

### 1.11.1.1: Bases- Properties and Examples

#### Learning Objectives

- Examine properties of bases.

Perhaps you have eaten too much pizza and felt very uncomfortable hours later. This feeling is due to excess stomach acid being produced. The discomfort can be dealt with by taking an antacid. The base in the antacid will react with the HCl in the stomach and neutralize it, taking care of that unpleasant feeling.

#### Bases

Bases have properties that mostly contrast with those of acids.

- Aqueous solutions of bases are also electrolytes. Bases can be either strong or weak, just as acids can.
- Bases often have a bitter taste and are found in foods less frequently than acids. Many bases, like soaps, are slippery to the touch.
- Bases also change the color of indicators. Litmus turns blue in the presence of a base, while phenolphthalein turns pink.
- Bases do not react with metals in the way that acids do.
- Bases react with acids to produce a salt and water.



Figure 1.11.1.1.1: Phenolphthalein indicator in presence of base.

#### Warning!

Tasting chemicals and touching them are NOT good lab practices and should be avoided—in other words—don't do this at home.

Bases are less common as foods, but they are nonetheless present in many household products. Many cleaners contain ammonia, a base. Sodium hydroxide is found in drain cleaner. **Antacids**, which combat excess stomach acid, are comprised of bases such as magnesium hydroxide or sodium hydrogen carbonate. Various common bases and corresponding uses are given in Table 1.11.1.1.2

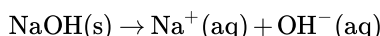
Table 1.11.1.1.1: Common Bases and Corresponding Uses

Some Common Bases	Uses
sodium hydroxide, NaOH (lye or caustic soda)	Used in the manufacture of soaps and detergents, and as the main ingredient in oven and drain cleaners.
potassium hydroxide, KOH (lye or caustic potash)	Used in the production of liquid soaps and soft soaps. Used in alkaline batteries.
magnesium hydroxide, Mg(OH) <sub>2</sub> (milk of magnesia)	Used as an ingredient in laxatives, antacids, and deodorants. Also used in the neutralization of acidic wastewater.
calcium hydroxide, Ca(OH) <sub>2</sub> (slaked lime)	Used in the manufacture of cement and lime water. Also, added to neutralize acidic soil.
aluminum hydroxide	Used in water purification and as an ingredient in antacids.
ammonia, NH <sub>3</sub>	Used as a building block for the synthesis of many pharmaceutical products and in many commercial cleaning products. Used in the manufacture of fertilizers.

## Sodium Hydroxide

Sodium hydroxide, also known as lye and caustic soda, is an inorganic compound with formula NaOH. It is a white solid ionic compound consisting of sodium cations  $\text{Na}^+$  and hydroxide anions  $\text{OH}^-$ .

Dissolution of solid sodium hydroxide in water is a highly exothermic reaction:



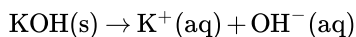
The resulting solution is usually colorless and odorless and feels slippery when it comes in contact with skin.



Figure 1.11.1.1.1: Sample of sodium hydroxide as pellets in a watch glass. (Public Domain; Walkerma.)

## Potassium Hydroxide

Potassium hydroxide is an inorganic compound with the formula KOH, and is commonly called caustic potash. Along with sodium hydroxide (NaOH), this colorless solid is a prototypical strong base. It has many industrial and niche applications, most of which exploit its corrosive nature and its reactivity toward acids. Its dissolution in water is strongly exothermic.



Concentrated aqueous solutions are sometimes called *potassium lyes*.

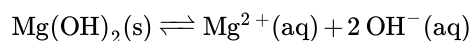
## Magnesium Hydroxide

Magnesium hydroxide is the inorganic compound with the chemical formula  $\text{Mg}(\text{OH})_2$ . Magnesium hydroxide is a common component of antacids, such as milk of magnesia, as well as laxatives.



Figure 1.11.1.1.1: Bottle of Antacid tablets. (CC BY 2.,5; Midnightcomm).

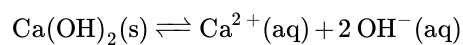
It is a white solid with low solubility in water. Combining a solution of many magnesium salts with basic water induces precipitation of solid  $\text{Mg}(\text{OH})_2$ . However, a weak concentration of dissociated ions can be found in solution:



## Calcium Hydroxide

Calcium hydroxide (traditionally called slaked lime) is an inorganic compound with the chemical formula  $\text{Ca}(\text{OH})_2$ . It is a colorless crystal or white powder. It has many names including hydrated lime, caustic lime, builders' lime, slaked lime, cal, or pickling lime. Calcium hydroxide is used in many applications, including food preparation. Limewater is the common name for a saturated solution of calcium hydroxide.

Calcium hydroxide is relatively insoluble in water, but is large enough that its solutions are basic according to the following reaction:



## Ammonia

Ammonia is a compound of nitrogen and hydrogen with the formula  $\text{NH}_3$  and is a colorless gas with a characteristic pungent smell. It is the active product of “smelling salts,” and can quickly revive the faint of heart and light of head. Although common in nature and in wide use, ammonia is both caustic and hazardous in its concentrated form.

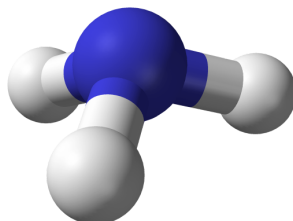
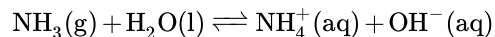


Figure 1.11.1.1.1: Ball-and-stick model of the ammonia molecule. (Public Domain; Ben Mills).

In aqueous solution, ammonia acts as a base, acquiring hydrogen ions from  $\text{H}_2\text{O}$  to yield ammonium and hydroxide ions:



Ammonia is also a building block for the synthesis of many pharmaceutical products and is used in many commercial cleaning products.

## Summary

- A brief summary of properties of bases was given.
- The properties of bases mostly contrast those of acids.
- Bases have many, varied uses.

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