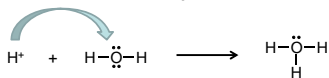


Acids and Bases

Acids

Acid – an acid is a substance that donates a proton (H^+) to form a hydronium ion (H_3O^+)



Acids usually start with an "H"

Example: HCl, HBr, H_2S , HNO_3 , H_2SO_4 , H_2CO_3

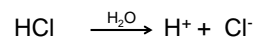
1

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%.



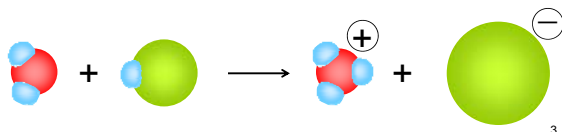
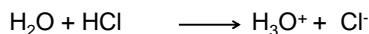
2

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^+



3

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

4

Strong Acids

Strong acids will ionize completely

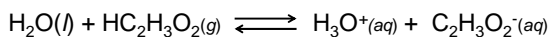
Six Strong Acids

- | | |
|---------------------|-----------|
| • 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



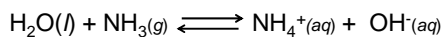
Majority of reaction

6

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



7

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

8

Strong Bases

Strong bases will dissociate completely.

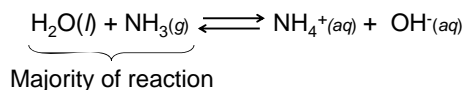
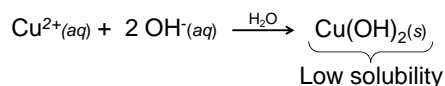
Six Strong Bases

- | | |
|-----------------------|---------------------|
| • 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

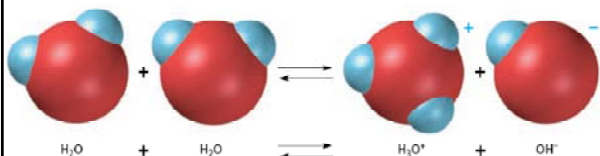
- Poorly soluble weak bases will produce little OH⁻
- Soluble weak bases will react partially
- They are weak electrolytes



10

Concentration of Acids and Bases

Acids and bases differ on their relative amounts of H₃O⁺ and OH⁻ present.



Pure water is neutral because the relative amounts of H₃O⁺ and OH⁻ are equal.

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Concentration of Acids and Bases

Acids and bases can be measured by the concentration of H₃O⁺ or H⁺ that is present.

The molarity of H₃O⁺ is written as: [H₃O⁺]
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.

$$\text{pH} = -\text{Log} [\text{H}_3\text{O}^+]$$

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Common pH Values

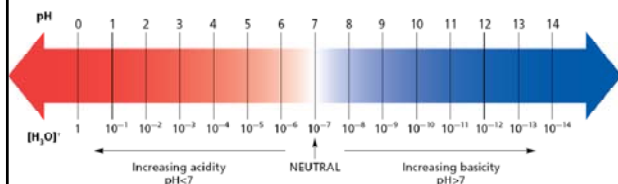
Item	pH Value	Item	pH Value
Hydrochloric acid	0.1	Rainwater	5.2–5.8
Sulfuric acid	0.3	Potatoes	5.6–6.0
Stomach Acid	1–3	Normal rain	5.7
Lime	1.8–2	Milk	6.3–6.6
Soft drinks	2.0–4.0	Saliva	6.5–7.5
Lemons	2.2–2.4	Drinking water	6.5–8
Vinegar	2.4–3.4	Distilled water	7
Apple juice	2.9–3.3	Pure water	7.0
Grapefruit juice	3–3.3	Blood	7.3–7.5
Orange juice	3–4	Sea water	7.4–8.5
Cherries	3.2–4.0	Eggs	7.6–8.0
Grapes	3.5–4.5	Baking soda	8
Tomatoes	4.0–4.4	Borax	9.2
Sour milk	4.3–4.5	Milk of magnesia	10.5
Bananas	4.5–5.7	Ammonia water	11.6
White bread	5–6	Limewater	12.4
Acid rain	5.2	Soda lye	14

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The pH Scale

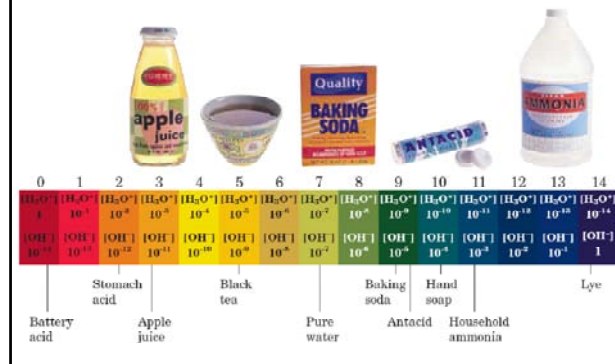
pH is calculated using the following equation:

$$\text{pH} = -\text{Log} [\text{H}_3\text{O}^+]$$



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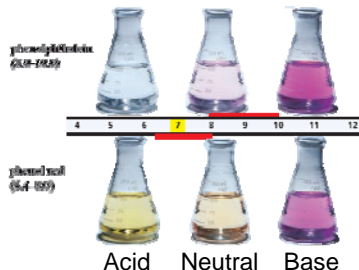
pH of Common Things



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.



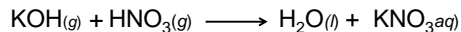
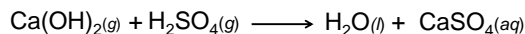
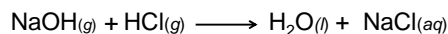
Acid Neutral Base

17

Neutralization Reactions

Neutralization

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



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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.

