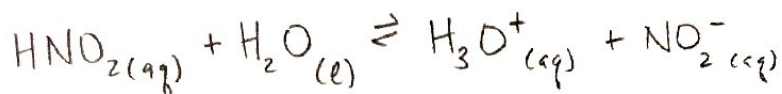


Now you try!

1. What is the pH of a 0.200 M solution of HNO_2 ? The K_a of HNO_2 is 4.6×10^{-4} .



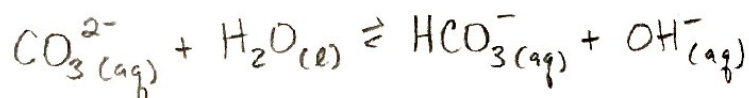
$$K_a = \frac{[\text{H}_3\text{O}^+][\text{NO}_2^-]}{[\text{HNO}_2]} = \frac{x^2}{0.200 - x} \approx \frac{x^2}{0.200} = 4.6 \times 10^{-4}$$

$K_a \ll 1$, x negligible

$$x = [\text{H}_3\text{O}^+] = \sqrt{(0.200)(4.6 \times 10^{-4})} = 9.6 \times 10^{-3} \text{ M}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+] = -\log (9.6 \times 10^{-3}) = \boxed{2.02}$$

2. The carbonate ion, CO_3^{2-} , is a weak base ($K_b = 2.13 \times 10^{-4}$). Calculate the pH of a 1.3 M carbonate solution.



$$K_b = \frac{[\text{HCO}_3^-][\text{OH}^-]}{[\text{CO}_3^{2-}]} = \frac{x^2}{1.3 - x} \approx \frac{x^2}{1.3} = 2.13 \times 10^{-4}$$

$K_b \ll 1$, x negligible

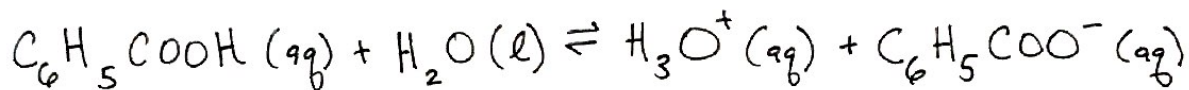
$$x = [\text{OH}^-] = \sqrt{(1.3)(2.13 \times 10^{-4})} = 0.017 \text{ M}$$

$$\text{pOH} = -\log [\text{OH}^-] = -\log (0.017) = 1.78$$

$$\Rightarrow \text{pH} = 14 - \text{pOH} = 14 - 1.78 = \boxed{12.22}$$

3. The pH of a 0.010 M solution of benzoic acid, C_6H_5COOH (a monoprotic acid), is 3.09. What is the ionization constant for benzoic acid?

$$[H_3O^+] = 10^{-pH} = 10^{-3.09} = 8.1 \times 10^{-4} M = x$$



$$K_a = \frac{[H_3O^+][C_6H_5COO^-]}{[C_6H_5COOH]} = \frac{x^2}{0.010 - x} = \frac{(8.1 \times 10^{-4})^2}{0.010 - 8.1 \times 10^{-4}} = \boxed{7.1 \times 10^{-5}}$$

Multiple Choice Practice

1. Which of the following could be added to an aqueous solution of the weak acid HF to increase the percent dissociation?

a. NaF(s)

b. $H_2O(l)$

c. NaOH(s)

d. $NH_3(aq)$

increase $H_2O \Rightarrow \downarrow [HF] = \uparrow \% \text{ Ion}$

2. Which of the following solutions will have the highest pH? $\uparrow pH = \downarrow [H_3O^+]$

a. 0.20 M HCl

b. 0.10 M HCl

c. 0.20 M $HC_2H_3O_2$

d. 0.10 M $HC_2H_3O_2$

Strong acid = $\uparrow [H_3O^+]$

3. A weak monoprotic acid has an ionization constant of 1.0×10^{-8} . What will be the percent dissociation of the acid in a 4.0-molar solution?

a. 0.8%

b. 0.05%

c. 0.005%

d. 0.0002%

$$K_a = \frac{x^2}{[HA]} = \frac{x^2}{4.0} = 1.0 \times 10^{-8}$$

$$\Rightarrow x = [H_3O^+] = \sqrt{4.0 \times (1.0 \times 10^{-8})} = 2.0 \times 10^{-4} M$$

$$\% \text{ Diss} = \frac{[H_3O^+]_{eq}}{[HA]_i} \times 100$$

$$= \frac{2.0 \times 10^{-4}}{4.0} \times 100 = \boxed{0.0050\%}$$

4. Which of the following solutions has the greatest percent ionization?

- a. 0.20 M $\text{HC}_2\text{H}_3\text{O}_2$ b. 0.10 M $\text{HC}_2\text{H}_3\text{O}_2$ c. 0.050 M $\text{HC}_2\text{H}_3\text{O}_2$ (d.) 0.010 M $\text{HC}_2\text{H}_3\text{O}_2$

★ all the same weak acid

↓ $[\text{HA}] = \uparrow \% \text{ Ion.}$

5. A weak monoprotic acid, HA, has a pH of 5.00 when $[\text{HA}] = 0.25 \text{ M}$. Calculate the ionization constant of this acid.

- a. 2.5×10^{-5} b. 2.5×10^{-10} (c.) 4.0×10^{-10} d. 4.0×10^{-11}

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-5.00} = 1.0 \times 10^{-5} \text{ M} = x$$

$$K_a = \frac{[\text{H}_3\text{O}^+][\text{A}^-]}{[\text{HA}]} = \frac{x^2}{0.25} = \frac{(1.0 \times 10^{-5})^2}{0.25} = \boxed{4.0 \times 10^{-10}}$$

6. Acetic acid has an ionization constant that is approximately equal to 2.0×10^{-5} . What will be the percent dissociation of acetic acid in a 0.20 M solution?

- (a.) 1.0% b. 0.20% c. 0.010% d. 0.0020%

$$K_a = \frac{x^2}{[\text{HA}]} = \frac{x^2}{0.20} = 2.0 \times 10^{-5}$$

$$x = [\text{H}_3\text{O}^+] = \sqrt{(0.20)(2.0 \times 10^{-5})} \\ = 2.0 \times 10^{-3} \text{ M}$$

$$\% \text{ Diss} = \frac{[\text{H}_3\text{O}^+]_{\text{eq}}}{[\text{HA}]_i} \times 100 \\ = \frac{2.0 \times 10^{-3}}{0.20} \times 100 = \boxed{1.0\%}$$

7. Which of the following solutions has the smallest percent ionization?

- (a.) 0.20 M HNO_2 b. 0.10 M HNO_2 c. 0.20 M HNO_3 d. 0.10 M HNO_3

↑ $[\text{HA}] = \downarrow \% \text{ Ion}$

(of a weak acid)

100% ionization! (strong acid ☺)

8. A 1-molar solution of a very weak monoprotic acid has a pH of 5. What is the value of K_a for the acid?

- (a.) 1×10^{-10} b. 1×10^{-7} c. 1×10^{-5} d. 1×10^{-2}

$$[\text{H}_3\text{O}^+] = 10^{-\text{pH}} = 10^{-5} = x$$

$$K_a = \frac{x^2}{[\text{HA}]} = \frac{(10^{-5})^2}{1} = \boxed{10^{-10}}$$