

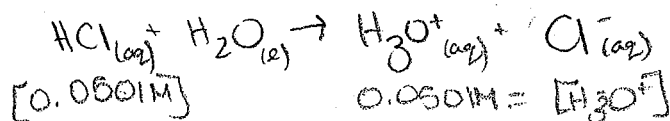
6.4 - Comparing the Strength of Acids and Bases.notebook

6.4 - Calculating $[H_3O^+]$ and $[OH^-]$ - Worksheet

1. Calculate $[H^+]$ in a 2.00 L solution of HCl in which 3.65 g of HCl is dissolved.

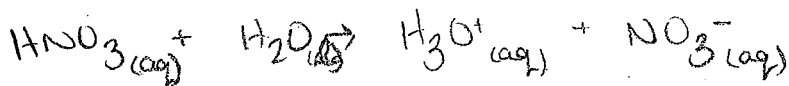
$$M = \frac{wt}{mm \cdot V} = \frac{3.65g}{(36.46)(2L)} = 0.0501M$$

$\rightarrow 36.46g/mol$



2. Calculate $[H^+]$ in a solution containing 3.20 g of HNO_3 in 250 mL of solution.

$$63.02g/mol$$

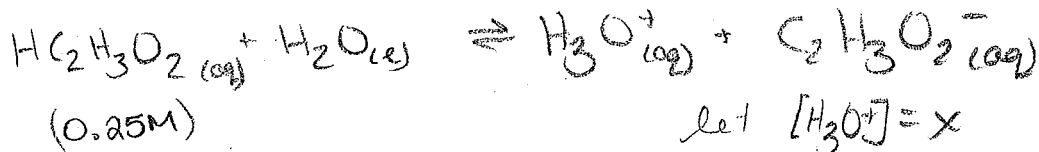


$$M = \frac{wt}{mm \cdot V} = \frac{3.20g}{(63.02g/mol)(.25L)} = 0.203M$$

$$\therefore [H_3O^+] = 0.20M$$

3. An acetic acid ($HC_2H_3O_2$) solution is 0.25 M. Find $[H_3O^+]$.

$$K_a = 1.8 \times 10^{-5}$$



$$K_a = \frac{[H_3O^+][C_2H_3O_2^-]}{[HC_2H_3O_2]}$$

$$1.8 \times 10^{-5} = \frac{x^2}{0.25M}$$

$$\sqrt{4.5 \times 10^{-6}M} = \sqrt{x^2} \quad \therefore x = 0.00212M$$

4. A 500.0 mL solution contains 12.0 g of hydrofluoric acid. Calculate $[H^+]$.

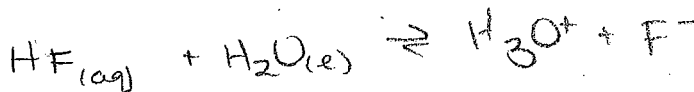
$$20.01g/mol$$

$$\therefore [H_3O^+] = 0.002$$

$$K_a = 6.7 \times 10^{-4}$$

$$M = \frac{wt}{mm \cdot V} = \frac{12.0g}{(20.01g/mol)(0.5L)} = 1.2M$$

$$\text{let } [H_3O^+] = [F^-] = x$$



$$K_a = \frac{[H_3O^+][F^-]}{[HF]}$$

$$6.7 \times 10^{-4} = \frac{x^2}{1.2M}$$

$$\therefore x = 0.02835M$$

$$\therefore [H_3O^+] = 0.0284M$$

6.4 - Comparing the Strength of Acids and Bases.notebook

$$\rightarrow 122.13 \text{ g/mol}$$

5. When 1.22 g of benzoic acid ($\text{C}_6\text{H}_5\text{COOH}$) is dissolved to make 1.00L of solution, the resulting $[\text{H}^+] = 8.0 \times 10^{-4} \text{ M}$. Determine the K_a of the acid.

$$\text{Initial: } M = \frac{\text{wt}}{\text{mm} \cdot V} = \frac{1.22 \text{ g}}{(122.13 \text{ g/mol})(1 \text{ L})} = 0.01 \text{ M} \Rightarrow [\text{C}_6\text{H}_5\text{COOH}]$$

$$K_a = \frac{[\text{C}_6\text{H}_5\text{COO}^-][\text{H}^+]}{[\text{C}_6\text{H}_5\text{COOH}]}$$

$$= \frac{(8.0 \times 10^{-4})^2}{0.0092}$$

$$= 6.956 \times 10^{-5}$$

$$K_a = 7.0 \times 10^{-5}$$

6. Calculate $[\text{H}^+]$ and $[\text{OH}^-]$ at 25°C in:

a. a 5.0 M NaOH solution. NaOH is a strong base.



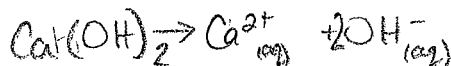
$$[\text{NaOH}] = [\text{OH}^-] = 5.0 \text{ M}$$

$$K_w = [\text{OH}^-][\text{H}^+]$$

$$1.0 \times 10^{-14} = (5.0 \text{ M})[\text{H}^+]$$

$$\therefore [\text{H}^+] = 2.0 \times 10^{-16}$$

b. a 0.025 M $\text{Ca}(\text{OH})_2$ solution. $\text{Ca}(\text{OH})_2$ is a strong base.



$$K_w = [\text{H}^+][\text{OH}^-]$$

$$1.0 \times 10^{-14} = (0.05 \text{ M})[\text{H}^+]$$

$$[\text{H}^+] = 2.0 \times 10^{-13}$$

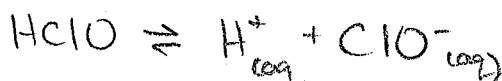
$$[\text{OH}^-] = 2[\text{Ca}(\text{OH})_2]$$

$$= 2(0.025 \text{ M})$$

$$[\text{OH}^-] = 0.05 \text{ M}$$

c. a 0.10 M hypochlorous acid solution.

$\text{HClO} = \text{weak}$



$$K_w = [\text{H}^+][\text{OH}^-]$$

$$K_a = \frac{[\text{H}^+][\text{ClO}^-]}{[\text{HClO}]}$$

$$2.9 \times 10^{-8} = \frac{x^2}{0.10 \text{ M}}$$

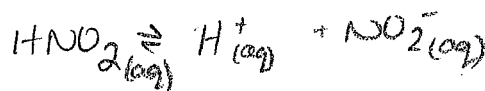
$$x = 5.38 \times 10^{-5} \text{ M} = [\text{H}^+]$$

$$1.0 \times 10^{-14} = (5.38 \times 10^{-5})[\text{OH}^-]$$

$$[\text{OH}^-] = 1.9 \times 10^{-10}$$

$\text{HNO}_2 = \text{weak}$

d. a 0.010 M Nitrous acid solution.



$$0.010 \text{ M}$$

$$K_a = \frac{[\text{H}^+][\text{NO}_2^-]}{[\text{HNO}_2]}$$

$$5.1 \times 10^{-4} = \frac{x^2}{(0.01 \text{ M})}$$

$$\therefore x = 0.0023 \text{ M} = [\text{H}^+]$$

$$K_w = [\text{H}^+][\text{OH}^-]$$

$$1.0 \times 10^{-14} = (0.0023 \text{ M})[\text{OH}^-]$$

$$[\text{OH}^-] = 4.3 \times 10^{-12} \text{ M}$$

