Acid-Base Chemistry Review

- Arrenhius Concept of Acid and Bases (Old and Revised)
- Bronsted-Lowry Acid-Base Concept

(Identify acids/bases, amphiprotic)

- Conjugate Acids and Bases
- Polyprotic Acids
- Water Equilibrium
- Strong acids / bases
- Weak acids / bases
- Predicting Acid-Base Equilibria

Calculate the pH and hydronium ion concentration if a 0.227 mol/L solution of benzoic acid is added to water.

$$C_6H_5COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_5COO^-_{(aq)} + H_3O^+_{(aq)}$$

0.227 mol/L

$$K_a = \frac{[C_6H_5COO^-_{(aq)}][H_3O^+_{(aq)}]}{[C_6H_5COOH_{(aq)}]} \quad , \quad [C_6H_5COO^-] = [H_3O^+]$$

$$K_a = \frac{[H_3O^+_{(aq)}]^2}{[C_6H_5COOH_{(aq)}]}$$

$$[H_3O^+_{(aq)}] = \sqrt{(6.3 \times 10^{-5})[0.227]}$$

$$[H_3O^+_{(aq)}] = 3.78 \times 10^{-3} M$$

$$pH = -\log[H_3O^+_{(aq)}]$$

$$pH = -\log[3.78 \times 10^{-3}]$$

$$\boxed{pH = 2.423}$$

Calculate the pOH and hydroxide ion concentration if a 0.350 mol/L solution of nitrite ions is added to water.

$$NO_{2(aq)}^- + H_2O_{(l)} \rightleftharpoons HNO_{2(aq)} + OH_{(aq)}^-$$

0.350mol/L

$$K_b = \frac{[HNO_{2(aq)}][OH_{(aq)}^-]}{[NO_{2(aq)}^-]}, \quad [HNO_{2(aq)}] = [OH_{(aq)}^-]$$

$$K_b = \frac{[OH_{(aq)}^-]^2}{[NO_{2(aq)}^-]}$$

$$K_aK_b = K_w$$

$$K_b = \frac{K_w}{K_a}$$

$$[OH_{(aq)}^-] = \sqrt{(1.39\times10^{-11})[0.350]}$$

$$K_b = \frac{1.0\times10^{-14}}{7.2\times10^{-4}}$$

$$[OH_{(aq)}^-] = 2.21\times10^{-6}\ M$$

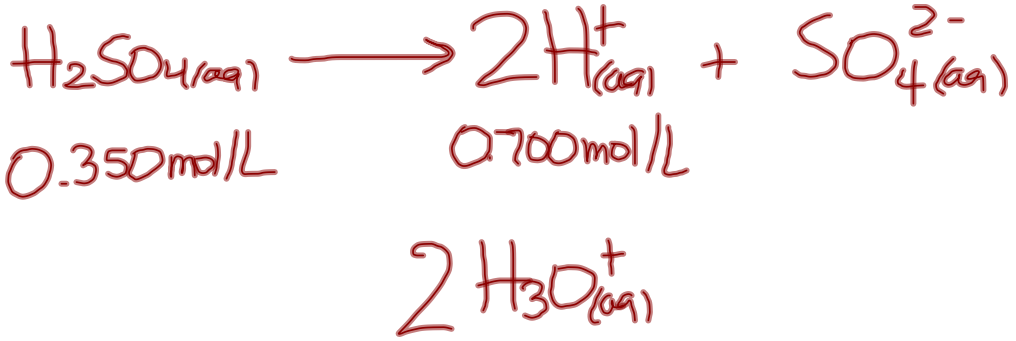
$$K_b = 1.39\times10^{-11}$$

$$pOH = -\log[OH^-]$$

$$pOH = -\log[2.21\times10^{-6}]$$

$$\boxed{pOH = 5.656}$$

Calculate the pH and hydronium ion concentration of a 0.350 mol/L solution of sulfuric acid.



Calculate the pH and hydronium ion concentration of a 0.350 mol/L solution of sodium hydroxide.

$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$

0.350 mol/L 0.350 mol/L

$pOH = -\log[OH^-]$

$pOH = -\log[0.350]$

$pOH = 0.456$

$pH + pOH = 14.000$

$pH = 14.000 - 0.456$

$pH = 13.544$

Predicting Acid-Base Reactions

1. List all entities (ions, atoms, or molecules) initially present.

2. Identify all possible acids and bases, using Bronsted-Lowry definition.

3. Identify the strongest acid and strongest base, using table of acids and bases.

4. Transfer one proton from the acid to the base and predict the conjugate acid and conjugate base as products.

5. Predict the position of the equilibrium.

Use the five-step method to predict the following acid-base equilibria:

NH_4^+ Cl^-

- Ammonium chloride is added to a nitric acid solution.

$NH_4Cl_{(aq)}$ and $HNO_{3(aq)}$

(SA) (SB)

$NH_{4(aq)}^+$, $Cl_{(aq)}^-$, $H_3O_{(aq)}^+$, $NO_{3(aq)}^-$, $H_2O_{(l)}$

A B A B A/B

$$H_3O^+_{(aq)} + H_2O_{(l)} \rightleftharpoons H_2O_{(l)} + H_3O^+_{(aq)}$$

- Methanoic acid is added to a sodium hydrogen carbonate solution.

$HCOOH_{(aq)}$ and $NaOH_{(aq)}$

(SA) (SB)

$HCOOH_{(aq)}$, $Na^+_{(aq)}$, $OH^-_{(aq)}$, $H_2O_{(l)}$

A — B A/B

$$HCOOH_{(aq)} + OH^-_{(aq)} \overset{>50\%}{\rightleftharpoons} HCOO^-_{(aq)} + H_2O_{(l)}$$

Worksheet