## Strong Acids

As we have learned previously, a **strong acid** is an acid that ionizes completely in water to form hydrogen (hydronium) ions. For example, we will assume that every molecule of $HCl$ that dissolves in water ionizes into an $H_3O^+$ and a $Cl^-$ ion.

$$HCl(g) + H_2O(l) \rightarrow H_3O^+(aq) + Cl^-(aq)$$

This means that, for the purposes of calculations, when a strong acid dissolves in water, the hydronium ion concentration will be equal to the concentration of the acid before ionization. For the above example,

$$\left[H_3O^+\right] = [HCl]$$

There are relatively few strong acids: hydrochloric acid, hydrobromic acid ($HCl$), hydroiodic acid ($HI$), sulfuric acid ($H_2SO_4$), nitric acid ($HNO_3$), phosphoric acid ($H_3PO_4$), and perchloric acid ($HClO_4$) are the most familiar.

Acids that contain only one ionizable hydrogen, such as $HCl$, are known as **monoprotic acids**. Diprotic acids, such as $H_2SO_4$, have two ionizable hydrogen atoms. Triprotic acids, such as $H_3PO_4$, have three ionizable hydrogen atoms.

### Calculating $\left[H_3O^+\right]$ and $\left[OH^-\right]$ of a Strong Acid

The assumption that strong acids ionize completely and the value of $K_W$ can be used to determine the hydronium ion or hydroxide ion concentrations of strong acid solutions.

**Example 1**
Calculate the concentration of hydroxide ions in a 0.15 $mol/L$ solution of hydrochloric acid at STP.

**The pH of Strong Acids**

The pH of solutions of strong monoprotic acids is calculated from the concentration of hydronium ions, which is assumed to be equal to the molar concentration of the acid (before ionization).

**Example 2**

Calculate the pH, pOH, and $\left[OH^-\right]$ of a $0.042\ mol/L\ HNO_3$ solution.

**Worksheet**

1. In a 0.30 $mol/L\ HNO_3$ solution,

   a) what is the concentration of hydronium ions?

   b) what is the hydroxide ion concentration>

2. Calculate the hydroxide ion concentration in a solution prepared by dissolving 0.37 $g$ of hydrogen chloride in 250 $mL$ of water.

3. The hydronium ion concentration in an industrial effluent is $4.40 \times 10^{-3}\ mol/L$. Calculate the concentration of hydroxide ions in the effluent.

4. Calculate the pH, pOH, and $\left[OH^-\right]$ of each of the following solutions.

   a) 0.006 $mol/L\ HI(aq)$

   b) 0.025 $mol/L\ HNO_3(aq)$

   c) 0.010 $mol/L\ HCl(aq)$

5. To clean a clogged drain, 26 $g$ of sodium hydroxide is added to water to make 150 $mL$ of solution. What are the pH and pOH values for the solution?

6. What mass of potassium hydroxide is contained in 500 $mL$ of solution that has a pH of 11.5?

7. Food scientists and dieticians measure the pH of foods when they devise recipes and special diets. The juices of various fruits and vegetables are extracted. Various measurements related to their acidity are made and recorded in the table below.

| **Food** | $\left[H_3O^+\right]\ (mol/L)$ | $\left[OH^-\right]\ (mol/L)$ | **pH** | **pOH** |
|---|---|---|---|---|
| oranges | $5.5 \times 10^{-3}$ | | | |
| asparagus | | | | 5.6 |
| olives | | $2.0 \times 10^{-11}$ | | |
| blackberries | | | | 10.60 |

   a) Complete the table.

b) Based on pH only, predict which of the foods would taste most sour, assuming that sour taste is directly proportional to pH.

c) Which of these foods might dieticians recommend to their patients to help relieve heartburn? Why?

8. When food enters the stomach, it stimulates the production and secretion of hydrochloric acid for digestion, reducing the pH of the stomach contents from 4 to 2. Compare the $\left[H_3O^+\right]$ before and after the change in pH.