Properties of Acids

Binary Acid – an acid that is composed of hydrogen and a more electronegative element.

Example: HCl, HBr, H_2S

Oxyacid – an acid composed of hydrogen and a polyatomic ion containing oxygen.

Example: HNO_3, H_2SO_4, H_2CO_3

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Ionization Reactions

Ionization

When an acid dissolves, covalent bonds are broken and ions are formed.

- Strong acids almost completely ionize
- Weak acids typically ionize less than 5%.

$$HCl(g) \xrightarrow{H_2O} H^+(aq) + Cl^-(aq)$$

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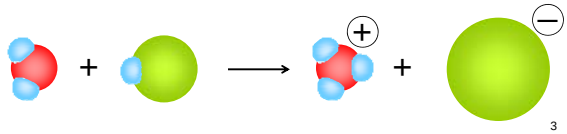
Acids - Formation of the Hydronium Ion

Hydronium – H_3O^+

The H^+ ion is too reactive to exist by itself. It immediately attaches to a water molecule to form the hydronium ion.

The hydronium ion is H_3O^+

$$H_2O(l) + HCl(g) \longrightarrow H_3O^+(aq) + Cl^-(aq)$$



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Properties of Acids

Acids typically…

- Have a sour taste
- Change the color of acid-base indicators
- Can react with active metals to release hydrogen gas
- React with bases to produce water and a salt
- Are electrolytes

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Strong Acids

Strong acids will ionize completely

Six Strong Acids

• Perchloric Acid	$HCLO_4$
• Hydroiodic Acid	HI
• Hydrobromic Acid	HBr
• Hydrochloric Acid	HCl
• Sulfuric Acid	H_2SO_4
• Nitric Acid	HNO_3

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Weak Acids

- Weak acids will ionize partially
- They are weak electrolytes
- Reactions are seen as reversible

$$H_2O(l) + HC_2H_3O_2(g) \rightleftharpoons H_3O^+(aq) + C_2H_3O_2^-(aq)$$

Majority of reaction

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Bases – Formation of the Hydroxide Ion

Hydroxide – OH^-

- Bases will form the OH^- ion in water.
- Most bases are metal hydroxides
- Some molecules ionize to form bases
- Basic solutions are sometimes called alkaline solutions

$$NaOH(g) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$$

$$H_2O(l) + NH_3(g) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

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Properties of Bases

Bases typically…

- Have a bitter taste
- Change the color of acid-base indicators
- Feel slippery (When dilute solutions)
- React with acids to produce water and a salt
- Are electrolytes

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Strong Bases

Strong bases will dissociate completely.

Six Strong Bases

• Lithium Hydroxide	LiOH
• Sodium Hydroxide	NaOH
• Potassium Hydroxide	KOH
• Calcium Hydroxide	$Ca(OH)_2$
• Strontium Hydroxide	$Sr(OH)_2$
• Barium Hydroxide	$Ba(OH)_2$

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Weak Bases

- Poorly soluble weak bases will produce little OH^-
- Soluble weak bases will react partially
- They are weak electrolytes

$$Cu^{2+}(aq) + 2\ OH^-(aq) \xrightarrow{H_2O} \underbrace{Cu(OH)_2(s)}_{\text{Low solubility}}$$

$$\underbrace{H_2O(l) + NH_3(g)}_{\text{Majority of reaction}} \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

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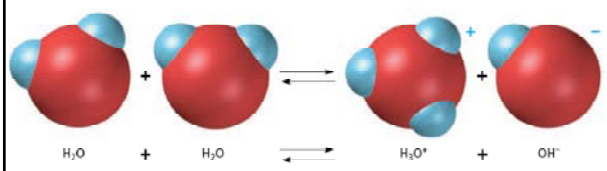
Concentration of Acids and Bases

Acids and bases differ on their relative amounts of H_3O^+ and OH^- present.



Pure water is neutral because of the relative amounts of H_3O^+ and OH^- are equal.

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Concentration of Acids and Bases

Acids and bases can be measured by the concentration of H_3O^+ or H^+ that is present.

The molarity of H_3O^+ is written as: $[H_3O^+]$
The brackets, [ ], are short for "concentration".

The numbers used in concentration tend to be very tiny and need scientific notation.

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Concentration of Acids and Bases

In order to work with more ordinary numbers, the pH scale was made.

pH is logarithmic, meaning each number increase is ten times stronger.

Ex. An acid with a pH of 2.0 is ten times stronger than an acid with a pH of 3.0.

$$pH = - Log [H_3O^+]$$

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Common pH Values

Item	pH Value
Hydrochloric acid	0.1
Sulfuric acid	0.3
Stomach Acid	1 – 3
Lime	1.8 – 2
Soft drinks	2.0 – 4.0
Lemons	2.2 – 2.4
Vinegar	2.4 – 3.4
Apple juice	2.9 – 3.3
Grapefruit juice	3 – 3.3
Orange juice	3 – 4
Cherries	3.2–4.0
Grapes	3.5 – 4.5
Tomatoes	4.0–4.4
Sour milk	4.3 – 4.5
Bananas	4.5–5.7
White bread	5 – 6
Acid rain	5.2

Item	pH Value
Rainwater	5.2–5.8
Potatoes	5.6–6.0
Normal rain	5.7
Milk	6.3–6.6
Saliva	6.5–7.5
Drinking water	6.5 – 8
Distilled water	7
Pure water	7.0
Blood	7.3–7.5
Sea water	7.4 – 8.5
Eggs	7.6–8.0
Baking soda	8
Borax	9.2
Milk of magnesia	10.5
Ammonia water	11.6
Limewater	12.4
Soda lye	14

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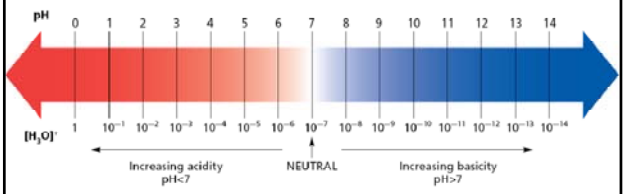
The pH Scale

pH is calculated using the following equation:

$$pH = - Log [H_3O^+]$$



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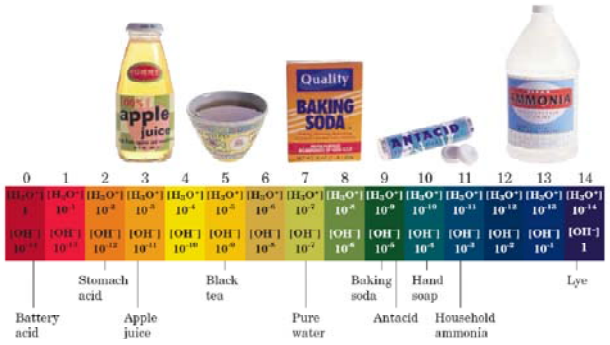
pH of Common Things



Neutralization Reactions

Neutralization

The H and OH parts combine to form water (H-OH). The cation and anion parts form a salt.

$$NaOH_{(g)} + HCl_{(g)} \longrightarrow H_2O_{(l)} + NaCl_{(aq)}$$

$$Ca(OH)_{2(g)} + H_2SO_{4(g)} \longrightarrow H_2O_{(l)} + CaSO_{4(aq)}$$

$$KOH_{(g)} + HNO_{3(g)} \longrightarrow H_2O_{(l)} + KNO_{3aq)}$$

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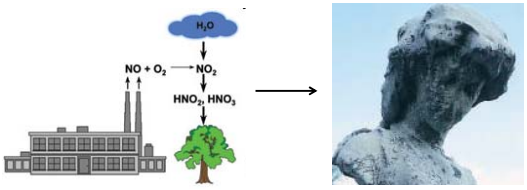
Neutralization Reactions

Acid Rain

Acid rain has traces of different acids. Marble statues, which are mostly calcium carbonate, neutralize the acids but wear away in the process.

$$CaCO_{3(g)} + H_2SO_{4(g)} \longrightarrow H_2O_{(l)} + CaSO_4(aq) + CO_2(g)$$



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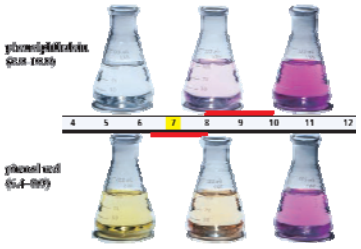
Acid / Base Indicator

Indicator

An indicator will change certain colors depending on the pH of a solution. A variety of indicators are used depending on the strength of acids or bases.



Acid Neutral Base

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Titration to Determine Concentration

Equivalence Point

Acids and bases are titrated to compare what volumes will provide a complete neutralization from equal parts of acid and base.

Titration

A solution of a known concentration is used to neutralize another solution of unknown concentration. At the equivalence point, the following equation can be used:

$$M_A V_A \left[\frac{\text{mol B}}{\text{mol A}}\right] = M_B V_B$$

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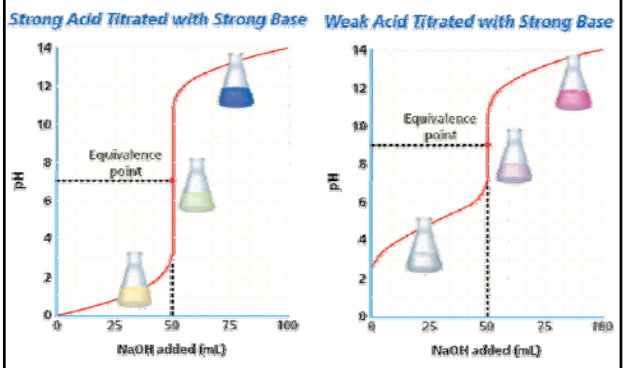
Titration



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