Acid and Base Equilibrium
And pH

Three things are required for a reaction to occur:

•Molecules must collide.

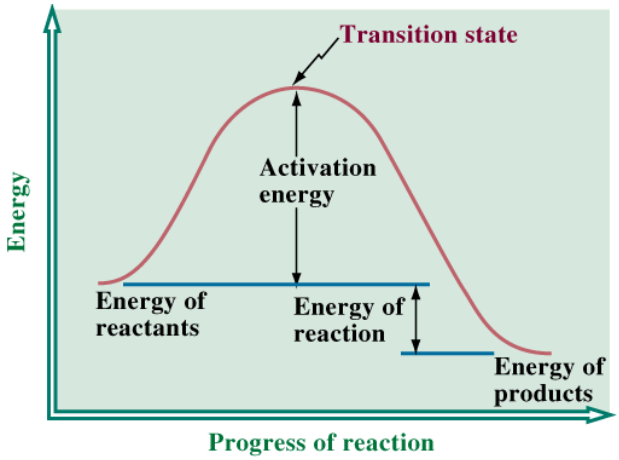
•They must collide with enough energy to break old bonds so new ones can form.

•They must collide in the correct orientation.

Example

$$2\ H_2 + O_2 \rightarrow 2\ H_2O$$

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.

–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

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

Strong Acids ↑

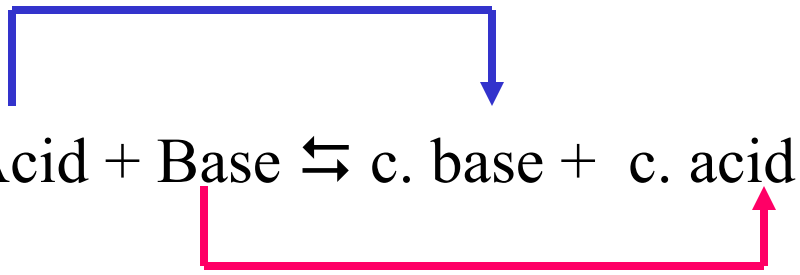
Acid		Conjugate Base	
HI	Hydroiodic acid	I^-	Iodide ion
H_2SO_4	Sulfuric acid	HSO_4^-	Hydrogen sulfate ion
HC1	Hydrochloric acid	Cl^-	Chloride ion
HNO_3	Nitric acid	NO_3^-	Nitrate ion
H_3O^+	Hydronium ion	H_2O	Water
HSO_4^-	Hydrogen sulfate ion	SO_4^{2-}	Sulfate ion
H_3PO_4	Phosphoric acid	$H_2PO_4^-$	Dihydrogen phosphate ion
HF	Hydrofluoric acid	F^-	Fluoride Ion
CH_3CO_2H	Acetic acid	$CH_3CO_2^-$	Acetate ion
H_2CO_3	Carbonic acid	$HC0_3^-$	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
C_2H_5OH	Ethanol	$C_2H_5O^-$	Ethoxide ion

Weak Acids

Weak Bases ↓

Strong Bases

A standard acid/base reaction



$CH_3COOH + H_2O \leftrightarrows CH_3COO^- + H_3O^+$

$NH_3 + H_2O \leftrightarrows NH_4^+ + OH^-$

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

$$H_2O + H_2O \leftrightarrows H_3O^+ + OH^-$$

acid base $[10^{-7}M]$ $[10^{-7}M]$

$$K = \frac{[H_3O^+][OH^-]}{[H_2O]^2} = [H_3O^+][OH^-] = 1\times10^{-14}$$

Acids and pH

	0.1 M HCl	pure water	0.1 M NaOH
$[H^+]$ or $[H_3O^+]$			
$[OH^-]$			
pH			
pOH			
acid or basic			

The Big Six

1. $[H_3O^+]\ [OH^-] = 1 \times 10^{-14}$
2. $pH = -\log[H_3O^+]$
3. $pOH = -\log[OH^-]$
4. $[H_3O^+] = 10^{-pH}$
5. $[OH^-] = 10^{-pOH}$
6. $pH + pOH = 14$

The [H+] of 0.1 M NH_3

- 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.

$CH_3CO_2H/CH_3CO_2^-$

- If you add an acid, H+, The base of the buffer reacts.
  - $H^+ + CH_3CO_2^- \rightarrow CH_3CO_2H$
  - $H_3O^+ + CH_3CO_2^- \rightarrow H_2O + CH_3CO_2H$
- Of you add a base, OH-, the acid of the buffer system reacts.
  - $CH_3CO_2H + OH^- \rightarrow H_2O + CH_3CO_2^-$