Chemistry 1010

Acids and Bases:

What They Are and Where They Are Found

Introduction

In this unit, we are studying ionic compounds, and acids and bases. Now that we've looked at ionic compounds, it's time to talk about acids and bases.

Discussion questions:

What do you think of when you hear the word acid?

What do you think of when base you hear the word base?

In chemistry, acids and bases are two special categories of compounds.

They are considered chemical opposites because if you mix them together, they neutralize each other.

Common Acids and Bases

Before we talk about what makes a compound an acid or a base, let's look at some examples.

Common acids

mineral acids	organic acids
HCl hydrochloric acid	$C_2H_4O_2$ acetic acid
H_2SO_4 sulfuric acid	$C_3H_6O_3$ lactic acid
HNO_3 nitric acid	$C_6H_8O_7$ citric acid
H_3PO_4 phosphoric acid	

What do all of these acids all have in common?

How could they be divided into two groups?

Common bases

NaOH sodium hydroxide

KOH potassium hydroxide

$NaHCO_3$ sodium bicarbonate

$CaCO_3$ calcium carbonate

NH_3 ammonia

What do most of the bases have in common?

Which of them ones seem most alike?

hydrochloric acid (HCl)

HCl is the acid found in the stomach. It destroys nearly all bacteria that enter the digestive system, and activates the digestive enzyme pepsin.

HCl is also found in some toilet bowl cleaners, where it kills germs and reacts with hard water deposits.

You can buy HCl solutions at hardware stores under the name “muriatic acid.” It is used to clean masonry and cement, etch metal, and adjust the acidity of swimming pools.

sulfuric acid (H_2SO_4)

Sulfuric acid is found in car batteries. It participates in the reaction that makes the electrons flow.

$$Pb + PbO_2 + H_2SO_4 \longrightarrow 2\ PbSO_4 + 2\ H_2O$$

Sulfuric acid is also formed in the atmosphere. The process starts when coal containing sulfur is burned, forming SO_2. The SO_2 reacts with oxygen and water in the air to form sulfuric acid.

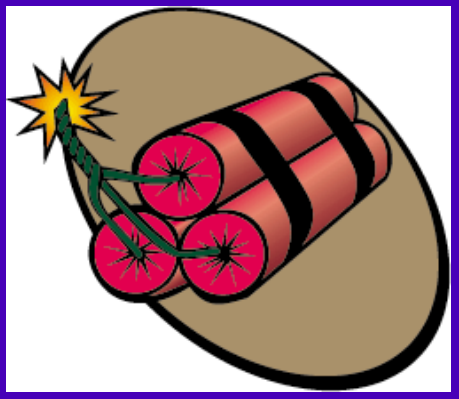
$$S + O_2 \longrightarrow SO_2$$

$$2\ SO_2 + O_2 \longrightarrow 2\ SO_3$$

$$SO_3 + H_2O \longrightarrow H_2SO_4$$

It forms acid rain, which causes significant environmental damage.

nitric acid (HNO_3)



Nitric acid is used in the manufacture of fertilizers and explosives.

Acid rain may also contain nitric acid. It is formed from when nitrogen impurities in gasoline are burned to make nitrogen oxides, which react with water to make nitric acid.

Acid rain also reacts with and dissolves away marble and cement, including buildings, statues, and tombstones.

phosphoric acid (H_3PO_4)

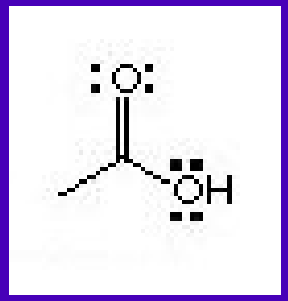
Phosphoric acid is used as an additive in cola drinks to give them a tart taste, and to increase the shelf life.

Phosphoric acid is also found in cleaning solutions for toilets and tubs – it is good at disinfecting and dissolving hard water deposits, just like HCl.

This is why cola drinks can be used to clean pennies, toilets, and battery terminals!

acetic acid ($C_2H_4O_2$)

structure:



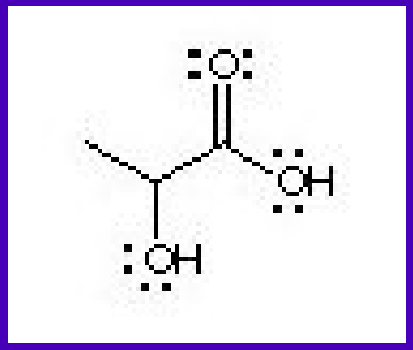
organic acids all contain
a carboxylic acid functional group

Acetic acid is found in vinegar, which is made from the oxidation of wine.

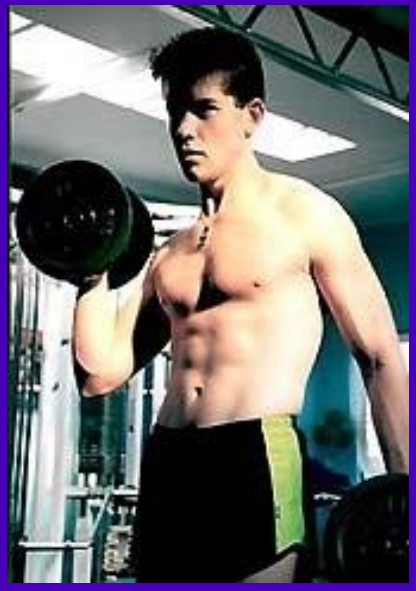
Many people enjoy the sharp taste of acetic acid on potato chips or a salad.

lactic acid ($C_3H_6O_3$)

structure:



contains an alcohol and a carboxylic acid



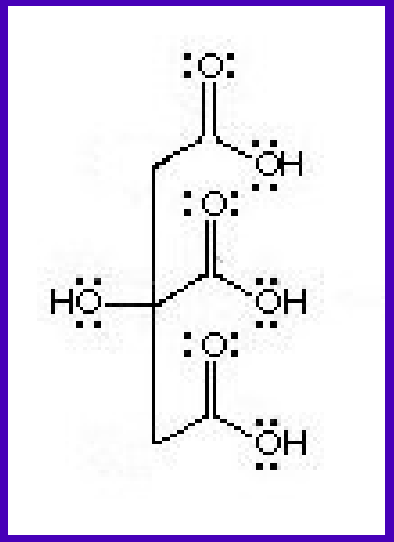
Lactic acid is an intermediate in the reaction that converts burns glucose in your muscles.

When muscles are working hard, it can build up temporarily and cause a burning sensation.

It also contributes to the sour taste of yogurt, pickles and sauerkraut.

citric acid ($C_6H_8O_7$)

structure:

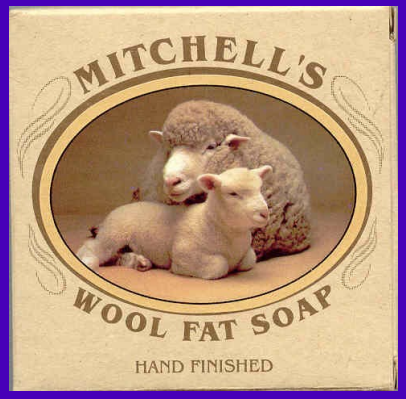


contains three carboxylic acids and an alcohol

Citric acid is found abundantly in nature, especially in citrus fruits like oranges, grapefruit, lemons, and lines.

It is also used to add flavor and tartness to candies and fruit drinks.

sodium hydroxide (NaOH)



Sodium hydroxide is also known as lye. It is used to make soap, and also cement.

potassium hydroxide (KOH)

Potassium hydroxide is found in drain cleaners and oven cleaners because it is good at dissolving grease and hair.

sodium bicarbonate ($NaHCO_3$)

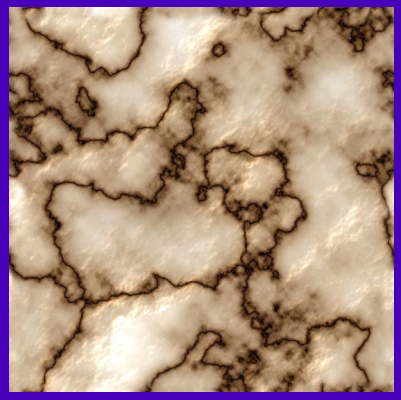
Sodium bicarbonate is also known as baking soda. It is used as a leavening agent for cookies, biscuits, and banana bread.

Baking soda is also good for putting out grease fires...

... and absorbing odors in the refrigerator.

It can also be found in toothpaste, where it serves as a mild abrasive, and helps neutralize acids in the mouth.

calcium carbonate (Ca_2CO_3)



Calcium carbonate is found in limestone, a sedimentary rock. Under heat and pressure, it becomes marble.

Sea shells and pearls are also made of mostly calcium carbonate.

It forms in caves, and also as hard water deposits on fixtures.

It is also an active ingredient in antacids.

ammonia (NH_3)

Ammonia is a common household cleaner. It is often found in window cleaners and floor cleaners. It can be recognized by its distinctive odor.

It is also found in hair permanent solutions.

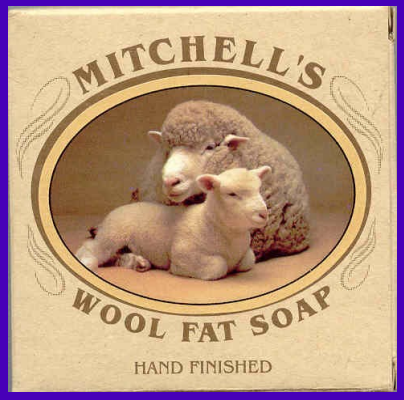
What Acids and Bases are Like

Now that we've seen all of these examples, let's look at some of the characteristics of acids and bases.

physical characteristics:

acids – often have a tart or sour taste

bases – often have a bitter taste, and feel slippery



chemical characteristics:

acids

- react with water by giving up a H
- form H_3O^+ and an anion.

$$HCl + H_2O \longrightarrow Cl^- + H_3O^+$$

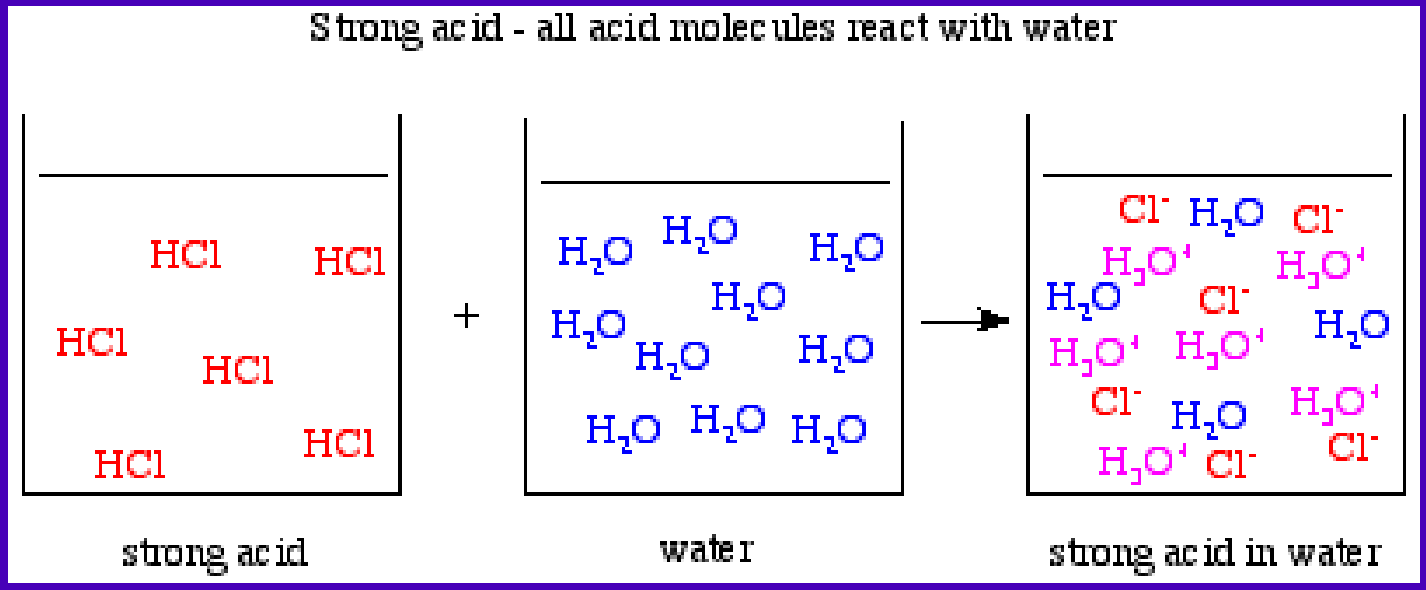
bases

- react with water by taking a H
- form an OH^- ion
- OR already contain an OH^- ion

$$NH_3 + H_2O \longrightarrow NH_4^+ + OH^-$$

Some acids and bases have a greater tendency to do this than others.

strong acids and bases – all molecules react



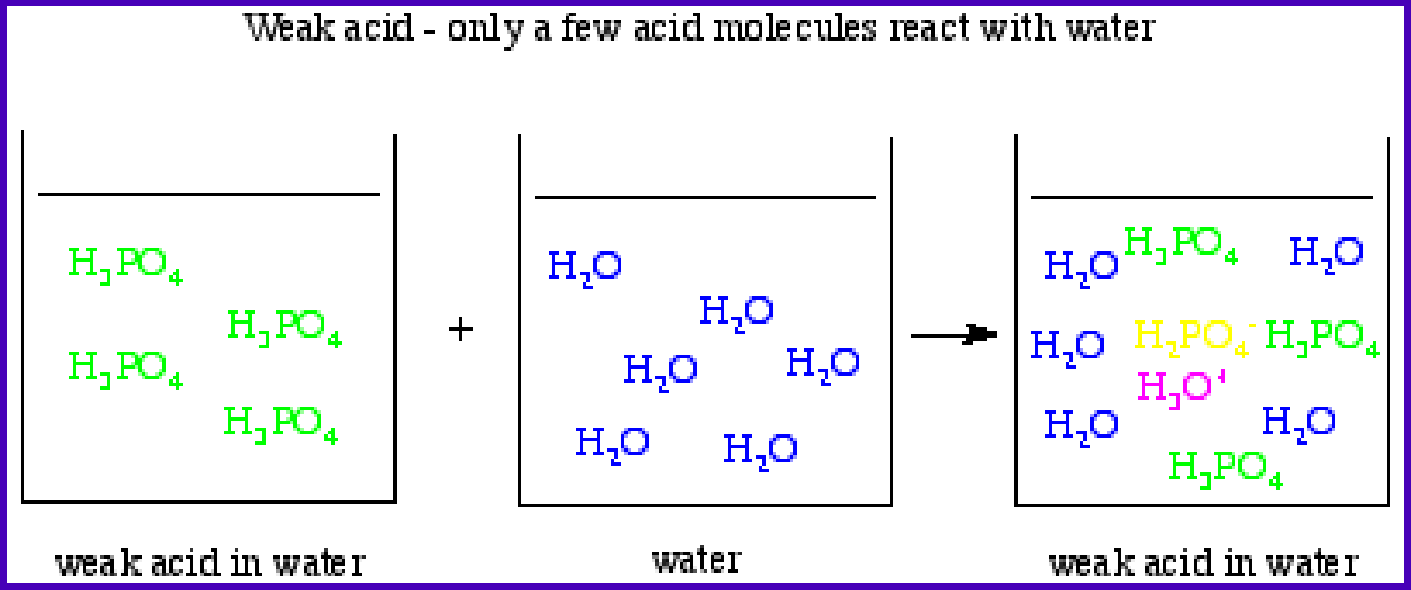
strong acids

HCl hydrochloric acid
H_2SO_4 sulfuric acid
HNO_3 nitric acid

strong bases

NaOH
KOH

weak acids and bases – only some of the molecules react



weak acids

H_3PO_4 phosphoric acid
$C_2H_4O_2$ acetic acid
$C_3H_6O_3$ lactic acid
$C_6H_8O_7$ citric acid

weak bases

$NaHCO_3$ sodium bicarbonate
$CaCO_3$ calcium carbonate
NH_3 ammonia