

Acid and Base Equilibrium

Chapter 8

Arrhenius

- Acid: A substance that makes H^+ (H_3O^+) when dissolved in water.
- Base: A substance that makes OH^- when dissolved in water.
- An acid/base reaction occurs when an H^+ from an acid reacts with an OH^- from a base.

Acids

- Strong acids: Dissociate completely when dissolved in water.
 - HCl, HNO_3
- Weak acids only dissociate a little bit.
 - CH_3CO_2H

Base

- Strong base: dissociates completely when dissolved in water.
 - NaOH, KOH
- Weak base: Makes only a little bit of OH^- .
 - NH_3

1.00 M Acetic acid, a weak acid



$$K = \frac{[\text{H}_3\text{O}^+][\text{CH}_3\text{CO}_2^-]}{[\text{CH}_3\text{CO}_2\text{H}]}$$

- The K_a for this reaction is 1.8×10^{-5} . Since little of the $\text{CH}_3\text{CO}_2\text{H}$ dissociates, we can call it 1 M.
- For every H_3O^+ there will be one CH_3COO^- . Let these concentrations = x
- $x = [\text{H}^+] = [\text{CH}_3\text{COO}^-] = .00042$

Brønsted-Lowry Definition

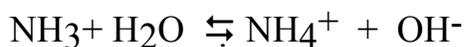
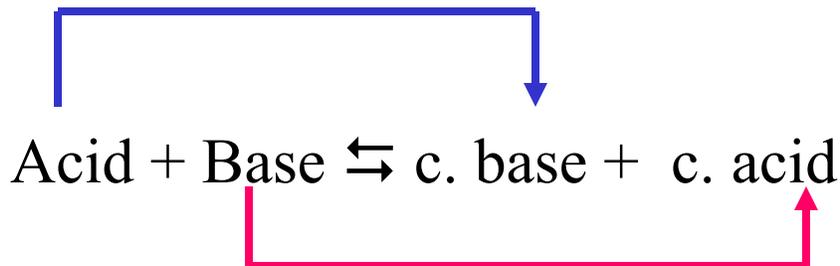
- Acid: A proton donor.
- Base: A proton acceptor.
- An acid base reaction is one where there is a proton transfer.
- A broader definition than the Arrhenius definition.
- conjugate base: The acid without an H^+ .
- conjugate acid: The base with an H^+ .

Table 8.2

TABLE 8.2 Some Acids and Their Conjugate Bases, in Decreasing Order of Acid Strength

	Acid		Conjugate Base		
Strong Acids 	HI	Hydroiodic acid	I^-	Iodide ion	
	H_2SO_4	Sulfuric acid	HSO_4^-	Hydrogen sulfate ion	
	HCl	Hydrochloric acid	Cl	Chloride ion	
	HNO_3	Nitric acid	NO_3^-	Nitrate ion	
	H_3O^+	Hydronium ion	H_2O	Water	
	HSO_4^-	Hydrogen sulfate ion	SO_4^{2-}	Sulfate ion	
	H_3PO_4	Phosphoric acid	H_2PO_4^-	Dihydrogen phosphate ion	
	CH_3COOH	Acetic acid	CH_3COO^-	Acetate ion	
	H_2CO_3	Carbonic acid	HCO_3^-	Bicarbonate ion	
	H_2S	Hydrogen sulfide	HS	Hydrogen sulfide ion	
	H_2PO_4^-	Dihydrogen phosphate ion	HPO_4^{2-}	Hydrogen phosphate ion	
	NH_4^+	Ammonium ion	NH_3	Ammonia	
	$\text{C}_6\text{H}_5\text{OH}$	Phenol	$\text{C}_6\text{H}_5\text{O}^-$	Phenoxide ion	
	HCO_3^-	Bicarbonate ion	CO_3^{2-}	Carbonate ion	
	HPO_4^{2-}	Hydrogen phosphate ion	PO_4^{3-}	Phosphate ion	
	H_2O	Water	OH^-	Hydroxide ion	
	$\text{C}_2\text{H}_5\text{OH}$	Ethanol	$\text{C}_2\text{H}_5\text{O}^-$	Ethoxide ion	
	NH_3	Ammonia	NH_2^-	Amide ion	
	Weak Acids 				Weak Bases
					Strong Bases

A standard acid/base reaction

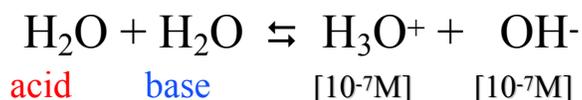


More on Acid Base reactions

- Water is amphoteric or amphiprotic, it can act as both an acid and a base.
- All acid base reactions are equilibrium reactions
- The equilibrium lies to the side of the weaker acid.
- When the equilibrium lies to the right, a lot of reaction occurs and there is often heat released or there is a color change....
- When the equilibrium lies to the left very little reaction occurs. (no heat...)

Water

- Water auto-ionizes



$$K = \frac{[\text{H}_3\text{O}^+][\text{OH}^-]}{[\text{H}_2\text{O}]^2} = [\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$$

Acids and pH

	0.1 M HCl	pure water	0.1 M NaOH
[H ⁺] or [H ₃ O ⁺]			
[OH ⁻]			
pH			
pOH			
acid or basic			

The big six

1. $[H^+] [OH^-] = 10^{-14}$

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

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

4. $[H^+] = 10^{-pH}$

5. $[OH^-] = 10^{-pOH}$

6. $pH + pOH = 14$

The [H⁺] of 0.1 M NH₃

- The pH is 11.13. What is the [H⁺] ?
- $pH = -\log [H^+]$
- $[H^+] = 10^{-pH}$
- $[H^+] = 10^{-11.13}$

Filling out a table

	[H ⁺]	[OH ⁻]	pH	pOH
0.08 M HCl				
0.08 M Acetic Acid				

Buffer solution

A buffer solution keeps the pH approximately the same even upon the addition of a strong acid or strong base.

- Need a weak acid.
- Its conjugate base.
- Present in a large enough quantity to resist the pH changes.

CH₃CO₂H/CH₃CO₂⁻

- If you add an acid, H⁺, The base of the buffer reacts.
 - $\text{H}^+ + \text{CH}_3\text{CO}_2^- \rightarrow \text{CH}_3\text{CO}_2\text{H}$
 - $\text{H}_3\text{O}^+ + \text{CH}_3\text{CO}_2^- \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CO}_2\text{H}$
- Of you add a base, OH⁻, the acid of the buffer system reacts.
 - $\text{CH}_3\text{CO}_2\text{H} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CO}_2^-$