Auburn Mountainview

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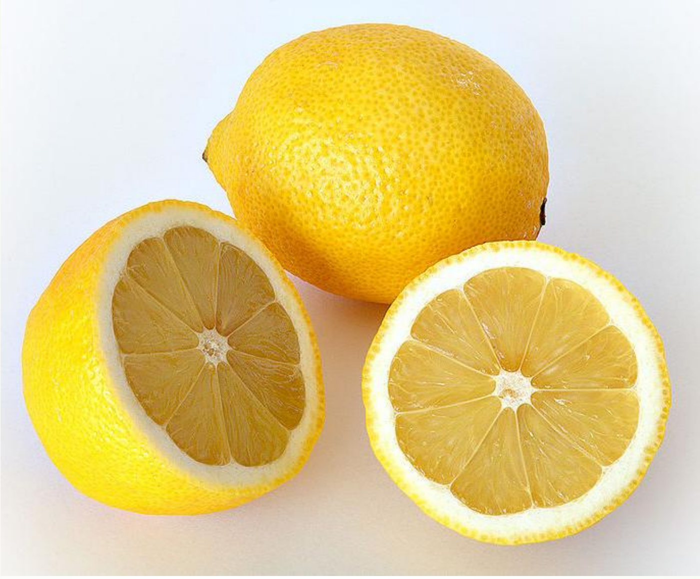


Acid-Base Chemistry

By end of this unit I can…

- A.1 Create and/or evaluate models of strong and weak acids and bases.
- A.2 Distinguish between strong and weak acids in terms of degree of dissociation in aqueous solution.
- A.3 Evaluate a claim about whether a compound is a strong or weak acid or base.
- B.1 Explain the relationship between the hydrogen ion concentration and the pH of a solution.
- B.2 Calculate the pH of a solution.
- C.1 Predict the products of a reaction between a strong acid and a strong base.

Basic Properties

	Acid	Base
Name	Latin for acidus; sour or tart.	Latin for basis; foundation (needed for salt formation).
Examples	Fruit (Citric), Yogurt (Lactic), Soda (Carbonic)	Soap, Bleach, Antacid Tablets
Touch	Watery on the skin, stinging in open wounds.	Smooth, soapy, soothing on the skin, eye's sting.
Taste	Sour, Tart, Sharp	Bitter
Phase	Liquid of Gas	Solids (NH_3 is a Gas)
Reactivity	With metals to form Hydrogen gas and Salt	With oils and greases
Conductive	Strong	Strong

Defining: Arrhenius

- In 1884 chemist Svante Arrhenius determined:
  - Acids dissociate in water to produce Hydrogen ions (increases H^+).
  - Bases dissociate in water to produce anions (increases OH^-).
  - Mixing together results in neutralization: Acid + Base → Salt + Water
- Problems with the Arrhenius Definition:
  - This only explains water reactions.
  - Certain bases do have an OH^- anion.
    - This is a simplification (does not explain NH_3).

Defining: Brønsted-Lowry

- In 1923 chemists Johannes Brønsted and Thomas Lowry determined:
  - An acid is any substance that can donate H+ ions.
  - A base is any substance that can accept H+ ions.
- This expands the last definition in two ways:
  - Definition is independent from water.
  - It focuses only on the H^+ ions (not the OH^- ions).

Defining: Strong versus Weak

- Discussed: Ions disassociate in water.

$$NaCl_{(aq)} \rightarrow Na^{+}_{(aq)} + Cl^{-}_{(aq)}$$

- Some Acids and Bases may not fully disassociate:
  - Bonds: The Ionic bond is too strong to break up in the solvent.
  - Unstable: The ionic charge or stability issues causes recombination of the Hydrogen Ions.
- This has nothing to do with reactivity or concentration.
  - Hydrofluoric Acid is weak yet one of the most toxic acids around.

Defining: Strong and Weak

- Strong acid/bases are compounds that completely disassociate in water.
  - 1-$\mathcal{M}$ HCl will cause nearly all of the H^+ ions to disassociate.

$$HCl_{(g)} + H_2O_{(l)} \rightarrow H_3O^+_{(aq)} + Cl^-_{(aq)}$$

  - 1-$\mathcal{M}$ $HC_2H_3O_2$ will only disassociate .4% of its ions.

$$CH_3COOH_{(l)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + CH_3COO^-_{(aq)}$$

H_3O^+ is called a Hydronium ion.

Common Acids and Bases

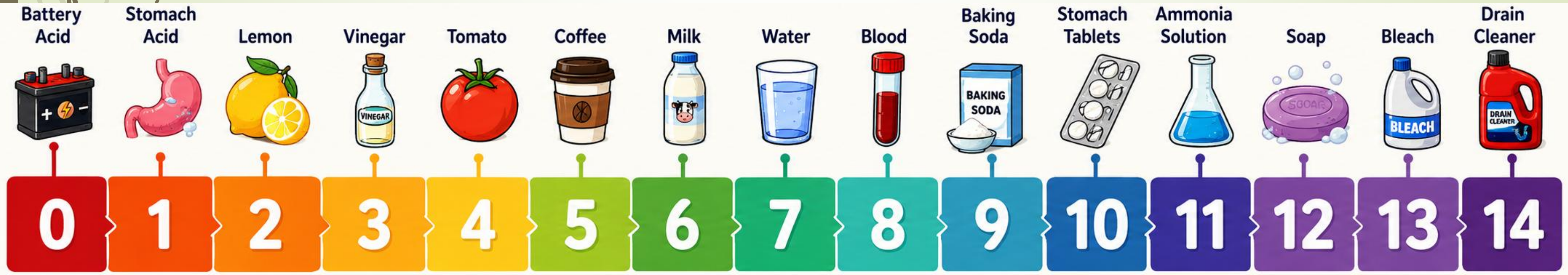
Acids			Bases (Hydroxides)		
Name	Formula	Strength	Name	Formula	Strength
HCl	Hydrochloric	Strong	$NaOH$	Sodium	Strong
HBr	Hydrobromic	Strong	$LiOH$	Lithium	Strong
HF	Hydrofluoric	Weak	KOH	Potassium	Strong
H_2CO_3	Carbonic	Strong	$Mg(OH)_2$	Magnesium	Weak
HNO_3	Nitric	Strong	$Ca(OH)_2$	Calcium	Strong
H_2SO_4	Sulfuric	Strong	NH_3	Ammonia	Weak
H_3PO_4	Phosphoric	Weak	CaO	Calcium Oxide	Strong
CH_3COOH	Acetic	Weak	$NaHCO_3$	Sodium Bicarbonate	Weak

Measuring

- Molarity is important to solutions including acid and bases.
  - Vinegar in salad dressing is normally 1-$\mathcal{M}$.
  - HCl as a 1-$\mathcal{M}$ solution will cause serious harm.
- For acids and bases though measuring the concentration of Hydronium ions in the solution is also very helpful.
  - This measurement is called the pH Scale.
  - It is logarithmic: a pH of 3 has 10x more H_3O^+ than a pH of 4.

pH (Power of H^+) Scale

- High amount of H^+: Acidic
- Equal amounts H^+ and OH^-: Neutral
- High amount of OH^-: Basic (Alkaline)
- To calculate: $pH = -\log[H_3O^+]$ $10^{-pH} = [H_3O^+]$



pH Example

- Before the industrial revolution (~1760) the ocean surface had 6.3 x 10^{-9}-$\mathcal{M}$ H_3O^+ what was the pH of the ocean?

$$pH = -\log[H_3O^+]$$

$$pH = -\log[6.3x10^{-9}]$$

$$\boxed{pH = 8.2\ (\text{Slightly Alkaline})}$$

pH=

H_3O^+ = 6.3 x 10^{-9}

- Today the oceans pH is 8.1, how many H_3O^+ is this?

$$10^{-pH} = [H_3O^+]$$

$$10^{-8.2} = [H_3O^+]$$

$$\boxed{[H^+] = 7.9x10^{-9}}$$

$$\frac{7.9x10^{-9}}{6.3x10^{-9}} = 1.25$$

pH= 8.2

H_3O^+ =

That is a 25% increase in acidity!!!

Indicators

- Qualitative methods to determine acids/bases exist:
- Common Indicators:
  - Litmus Paper: Made from lichen dyes. Universal, Red & Blue.
  - Phenolphthalein: $C_{20}H_{14}O_4$. Colorless in acid, pink in base.
  - Cabbage Juice: Purple juice turns red in acid, green in base.
- Universal Indicator: Several compounds. Paper & Solution.
  - Wider range of colors to better differentiate pH.

Titration

- A way to quantitatively figure out the concentration of a solution using volume.
- As acids and bases neutralize, knowing the Molarity and volume of one solution allows the other to be solved (normally volume needed to neutralize is found).

$$\mathcal{M}_a V_a = \mathcal{M}_b V_b$$

- Phenolphthalein often used.