Pearson

16.2: The Nature of Acids and Bases

Acids have the following general properties: a sour taste; the ability to dissolve many metals; the ability to turn blue litmus paper red; and the ability to neutralize bases. We look more closely at the structural characteristics of acids that lead to this behavior in Section 16.4, but first let's consider the common examples of acids listed in Table 16.1.

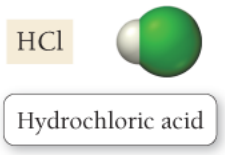
Litmus paper contains certain dyes that change color in the presence of acids and bases.

Table 16.1 Common Acids

Name	Occurrence/Uses
Hydrochloric acid (HCl)	Metal cleaning; food preparation; ore refining; primary component of stomach acid
Sulfuric acid (H_2SO_4)	Fertilizer and explosives manufacturing; dye and glue production; automobile batteries; electroplating of copper
Nitric acid (HNO_3)	Fertilizer and explosives manufacturing; dye and glue production
Acetic acid ($HC_2H_3O_2$)	Plastic and rubber manufacturing; food preservation; active component of vinegar
Citric acid ($H_3C_6H_5O_7$)	In citrus fruits such as lemons and limes; used to adjust pH in foods and beverages
Carbonic acid (H_2CO_3)	In carbonated beverages due to the reaction of carbon dioxide with water
Hydrofluoric acid (HF)	Metal cleaning; glass frosting and etching
Phosphoric acid (H_3PO_4)	Fertilizer manufacturing; biological buffering; beverage preservation

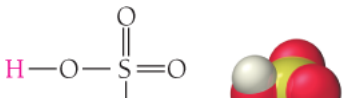
The formula for acetic acid can also be written as CH_3COOH.

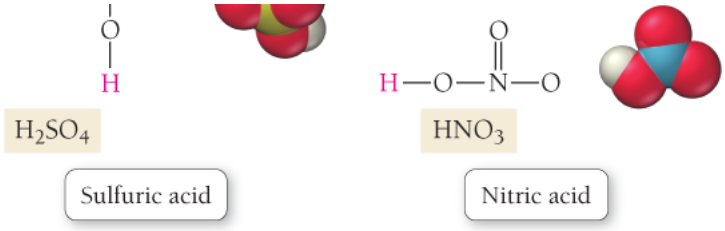
Hydrochloric acid is found in most chemistry laboratories. In industry, it is used to clean metals, to prepare and process some foods, and to refine metal ores. Hydrochloric acid is also the main component of stomach acid, which is why heartburn results in a sour taste (the sour taste occurs when HCl backs up out of the stomach and into the throat and mouth).



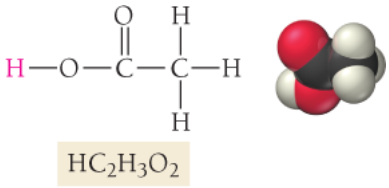
For a review of acid naming, see Section 8.7.

Sulfuric acid and nitric acid are also common in the laboratory. They are important in the manufacture of fertilizers, explosives, dyes, and glues. Sulfuric acid, produced in larger quantities than any other industrial chemical, is present in most automobile batteries.



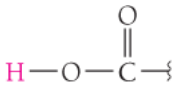


You can probably find acetic acid in your home—it is the active component of vinegar. It is also produced in improperly stored wines. The word "vinegar" originates from the French words *vin aigre*, which means sour wine. Wine experts consider the presence of vinegar in wines a serious fault because it makes the wine taste like salad dressing.

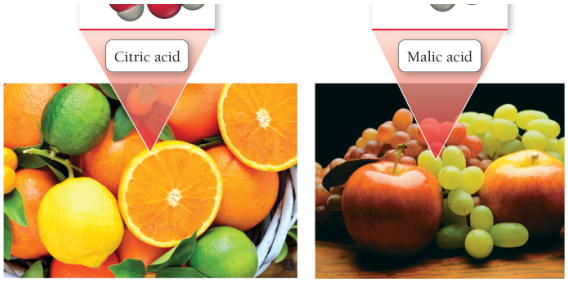


Acetic acid makes vinegar taste sour.

Acetic acid is a **carboxylic acid**, an acid that contains the following grouping of atoms:



Carboxylic acids are often found in substances derived from living organisms. Other examples of carboxylic acids are citric acid, the main acid in lemons and limes, and malic acid, found in apples, grapes, and wine.



Citrus fruits, apples, and grapes all contain acids.

Bases have the following general properties: a bitter taste; a slippery feel; the ability to turn red litmus paper blue; and the ability to neutralize acids. Because of their bitterness, bases are less common in foods than are acids. Our aversion to the taste of bases is probably an evolutionary adaptation to warn us against **alkaloids**, organic bases found in plants that are often poisonous. (For example, the active component of hemlock—the poisonous plant that killed the Greek philosopher Socrates—is the alkaloid coniine.) Nonetheless, some foods, such as coffee and chocolate (especially dark chocolate), contain bitter flavors. Many people enjoy the bitterness but only after acquiring the taste over time.

Bases feel slippery because they react with oils on the skin to form soap-like substances. Some household cleaning solutions, such as ammonia, are basic and have the characteristic slippery feel of a base. Bases turn red litmus paper blue; in the laboratory, we use litmus paper to test the basicity of solutions.

Table 16.2 lists some common bases. You can find sodium hydroxide and potassium hydroxide in most chemistry laboratories. They are used in petroleum and cotton processing, as well as in soap and plastic manufacturing. Sodium hydroxide is the active ingredient in products such as Drano® that unclog drains. In many homes, you can find sodium bicarbonate in the medicine cabinet (it is an active ingredient in some antacids) as well as in the kitchen (labeled as baking soda).

Many common household products and remedies contain bases.

Table 16.2 Common Bases

Name	Occurrence/Uses
Sodium hydroxide (NaOH)	Petroleum processing; soap and plastic manufacturing
Potassium hydroxide (KOH)	Cotton processing; electroplating; soap production; batteries
Sodium bicarbonate ($NaHCO_3$)	Sold as baking soda; antacid; source of CO_2
Sodium carbonate (Na_2CO_3)	Glass and soap manufacturing; general cleanser; water softener
Ammonia (NH_3)	Detergent; fertilizer and explosives manufacturing; synthetic fiber production