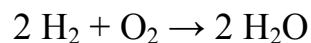


Acid and Base Equilibrium And pH

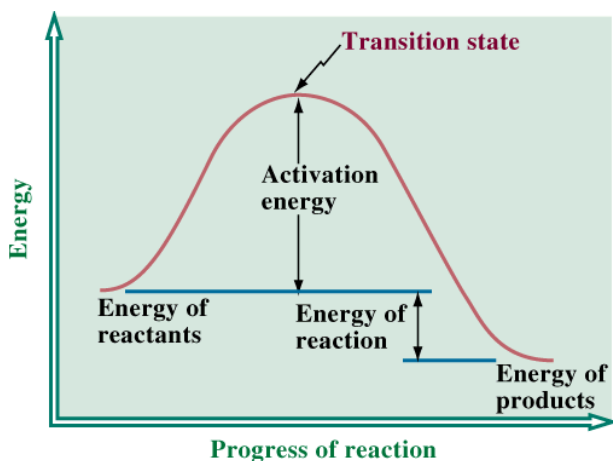
Three things are required for a reaction to occur:

- Molecules must collide.
- They must collide with enough energy to break old bonds so new ones can form.
- They must collide in the correct orientation.

Example



Energy Diagram for exothermic reaction

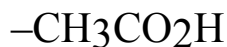


Arrhenius

- Acid: A substance that make H^+ (H_3O^+) when dissolved in water.
- Base: A substance that makes OH^- when dissolved in water.
- An acid/base reaction occurs when and 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.



Base

• Strong base: dissociates completely when dissolved in water.



• Weak base: Makes only a little bit of OH^-
 -NH_3

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^+ .

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

Acid		Conjugate Base	
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
HF	Hydrofluoric acid	F^-	Fluoride Ion
$\text{CH}_3\text{CO}_2\text{H}$	Acetic acid	CH_3CO_2^-	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
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

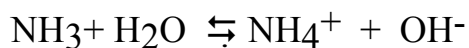
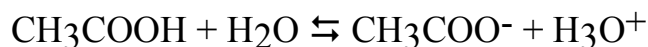
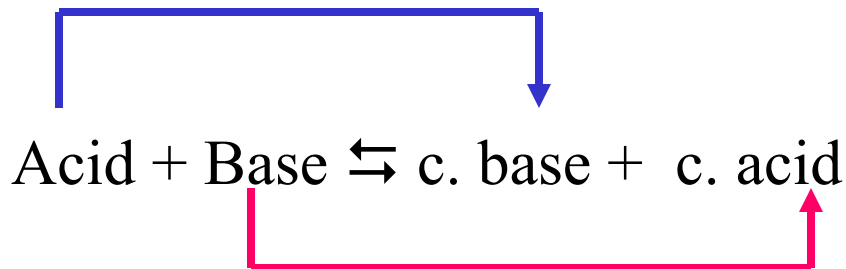
Strong Acids ↑

Weak Acids ↓

Weak Bases ↓

Strong Bases ↓

A standard acid/base reaction

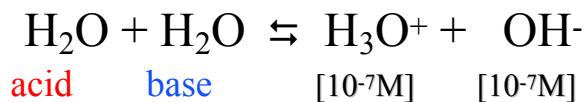


More on Acid Base reactions

- 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. $[\text{H}_3\text{O}^+][\text{OH}^-] = 1 \times 10^{-14}$
2. $\text{pH} = -\log[\text{H}_3\text{O}^+]$
3. $\text{pOH} = -\log[\text{OH}^-]$
4. $[\text{H}_3\text{O}^+] = 10^{-\text{pH}}$
5. $[\text{OH}^-] = 10^{-\text{pOH}}$
6. $\text{pH} + \text{pOH} = 14$

The [H⁺] of 0.1 M NH₃

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

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.
 - $\text{CH}_3\text{CO}_2\text{H} + \text{OH}^- \rightarrow \text{H}_2\text{O} + \text{CH}_3\text{CO}_2^-$