Colegio de
San Francisco de Paula
DEPARTAMENTO DE
CIENCIAS NATURALES

Acids and Bases

Acids are compounds that break up or dissociate in water giving off H^+ ions.

Acids are solutions of pure compounds in water, and they can be dilute or concentrated. There are **strong** and **weak** acids. Strong acids must be handled carefully as they are **corrosive**, especially when found as concentrated solutions. Strong acids can eat away metal, skin and cloth.

Properties of acids:

- conduct electricity (they are electrolytes)
- change blue litmus to red
- have a sour taste
- react with bases to neutralize their properties forming a salt and water as the only products
- react with active metals, such as alkali metals, alkaline earth metals, zinc, iron, aluminium, evolving hydrogen (H_2) and forming a salt as the only other product.
- evolve carbon dioxide when reaction with metal carbonates

Here are some of the main acids you will run across in chemistry:

hydrochloric acid (HCl), sulfuric acid (H_2SO_4), nitric acid (HNO_3), ethanoic acid (CH_3COOH)

Bases

Bases are another group of chemicals that must be handled with care as they can burn skin as well. Like acids, we can talk about strong or weak bases.

Bases are compounds that break up or dissociate in water producing OH^- ions.

Properties of bases:

- have a bitter taste
- feel slippery or soapy
- bases turn litmus to blue
- their aqueous solutions conduct electricity (they are electrolytes)
- react with acids to form salts and water as the only products

Here are some of the main ones you will meet in chemistry:

Sodium hydroxide (NaOH), potassium hydroxide (KOH), calcium hydroxide ($Ca(OH)_{2)}$, ammonia (NH_3).

We will later look at **neutralisation** reactions between **acids** and **bases**.

Indicators and the pH scale

Indicators are substances that change colour from acid to base, therefore telling or indicating if something is an acidic or basic. Litmus is one of these substances turning red with acid and blue with base. Another important indicator often used in a chemistry lab is phenolphthalein.

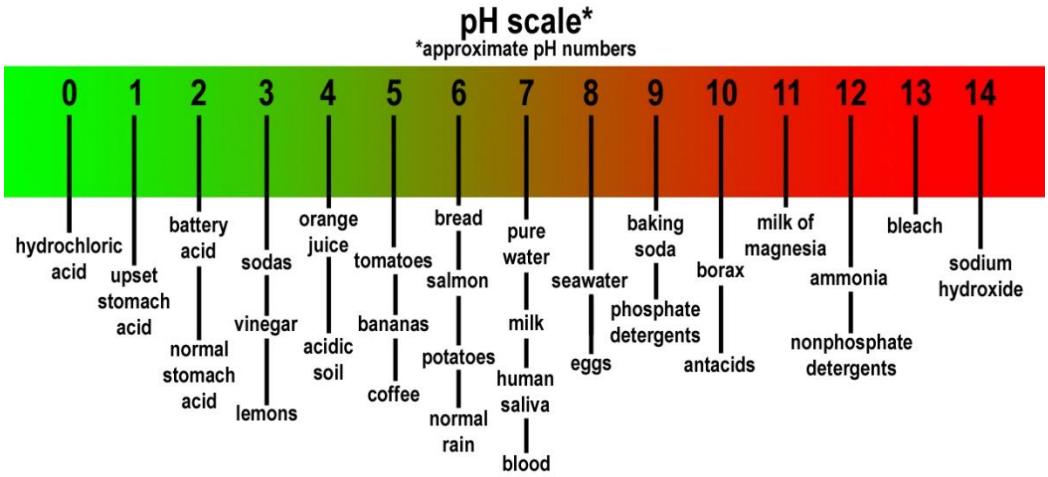
The colours of indicators in acidic and basic solutions

Indicator	Colour on acid side	pH at colour change	Colour on basic side
methyl orange	red	3–5	yellow
litmus	red	5–8	blue
phenolphthalein	colourless	8–10	pink

The pH scale

The pH scale is a number scale that tells you the acidity or basicity of a solution. It goes from 0 to 14.

On this scale, an **acidic** solution has a pH **lower than 7**, a **neutral** solution has a pH of **exactly 7** and a basic solution has a pH **higher than 7**.



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Let's take a closer look at acids and bases

Acids give off hydrogen ions.

Hydrogen chloride is a gas, made of molecules, which gives hydrochloric acid when dissolved in water. However, hydrochloric acid is not molecular. In water hydrochloric acid breaks up or **dissociates** into ions:

Example of a strong acid:

$HCl\ (aq) \rightarrow H^+\ (aq) + Cl^-\ (aq)$

In a hydrochloric acid solution all the molecules of hydrogen chloride become ions, so **it dissociates 100%. It is a strong acid**

Example of a weak acid

$CH_3COOH\ (aq) \rightarrow H^+\ (aq) + CHCOO^-\ (aq)$

In ethanoic acid, only some of the molecules become ions. **Much less than 100% dissociates, so it is a weak acid**

As you can see both acids contain hydrogen ions, and so do all other solutions of acids. It is the hydrogen ions that give them their acidity.

Solutions of acids contain hydrogen ions. In solutions of strong acids, all molecules become ions. In solutions of weak acids, only some do.

The higher the concentration of hydrogen ions, the lower the pH.

Bases produce hydroxide ions.

Let's use sodium hydroxide in solution as an example (an ionic solid)

Example of a strong base:

$NaOH \rightarrow Na^+(aq) + OH^-(aq)$

Sodium hydroxide, an ionic solid, will break up or **dissociate completely** into its ions when dissolved, so **it dissociates 100%. It is a strong alkali.**

Example of a weak base, ammonia (a molecular gas)

$NH_3 + H_2O \rightarrow NH_4^+ (aq) + OH^- (aq)$

When ammonia is dissolved in water, some of the molecules remove a hydrogen from a water molecule and this produces OH^- ions. **Only some of the ammonia molecules do this so we describe it as a weak base.**

Solutions of bases contain hydroxide ions. The more hydroxide ions there are in solution the stronger the base, and the less ions the weaker the base.

The higher the concentration of hydroxide ions, the higher the pH.

Neutralisation reactions, Reactions of acids and bases

Acids and bases are seen as opposites because the effect of an acid is to increase the H^+ ion concentration in water, whereas the bases reduce this concentration.

Neutralisation
When an acid and a base are placed together, they react to neutralise the acid and base properties, producing a salt. The H^+ cation of the acid combines with the OH^- anion of the base to form water. The compound formed by the cation of the base and the anion of the acid is the salt.

So a **salt** is any compound which can be derived from **the neutralization of an acid and a base**. The word "neutralisation" is used because the acid and base properties of H^+ and OH^- are destroyed or neutralised. In the reaction, H^+ and OH^- combine to form H_2O or water molecules.

Neutralisation is a type of double replacement reaction. A salt is the product of an acid-base reaction and is a much broader term then common table salt (NaCl).

The following are some examples of neutralisation reactions to form salts (Note that each time an acid reacts with a Hydroxide (Base)).

a. $HCl + NaOH \rightarrow NaCl + HOH$

b. $H_2SO_4 + 2\ NH_4OH \rightarrow (NH_4)_2SO_4 + 2\ HOH$