# 1.11.3: Strong and Weak Acids and Bases

**Learning Objectives**

- Define a strong and a weak acid and base.
- Recognize an acid or a base as strong or weak.
- Determine if a salt produces an acidic or a basic solution.

## Strong and Weak Acids

Except for their names and formulas, so far we have treated all acids as equals, especially in a chemical reaction. However, acids can be very different in a very important way. Consider HCl(aq). When HCl is dissolved in $H_2O$, it completely dissociates into $H^+$(aq) and $Cl^-$(aq) ions; all the HCl molecules become ions:

$$HCl \overset{100\%}{\rightarrow} H^+(aq) + Cl^-(aq)$$

Any acid that dissociates 100% into ions is called a **strong acid**. If it does not dissociate 100%, it is a **weak acid**. $HC_2H_3O_2$ is an example of a weak acid:

$$HC_2H_3O_2 \overset{\sim 5\%}{\longrightarrow} H^+(aq) + C_2H_3O_2^-(aq)$$

Because this reaction does not go 100% to completion, it is more appropriate to write it as **a reversible reaction**:

$$HC_2H_3O_2 \rightleftharpoons H^+(aq) + C_2H_3O_2^-(aq)$$

As it turns out, there are very few strong acids, which are given in Table 1.11.3.1. If an acid is not listed here, it is a weak acid. It may be 1% ionized or 99% ionized, but it is still classified as a weak acid.

> *Any acid that dissociates 100% into ions is called a strong acid. If it does not dissociate 100%, it is a weak acid.*

Table 1.11.3.1: Strong Acids and Bases

| Acids | Bases |
|---|---|
| HCl | LiOH |
| HBr | NaOH |
| HI | KOH |
| $HNO_3$ | RbOH |
| $H_2SO_4$ | CsOH |
| $HClO_3$ | $Mg(OH)_2$ |
| $HClO_4$ | $Ca(OH)_2$ |
| | $Sr(OH)_2$ |
| | $Ba(OH)_2$ |

## Strong and Weak Bases

The issue is similar with bases: a **strong base** is a base that is 100% ionized in solution. If it is less than 100% ionized in solution, it is a **weak base**. There are very few strong bases (Table 1.11.3.1); any base not listed is a weak base. All strong bases are $OH^-$ compounds. So a base based on some other mechanism, such as $NH_3$ (which does not contain $OH^-$ ions as part of its formula), will be a weak base.

**Example 1.11.3.1: Identifying Strong and Weak Acids and Bases**

Identify each acid or base as strong or weak.

a. HCl
b. $Mg(OH)_2$
c. $C_5H_5N$

**Solution**

a. Because HCl is listed in Table 1.11.3.1, it is a strong acid.
b. Because $Mg(OH)_2$ is listed in Table 1.11.3.1, it is a strong base.
c. The nitrogen in $C_5H_5N$ would act as a proton acceptor and therefore can be considered a base, but because it does not contain an OH compound, it cannot be considered a strong base; it is a weak base.

**Exercise 1.11.3.1**

Identify each acid or base as strong or weak.

a. RbOH
b. $HNO_2$

**Answer a**

strong base

**Answer b**

weak acid

**Example 1.11.3.2: Characterizing Base Ionization**

Write the balanced chemical equation for the dissociation of $Ca(OH)_2$ and indicate whether it proceeds 100% to products or not.

**Solution**

This is an ionic compound of $Ca^{2+}$ ions and $OH^-$ ions. When an ionic compound dissolves, it separates into its constituent ions:

$$Ca(OH)_2 \rightarrow Ca^{2+}(aq) + 2\,OH^-(aq)$$

Because $Ca(OH)_2$ is listed in Table 1.11.3.1, this reaction proceeds 100% to products.

**? Exercise 1.11.3.2**

Write the balanced chemical equation for the dissociation of hydrazoic acid ($HN_3$) and indicate whether it proceeds 100% to products or not.

**Answer a**

The reaction is as follows:

$$HN_3 \rightarrow H^+(aq) + N_3^-(aq)$$

It does not proceed 100% to products because hydrazoic acid is not a strong acid.

## Key Takeaways

- Strong acids and bases are 100% ionized in aqueous solution.
- Weak acids and bases are less than 100% ionized in aqueous solution.
- Salts of weak acids or bases can affect the acidity or basicity of their aqueous solutions.

## Contributions & Attributions