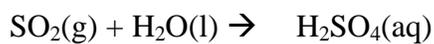


## Acid-Base Reactions

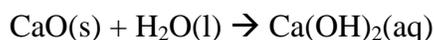
Acids and bases are the most important class of substances that occur in nature everywhere. Simple definitions of acid and base are:

- Acid is a substance that produces hydrogen ion ( $H^+$ ) or ions in solution
- Base is a substance that produces hydroxide ion ( $OH^-$ ) or ions in solution.

Some acids and bases occur naturally like hydrochloric acid in the stomach and ammonia gas (in aquatic organisms and some insects, nitrogenous waste (from the breakdown of amino acids) is excreted in the form of ammonia). Some acids and bases are also formed when oxides of nonmetals and oxides of metals react with water. For example, when sulfur dioxide (oxide of sulfur, a nonmetal) combines with water, it produces sulfuric acid (acid rain) according to the following equation.



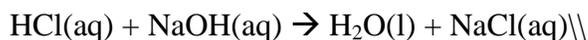
When oxide of metal like calcium oxide (also known as lime or quicklime) reacts with water, it forms a base calcium hydroxide.



When acid and base are mixed, they neutralize each other forming water as a soluble salt. This reaction is known **neutralization reaction**.



For example, when hydrochloric acid is neutralized by the sodium hydroxide, the following neutralization reaction takes place producing water and sodium chloride as a soluble salt.



This is the bases for designing the antacids. An **antacid** is any substance, generally a base, which counteracts stomach acidity. In other words, antacids are stomach acid neutralizers.

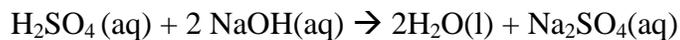
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Some examples of antacids (brand names may vary in different countries).

- **Amphojel**<sup>®</sup>, **AlternaGEL**<sup>®</sup> contain Aluminum hydroxide,  $Al(OH)_3$
- **Phillips'**<sup>®</sup> **Milk of Magnesia** contain Magnesium hydroxide,  $Mg(OH)_2$
- **Maalox**<sup>®</sup>, **Mylanta**<sup>®</sup> contain Aluminum hydroxide and Magnesium hydroxide
- **Basaljel**<sup>®</sup> contains Aluminum carbonate ( $Al_2(CO_3)_3$ ) gel
- **Alcalak**<sup>®</sup>, **Calcium Rich TUMS**<sup>®</sup>, **Quick-Eze**<sup>®</sup>, **Rennie**<sup>®</sup>, **Titralac**<sup>®</sup>, **Roloids**<sup>®</sup> contain Calcium carbonate,  $CaCO_3$
- **Alka-Seltzer**<sup>®</sup> contains Sodium bicarbonate,  $NaHCO_3$  (Bicarbonate of soda)
- **Talcid**<sup>®</sup> contains Hydrotalcite ( $Mg_6Al_2(CO_3)(OH)_{16} \cdot 4(H_2O)$ )

- **Pepto-Bismol** contains Bismuth subsalicylate
  - **Pepsil** contains Magaldrate + Simethicone
- 

Keep in mind that number of water molecules produced in the neutralization reaction depends on the acid. If the acid contains one hydrogen ion (monoprotic acid), like hydrochloric acid (HCl), it produces one molecule of water like the reaction between HCl and NaOH (see above). If the acid contains two hydrogen ions (diprotic acid), like H<sub>2</sub>SO<sub>4</sub>, it produces two molecules of water.



Similarly, if the acid contains three hydrogen ions (triprotic acid), like H<sub>3</sub>PO<sub>4</sub>, it produces three molecules of water.

