Acids and Bases

As early as the seventeenth century, chemists recognized two important classes of compounds, which they called **acids** and **bases**.

Properties of Acids

- acidic solutions taste sour or tart (e.g. citrus fruits, yogurt, carbonated beverages, vinegar)
- on normal skin, dilute acids feel like water
- on broken skin (cuts), acids give a sharp sting
- acids react vigorously with many metals
- acidic solutions are good conductors of electricity
- litmus paper turns red in an acidic solution

Properties of Bases

- basic solutions taste bitter (e.g. soapy water)
- basic solutions feel smooth, soothing, and slippery on normal skin
- mild basic solutions do not sting, except in the eyes
- bases do not react with most metals
- basic solutions are good conductors of electricity
- litmus paper turns blue in a basic solution

Note: Litmus paper is a form of acid-base indicator. An **indicator** is a substance that turns one color in an acidic solution and another color in a basic solution.

Naming Acids

Chemists have identified thousands of acids. Most fall into three categories based on their composition and structure: binary acids, oxy acids, and carboxylic acids.

Binary Acids

Molecules of these acids contain hydrogen and one other element. Usually, the other element is either a halogen or a chalcogen (oxygen group). Binary acids are named using the following procedure:

1. Write the prefix “hydro” first.

2. Follow this with the root of the anion (negative ion) in the acid.

3. Change the suffix of the anion (usually *–ide*) to *–ic*.

4. Add the word “acid” to the end of the name.

Example 1
Name the acid whose formula is HCl .

Oxy Acids

These acids contain hydrogen, oxygen, and one other element. The anion in an oxy acid is usually a polyatomic ion that contains oxygen (e.g. sulfate SO_4^{2-}). Oxy acids are named using the following procedure:

1. Begin with the root of the anion.
2. If the suffix of the anion is *–ate*, change it to *–ic*.
3. If the suffix of the anion is *–ite*, change it to *–ous*.
4. Add the word "acid" to the end of the name.

Example 2
Name the following oxy acids

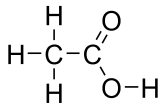
a) H_2SO_4

b) HNO_3

c) HNO_2

Carboxylic Acids

These acids are organic acids, or acids that include the carbon atom. The name carboxylic acid comes from the fact that these acids contain a carboxyl group ($-COOH$). One common carboxylic acid is acetic acid ($HC_2H_3O_2$), which is found in vinegar. The structure of acetic acid is shown below.



As you learned in grade 11 chemistry, carboxylic acids are named by taking the name of the parent chain and replacing the ending by "oic acid." For example, the proper name for acetic acid would be ethanoic acid.

Strong Acids

A **strong acid** is an acid that ionizes completely in water to form hydrogen ions. Hydrochloric acid is an example of a strong acid.

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

This means that we will assume that a solution of hydrochloric acid actually consists completely of hydrogen and chloride ions. Thus, if a problem states that a solution is 1.0 $mol/L\ HCl$, we will assume that the solution actually consists of 1.0 $mol/L\ H^+$ and 1.0 $mol/L\ Cl^-$.

Other strong acids include

- hydrobromic acid
- hydroiodic acid
- sulfuric acid
- nitric acid
- perchloric acid

Naming Bases

Most bases are named according to the standard rules for naming chemical compounds.

Example 3
Name the following bases.

a) $NaOH$

b) $Ca(OH)_2$

Strong Bases

A **strong base** is a base that ionizes completely in water to form hydroxide ions. All strong bases are ionic compounds that contain a hydroxide ion. Sodium hydroxide is an example of a strong base.

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

As with strong acids, any solution of a strong base will be considered to consist entirely of dissolved ions. Thus, a 1.0 $mol/L\ NaOH$ solution, will be assumed to consist of 1.0 $mol/L\ Na^+$ and 1.0 $mol/L\ OH^-$.

Any alkali metal or alkaline earth metal will form a strong base when combined with a hydroxide ion.

Worksheet

Write the name for each of the following acids.

1. HF
2. HBr
3. HNO_3
4. H_2SO_4
5. H_2SO_3
6. $HClO$
7. $HClO_2$
8. $HClO_3$
9. H_2CO_3
10. H_3PO_4

Write the formula for each of the following acids.

11. hydroiodic acid
12. hydrochloric acid
13. chromic acid
14. permanganic acid
15. nitrous acid
16. perchloric acid

Write the name for each of the following bases.

17. KOH
18. $Ca(OH)_2$
19. $Mg(OH)_2$
20. $Be(OH)_2$
21. $Fe(OH)_3$
22. $Fe(OH)_2$

Write the formula for each of the following bases.

23. lithium hydroxide
24. aluminum hydroxide
25. copper(I) hydroxide
26. copper(II) hydroxide
27. strontium hydroxide
28. sodium hydroxide

Answers

1. hydrofluoric acid
2. hydrobromic acid
3. nitric acid
4. sulfuric acid
5. sulfurous acid
6. hypochlorous acid
7. chlorous acid
8. chloric acid
9. carbonic acid
10. phosphoric acid
11. HI
12. HCl
13. H_2CrO_4
14. $HMnO_4$
15. HNO_2
16. $HClO_4$
17. potassium hydroxide
18. calcium hydroxide
19. magnesium hydroxide
20. beryllium hydroxide
21. iron(III) hydroxide
22. iron(II) hydroxide
23. $LiOH$
24. $Al(OH)_3$
25. $CuOH$
26. $Cu(OH)_2$
27. $Sr(OH)_2$
28. $NaOH$