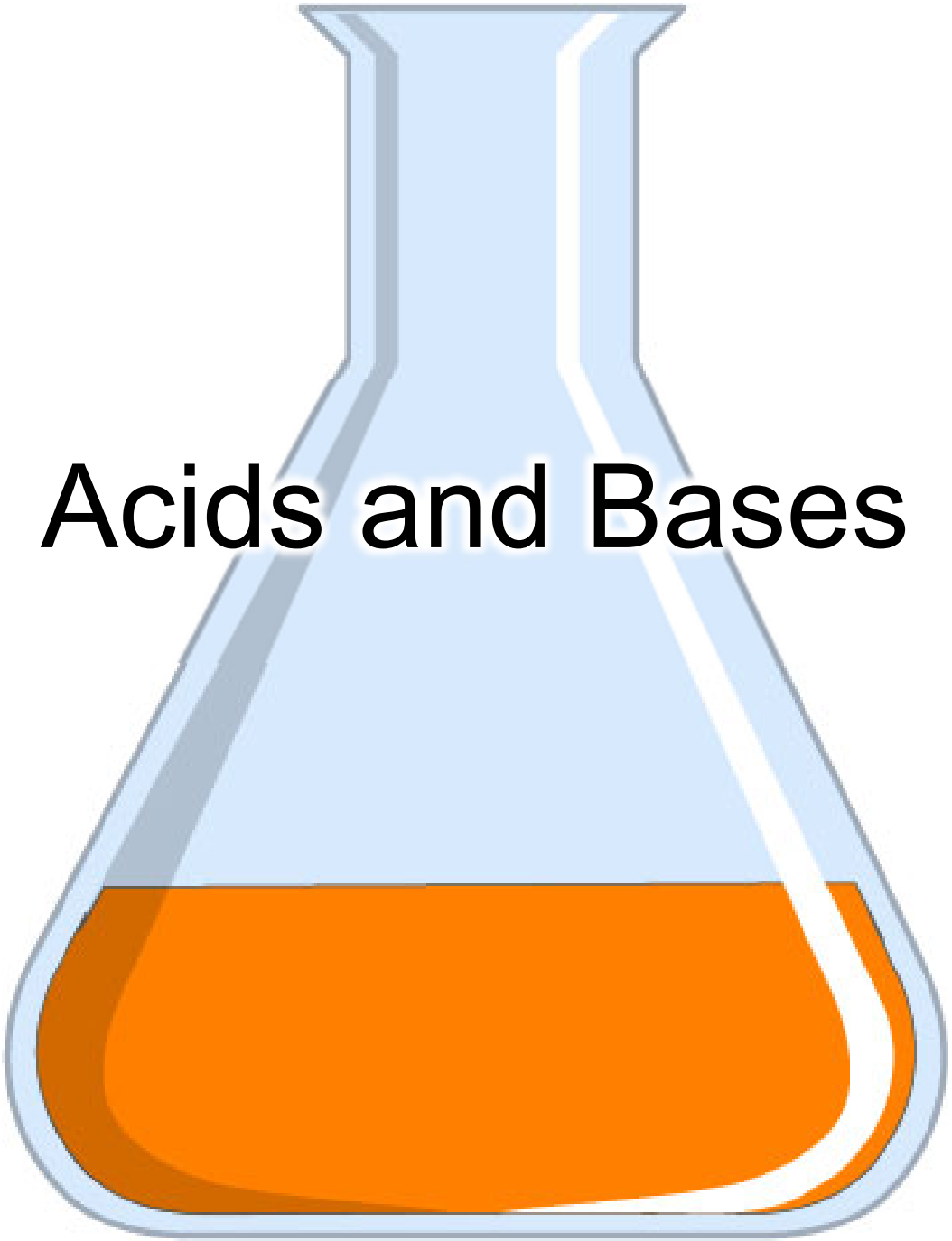
Acids and Bases



Clker-Free-Vector-Images (Pixabay)

Properties

Acids

- Taste sour
- React with metals to produce hydrogen gas

Bases

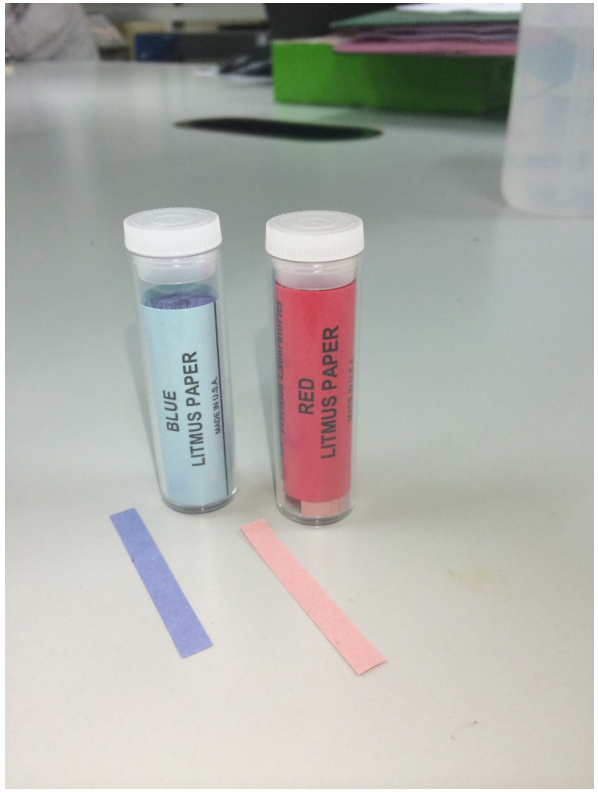
- Taster bitter
- Feel slippery

Indicators

- Indicators allow us to determine whether a substance is an acid or a base.

Image: Aris Suwanmalee (Adobe Stock)

- Litmus Paper
  - Red = Acid
  - Blue = Base

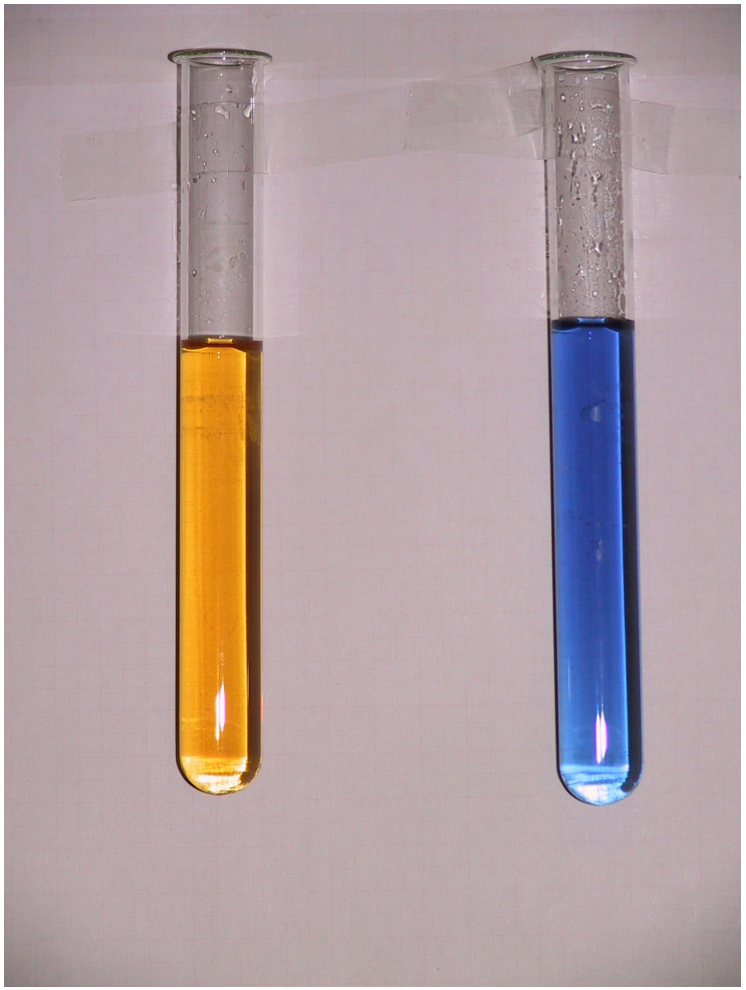


Blue and Red litmus papers – Kanesskong (CC BY-SA 4.0)

- Phenolphthalein
  - Clear = Acid
  - Pink = Base

Phenolphthalein at pH of 9 (public domain)

- Bromthymol Blue
  - Yellow = Acid
  - Blue = Base



Bromthymol blue – Xato (CC BY-SA 3.0)

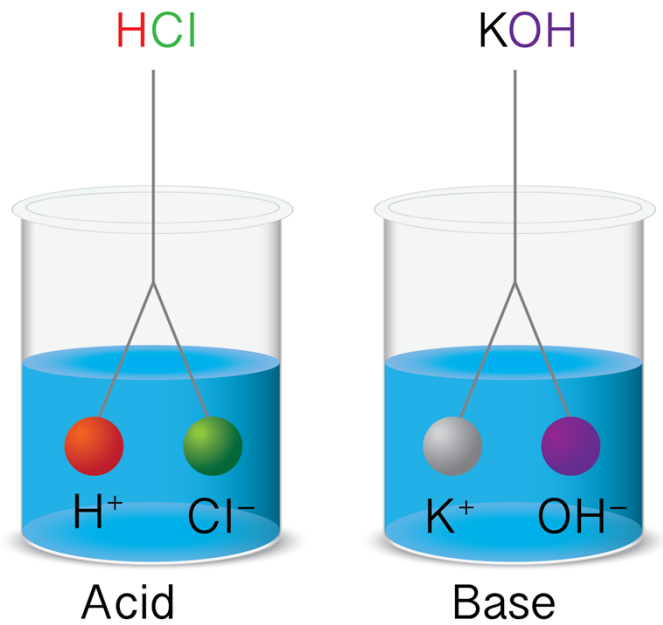
- Universal Indicator
  - Color depends on how acidic or basic a solution is.

Pack of litmus test paper and color samples – Coprid (Adobe Stock)

pH

- Water has an equal number of H^+ and OH^- ions.
  - Water is neutral.
- When an acid is dissolved in water it releases H^+ ions (increasing the overall number of H^+ ions).
- If the number of H^+ ions is greater than the number of OH^- ions, the solution is acidic.
- The more H^+ ions, the stronger the acid.

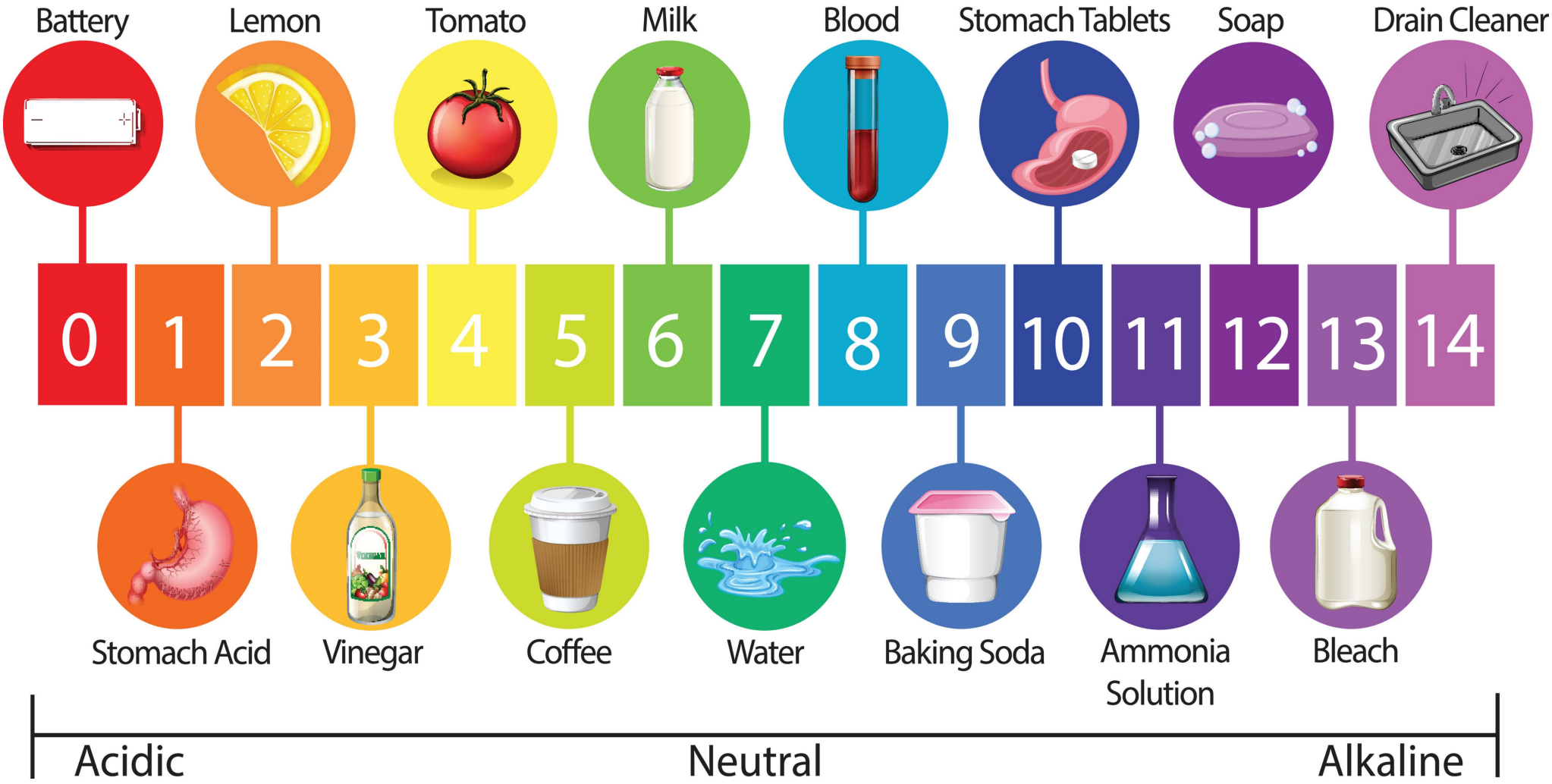
- When a base is dissolved in water, it releases OH^- ions (increasing the overall number of OH^- ions in the water).
- If the number of OH^- ions is greater than the number of H^+ ions, the solution is basic.
- The more OH^- ions, the stronger the base.



koray (Adobe Stock)

- The pH (power of hydrogen) of a solution is calculated from the number of H^+ ions in the solution.
  - It is, therefore, a value that represents how acidic or basic a solution is.
- The range of pH values (scale) is 0 to 14.
- Acids have a pH < 7.
- Bases have a pH > 7.
- A neutral substance (neither an acid nor base) has a pH of 7.

The pH Scale



Acids and Bases in Industry and in Daily Life

Car – Bruce Emmerling (Pixabay)
Pills – moritz320 (Pixabay)
Soap – Marc Pascual (Pixabay)
Tums – Brett Hondow (Pixabay)

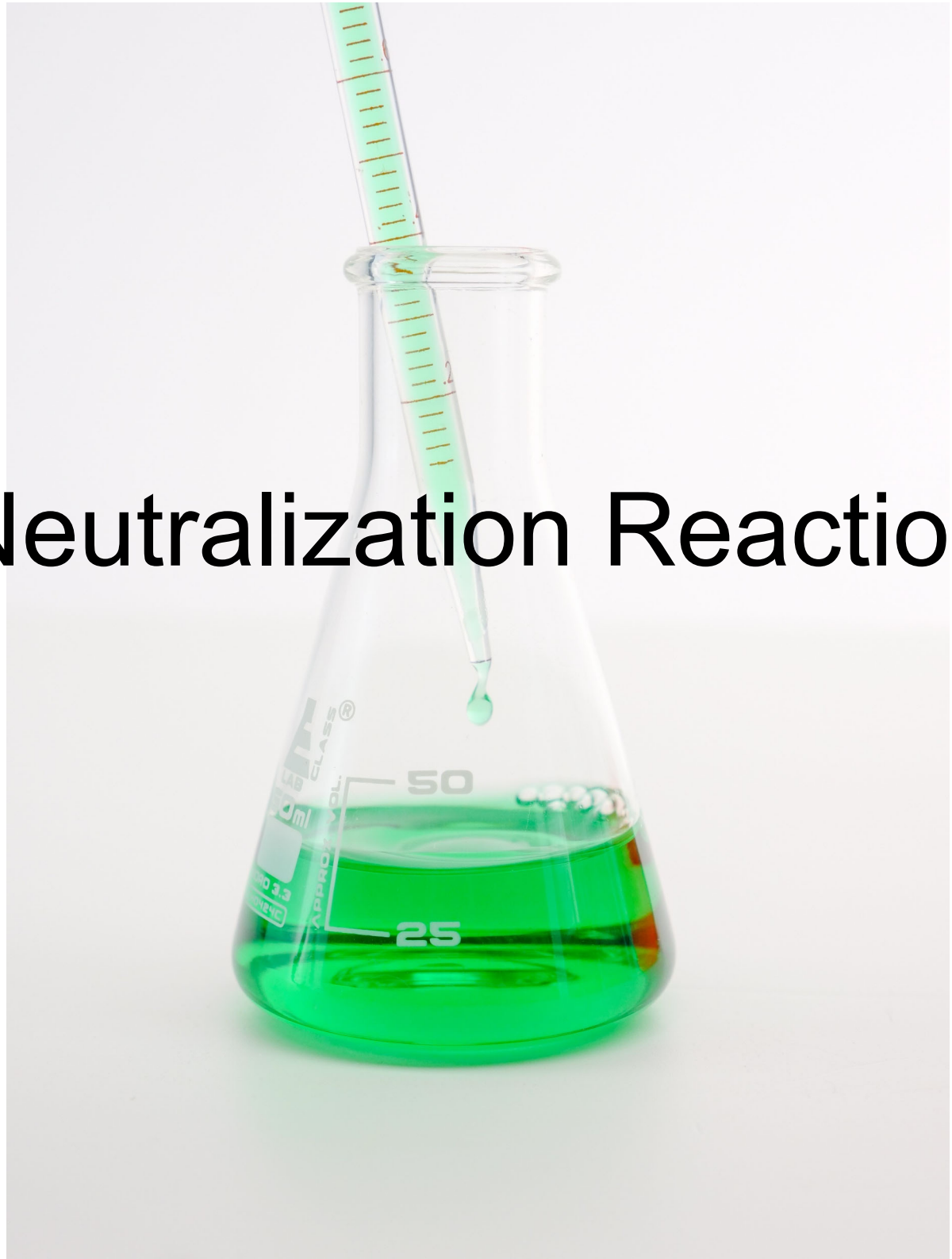
- hydrochloric acid, HCl
  - stomach acid; used in cleaning (refining) metals; maintenance of swimming pools; household cleaning
- sulfuric acid, H_2SO_4
  - car batteries; manufacture of fertilizers and many other commercial products
- nitric acid, HNO_3
  - manufacture of fertilizers, explosives; extraction of gold
- acetic acid, $HC_2H_3O_2$
  - vinegar

- carbonic acid, H_2CO_3
  - carbonated drinks
- citric acid, $C_6H_8O_7$
  - food; dietary supplements; creams, gels, liquids, and lotions.
- acetylsalicylic acid, $C_6H_4(OCOCH_3)CO_2H$
  - aspirin

- sodium hydroxide, NaOH
  - soaps and detergents; oven and drain cleaners
- potassium hydroxide, KOH
  - liquid soaps and soft soaps; alkaline batteries
- magnesium hydroxide, $Mg(OH)_2$
  - laxatives, antacids, and deodorants; used in the neutralization of acidic wastewater
- calcium hydroxide, $Ca(OH)_2$
  - antacids; manufacture of cement and lime water; added to neutralize acidic soil.

- aluminum hydroxide, $Al(OH)_3$
  - water purification; antacids
- ammonia, NH_3
  - Used as a building block for the synthesis of many pharmaceutical products; cleaning products; manufacture of fertilizers

Neutralization Reaction



Kindel Media (Pexels)

- The reaction between an acid and a base is a special kind of double displacement reaction called **neutralization**.
- An acid and base react together to form a salt and water.
  - A salt is an ionic solid consisting of a positive ion (other than hydrogen) and a negative ion (other than hydroxide).

Acid + Base → Salt + Water

Examples:

$HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

$2HCl(aq) + Ca(OH)_2(aq) \rightarrow CaCl_2(aq) + 2H_2O(\ell)$