Polyprotic Acids (More than one proton)

- Acid that can give up more than one proton (e.g. H_2CO_3 - carbonic acid)

- These acids lose protons in a stepwise fashion

e.g.

$$H_2CO_3 \rightleftharpoons HCO_3^- + H^+ \quad K_{a1} = 4.3 \times 10^{-7}$$

$$HCO_3^- \rightleftharpoons CO_3^{-2} + H^+ \quad K_{a2} = 5.6 \times 10^{-11}$$

[Pg 677 Table 14-4 for example K_a values]

In general, polyprotic acids with K_{a1} & K_{a2} (etc.) that are different by 10^3, you can consider that the second ionization (K_{a2}) does not occur to any appreciable extent.

① Use the first ionization equation (& K_{a1}) to find pH.

② If (you) are asked for concentration of CO_3^{-2}, you must solve the first ionization equilibrium to find the equilibrium concentration of second ionization equilibrium.

Polyprotic Acid (Pg 2)

Problem: The solubility of CO_2 in pure H_2O @ 25°C and 0.1 atm pressure is 0.0037M. Assuming All CO_2 dissolves in H_2O as carbonic acid (H_2CO_3), what is the pH of this solution (0.0037m H_2CO_3).

$K_{a1} = 4.3 \times 10^{-7}$

$K_{a2} = 5.6 \times 10^{-11}$

Answer: Since $K_{a1} >> K_{a2}$, we assume no contribution of $[H^+]$ from 2nd ionization rxn (K_{a2}).

Reaction: $H_2CO_3 \rightleftharpoons HCO_3^{-1} + H^+$

$$K_{a1} = \frac{[H^+][HCO_3^{-1}]}{[H_2CO_3]}$$

Assume 5%

$$4.3 \times 10^{-7} = \frac{x^2}{0.0037M} \Rightarrow x = 4.0 \times 10^{-5} M \Rightarrow pH = 4.40$$

(B) What is the concentration of CO_3^{-2}?

$HCO_3^{-1} \rightleftharpoons CO_3^{-2} + H^+$ $\quad K_{a2} = 5.6 \times 10^{-11}$

* IMPORTANT: USE 1st ionization equilibrium concentration

$$5.6 \times 10^{-11} = \frac{x^2}{4.0 \times 10^{-5}} \Rightarrow x = 4.7 \times 10^{-8} M = [CO_3^{-2}]$$

$[H^+]$ for 2nd ionization: 5.0×10^{-9} m

4.7×10^{-8} m

COMPARE TO

$[H^+]$ for 1st ionization = 4.0×10^{-5} m

Assumption ✓

H_2SO_4 special case:

READ Pg 680-682

Problems: #101, #102