

## Acid-Base Equilibria

1. What is the formula for percent ionization?

2. A solution of HCl has a pH of 2.3. Calculate the pOH,  $[H^+]$ , and  $[OH^-]$

$$pOH = 11.7$$

$$[H^+] = 5.0 \times 10^{-3}$$

$$[OH^-] =$$

$$pH = -\log[H^+]$$

$$10^{2.3} = 5.0 \times 10^{-3}$$

$$14 = pOH + pH$$

$$14 = pOH + 2.3$$

$$pOH = 11.7$$

3. What is the concentration of hydronium ions in a solution that has a volume of 2.50 L and 5.33 g of HCl? What is the pH of this solution?

$$\frac{5.33 \text{ g HCl}}{36.46 \text{ g HCl}} \times \frac{1 \text{ mol HCl}}{1 \text{ mol HCl}} = 0.146 \text{ mol H}^+$$

$$[H^+] = \frac{0.146 \text{ mol}}{2.50 \text{ L}} = 0.0584 \text{ M H}^+$$

$$pH = -\log[0.0584]$$

$$pH = 1.234$$

4. Calculate the pH of a solution prepared by mixing 0.15M HF with 0.18M NaF.  
( $K_a$  of HF is  $6.8 \times 10^{-4}$ ,  $pK_a = 3.17$ )

$$\textcircled{1} [HA] = 0.15 \text{ M}$$

$$[A^-] = 0.18 \text{ M}$$

$$pH = 3.25$$

$$\textcircled{2} pH = 3.17 + \log \frac{[0.18]}{[0.15]}$$

5. Calculate the pH of a solution that is 0.20M in  $HCHO_2$  and 0.15M in  $NaCHO_2$

	$HCHO_2 \rightleftharpoons H^+ + CHO_2^-$	
I	0.20	0
C	-x	+x
E	0.20 - x	x
	$\approx 0.20$	$\approx 0.15$

$$K_a = 1.8 \times 10^{-4}$$

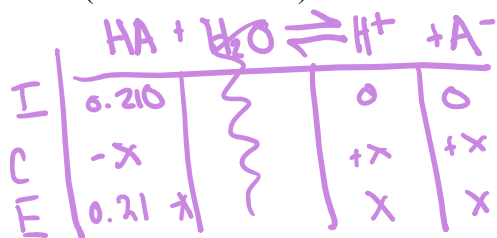
$$1.8 \times 10^{-4} = \frac{[H^+][CHO_2^-]}{[HCHO_2]}$$

$$1.8 \times 10^{-4} = \frac{0.15x}{0.20}$$

$$x = 2.4 \times 10^{-4}$$

$$pH = 3.62$$

6. Vinegar is a dilute solution of acetic acid ( $\text{HC}_2\text{H}_3\text{O}_2$ ). If the concentration of  $\text{HC}_2\text{H}_3\text{O}_2$  in a vinegar solution is  $0.210\text{M}$ , calculate the percent ionization of acetic acid. ( $K_a = 1.75 \times 10^{-5}$ )



$$1.75 \times 10^{-5} = \frac{x^2}{0.210}$$

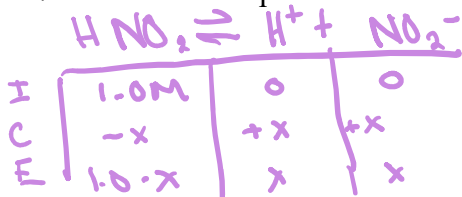
$$x = \sqrt{(1.75 \times 10^{-5})(0.210\text{M})}$$

$$= 0.001917\text{M}$$

$$\%I = \frac{[\text{H}^+]}{[\text{HA}]} \times 100 \quad \%I = \frac{0.001917}{0.210} \times 100$$

$$\%I = 0.913\%$$

7. Calculate the percent ionization in a  $1.0\text{M}$  solution of nitrous acid. ( $K_a = 4.5 \times 10^{-4}$ )



$$4.5 \times 10^{-4} = \frac{x^2}{1.0}$$

$$x = \sqrt{(4.5 \times 10^{-4})(1)}$$

$$= 2.1 \times 10^{-2}\text{M}$$

$$\%I = \frac{[\text{H}^+]}{[1.0]} = 2.1\%$$

8. If the hydrogen ion concentration of a solution is  $2.5 \times 10^{-5}\text{M}$ , what is the pH of the solution?

$$\text{pH} = -\log(2.5 \times 10^{-5})$$

$$\text{pH} = 4.60$$

9. What is the pOH of a solution with a pH of 8.72?

$$14 - 8.72 =$$

$$\text{pOH} = 5.28$$

10. What is the pH of a 0.50M ammonia,  $\text{NH}_3$  solution? The  $K_b$  of ammonia is  $1.8 \times 10^{-5}$ .

$$\text{NH}_3 + \text{H}_2\text{O} \rightleftharpoons \text{OH}^- + \text{NH}_4^+$$

I	0.50	—	0	0
C	-x	—	+x	+x
E	0.50-x	—	x	x

$$K_b = \frac{[\text{OH}^-][\text{NH}_4^+]}{[\text{NH}_3]}$$

$$1.8 \times 10^{-5} = \frac{x^2}{0.50}$$

$$x^2 = 9 \times 10^{-6}$$

$$x = 3.0 \times 10^{-3} \text{ M} = [\text{OH}^-]$$

$$\text{pOH} = -\log(3.0 \times 10^{-3})$$

$$\text{pOH} = 2.5$$