic acid** is an acid that possesses only one ionizable (acidic) hydrogen atom

- A polyprotic acid is an acid that possesses more than one ionizable (acidic) hydrogen atom

$$H_3PO_4 + H_2O \rightleftharpoons H_2PO_4^- + H_3O^+ \qquad K_{a1} = \frac{[H_2PO_4^-][H_3O^+]}{[H_3PO_4]} = 7.5 \times 10^{-3}$$

$$H_2PO_4^- + H_2O \rightleftharpoons HPO_4^{-2} + H_3O^+ \qquad K_{a2} = \frac{[HPO_4^{2-}][H_3O^+]}{[H_2PO_4^-]} = 6.23 \times 10^{-8}$$

$$HPO_4^{-2} + H_2O \rightleftharpoons PO_4^{-3} + H_3O^+ \qquad K_{a3} = \frac{[PO_4^{3-}][H_3O^+]}{[HPO_4^{2-}]} = 2.2 \times 10^{-13}$$

- Notice that the value of K_{a1} is much greater than the value of K_{a2}

Polyprotic Acids

Acid	Formula	K_{a1}	K_{a2}	K_{a3}
oxalic acid	$H_2C_2O_4(aq)$	5.4×10^{-2}	5.4×10^{-5}	–
ascorbic acid	$H_2C_6H_6O_6(aq)$	7.9×10^{-5}	1.6×10^{-12}	–
sulfuric acid	$H_2SO_4(aq)$	very large	1.0×10^{-2}	–
hydrosulfuric acid	$H_2S(aq)$	1.1×10^{-7}	1.3×10^{-13}	–
phosphoric acid	$H_3PO_4(aq)$	7.1×10^{-3}	6.3×10^{-8}	4.2×10^{-13}
arsenic acid	$H_3AsO_4(aq)$	5×10^{-3}	8×10^{-8}	4.0×10^{-12}
carbonic acid	$H_2CO_3(aq)$	4.4×10^{-7}	4.7×10^{-11}	–

$$K_{a1} > K_{a2} > K_{a3}$$

Practice

- Calculate the pH of a 1.00mol/L solution of sulfuric acid, $H_2SO_{4(aq)}$.

HOMEWORK

Required Reading:

p. 512-525

(remember to supplement your notes!)

Questions:

p. 513 #1,2

p. 516 #1,2

p. 520 #1,2

p. 521 #1,2

p. 524 #1,2

p. 525 #1-10a

Silent labs, difficult labs
All with math, all with graphs
Observations of colors and smells
Calculations and graph curves like bells
Memories of tests that have past
Oh, how long will chemistry last?

Silent labs, difficult labs
All with math, all with graphs
Lots of equations that need balancing
titration problems that make my head ring
Santa Chemistry's on his way
Oh, Please Santa bring me an 'A'.