**Acids & Bases**

* Acids Sour taste Examples:
  + HCl (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_), H2SO4
  + HC2H3O2 (acetic acid) – (vinegar = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
  + Citric acid (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_)
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Releases H+ when dissolved in water,   
  producing \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_!   
   H+ + H2O 🡪 H3O+
* Hydronium ions are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* React with metals to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + Ex. HCl + Zn 🡪 ZnCl2 + H2
* When diluting acids, always slowly pour the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ while stirring.
* Acid/Base Indicators:
  + Turns litmus paper **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
  + Phenolphthalein does not \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Bases **Bitter taste**, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Examples: NaOH, Mg(OH)2 (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_),   
  NH3 (\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_), soap, household cleaners
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (hydroxide ions) when dissolved in water.
* Electrolyte.
* Acid/Base Indicators:
  + Turns litmus paper **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
  + Phenolphthalein \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Neutralization Reaction
* ACID + BASE 🡪 SALT + WATER
  + Salt: ionic compound formed from the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Example:

  2HCl + Mg(OH)2 🡪MgCl2 + 2H2O

* *What type of reaction is this?* Synthesis, Decomposition, Single Replacement, Double Replacement, or Combustion?
* **Complete and Balance the Neutralization Reactions**

1. HCl + NaOH 🡪
2. HC2H3O2 + Ca(OH)2 🡪
3. HBr + Al(OH)3 🡪

* **Naming Acids**
* Acids are a group of ionic compounds with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* An **acid** is a compound that contains one or more \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Chemical formula of an acid: HnX
  + X = monatomic anion ***or*** polyatomic anion
  + n = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How to name an acid…
* Depends on the name of the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

1. When the name of the anion (X) ends in ***–ide***

A. The acid name begins with the prefix ***hydro-***

B. The stem of the anion has a suffix ***–ic*** followed by the word ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

**Example:**HCl – (X = chloride) hydrochloric acid

2. When the name of the anion (X) ends in ***–ite***

A. The stem of the anion has a suffix ***–ous***, followed by the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Example:**  H2SO3 – (X = sulfite) sulfurous acid

3. When the name of the anion (X) ends in ***–ate***

A. The stem of the anion has a suffix ***–ic***, followed by the word ***\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

**Example:**  H3PO4 – (X = phosphate) phosphoric acid

* **Naming Common Acids** **Practice:**
* H2S
* HNO2
* H2CO3
* HC2H3O2
* HF
* H2O

1. Complete the neutralization reactions.
   1. HNO3 + Ca(OH)2 🡪
   2. HCN + NaOH 🡪
   3. H3PO4 + Ni(OH)2 🡪
2. Name the following acids.
   1. HI
   2. H2SO3
   3. HClO4

* **Naming Bases**
* A **base** is an ionic compound that produces \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Bases are named in the same way as other ionic compounds
  + The name of the cation, followed by the name of the anion
    - Anion will always be **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
    - Exception: **NH3 - ammonia**
* **Practice:** LiOH
* Al(OH)3
* Fe(OH)3
* Mg(OH)2
* Pb(OH)2
* HO

**Definitions of Acids & Bases**

**1) Arrhenius Theory** Acids: ionize to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Monoprotic: HNO3, HCl, HC2H3O2 Diprotic: H2SO4, H2SO3

Triprotic: H3PO4

* HNO3 🡪 NO3- + H+ H2SO4 🡪 SO42- + 2H+
* Bases: dissociate to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
  + NaOH, KOH, Ca(OH)2, Al(OH)3
* NaOH 🡪 Na+ + OH- Ca(OH)2 🡪 Ca2+ + 2OH-

**2) Brønsted-Lowry Theory** Hydrogen ion (H+) = a proton

* Acids: proton donors – ex. \_\_\_\_\_\_\_\_\_\_\_ Bases: proton acceptors – ex. \_\_\_\_\_\_\_\_\_\_\_\_\_
* **Conjugate Acids and Bases**
* ***A conjugate acid is the product that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***
* ***A Conjugate base is the product that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_***

***Label: Acid, Base, Conjugate Base, Conjugate Acid***

* NH3 (aq) + H2O (l) NH4+ (aq) + OH- (aq)
* HCl (g) + H2O (l) H3O+ (aq) + Cl- (aq)

***Show the direction of H+ transfer.*** ***Label: Acid, Base, Conjugate Base, Conjugate Acid***

* H2SO4 + OH- HSO41- + H2O
* HSO41- + H2O SO42- + H3O+

For the following equations, label the acid, base, conjugate acid, and conjugate base.

\*Remember you are following the PROTON transfer.

HNO2 + H2O 🡪 NO2- + H3O+

HCl + NH3 🡪 NH4+ + Cl-

**3) Lewis Theory** Acids\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ acceptor Bases: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ donor

  HCl (g) + H2O (l) H3O+ (aq) + Cl- (aq)

In the equation above, which compound is accepting the electron pair and which is donating?

**pH Scale**

* **pH Scale:** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in which [H+] is expressed as a number from 0 to 14.

Acidic Neutral Basic

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

**pH – Examples (no calculator)**

1. What is the pH if [HCl] = 1 x 10-4 M?
2. What is the [H+] if the pH = 9?
3. What is the pH if [NaOH] = 1 x 10-2 M
4. What is the concentration of [OH-] if the pOH is 3?
5. What is the concentration of [H+] if the pOH is 10?
6. What is the pH of the solution?
   1. [H3O+] = 1 x 10-4 M
   2. [H+] = 1 x 10-10 M
   3. [HCl] = 1 x 10-2 M
7. What is the concentration of H3O+ if the pH is 5?
8. What is the concentration of H+ if the pH is 11?
9. What is the pOH of each solution?
   1. [OH-] = 1 x 10-4 M
   2. [NaOH] = 1 x 10-10 M
10. What is the pH of a solution if the pOH is 4?
11. What is the pH of each solution?
    1. [OH-] = 1 x 10-8 M
    2. [KOH] = 1 x 10-3 M
12. What is the [H3O+] in a solution if [OH-] = 1 x 10-3 M?
13. What is the [OH-] in a solution if [H3O+] = 1x 10-5 M?

* **pH equations** pH= - log [H+]
* pOH = - log [OH-] pH + pOH = 14 [H+] x [OH-] = 1 x 10-14

**Find the pH of the following solutions. Is the solution acidic or basic?**

1. 0.01 M HCl
2. 0.050 M Ca(OH)2
3. 2.6 x 10-12 M Mg(OH)2
4. 1 x 10-7 M HC2H3O2
5. Find the concentration of hydrogen ions if the pH is 3.
6. Find the concentration of hydroxide ions if the pH is 5.6.
7. Find the [H3O+] in a solution if [OH-] = 3 x 10-6 M

**Strong Acids and Bases**

* Strong Acids: completely \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_in water
  + *Ex. HCl, HBr, HI, HNO3, H2SO4, HClO3*
* Strong Bases: completely \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in water
  + *Ex. NaOH, LiOH, KOH, Ca(OH)2, Sr(OH)2, Ba(OH)2*
* Weak Acids and Bases
* Weak Acids: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in water
  + - * Ex: acetic acid (less than 0.5% of molecules ionize)
* Weak Bases: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ into ions in water
  + - * Ex: ammonia (only 0.5% of molecules dissociate)
* **Concentrated vs. Strong** **“Concentrated”** – refers to the amount \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in solution.
* **“Strong”** – refers to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_of molecules that ionize.
* *For example, if you put a lot of ammonia into a little water, you will create a highly concentrated solution. However, since only 0.5% of ammonia molecules ionize in water, this basic solution will not be very strong.*
* **Acid-Base Titration** Uses a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to determine the concentration of an acid or base.
* Standard Solution: the reactant that has a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Endpoint: the point at which the unknown has been \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* **Titration Examples** **Example #1)** .08 L of 0.100*M* NaOH is used to neutralize .02 L of HCl. What is the molarity of HCl? **NaOH + HCl 🡪 NaCl + H2O**
* **Example #2)** A 0.1*M* Mg(OH)2 solution was used to titrate an HBr solution of unknown concentration. At the endpoint, 21.0 mL of Mg(OH)2 solution had neutralized 10.0 mL of HBr. What is the molarity of the HBr solution?

1. What is the molarity of an Al(OH)3 solution if 30.0 mL of the solution is neutralized by 26.4 mL of a 0.25 M HBr solution?
2. A 0.3 Ca(OH)2 solution was used to titrate an HCl solution of unknown concentration. At the endpoint, 35.0 mL of Ca(OH)2 solution had neutralized 10.0 mL of HCl. What is the molarity of the HCl solution?
3. When 34.2 mL of a 1.02 M NaOH solution is added from a buret to 25.00 mL of a phosphoric acid solution that contains phenolphthalein, the solution changes from colorless to pink.  What is the molarity of the phosphoric acid?