15.1: Properties of Acids and Bases

Learning Objectives

- To examine properties of acids and bases.

Sour Patch Kids are a soft candy with a coating of invert sugar and sour sugar. The candy's slogan, "Sour. Sweet. Gone," refers to its sour-to-sweet taste. Sour sugar is a food ingredient that is used to impart a sour flavor, made from citric or tartaric acid and sugar. It is used to coat sour candies like Sour Patch Kids. Eating large amounts of sour sugar can cause irritation of the tongue due to the *acid*. It can also cause irreversible dental erosion.

Figure 15.1.1: Sour Patch Kids candies. Image courtesy of Evan-Amos (public domain).

Perhaps you have eaten too much pizza and felt very uncomfortable hours later. This feeling is due to excess stomach acid being produced. The discomfort can be dealt with by taking an antacid. The *base* in the antacid neutralizes the excess HCl in the stomach, taking care of that unpleasant feeling.

Acids

The word **acid** is derived from the Latin word *acidus*, which means sour, so it shouldn't be surprising that acids are commonly found in foods. Citrus fruits such as oranges and lemons contain citric acid and ascorbic acid. Ascorbic acid is better known as vitamin C. Carbonated sodas contain carbonic acid. In addition, many darker carbonated beverages, such as colas, also contain phosphoric acid. Vinegar is an aqueous solution of acetic acid. Your own stomach utilizes hydrochloric acid to digest food.

Bases

The word **base** is believed to have originated in the 1700s as an evolution of a term used by alchemists. A base may be thought of a "base material" from which other substances may be derived. One such example would be the ashes obtained from burning wood. When the ashes are mixed with water, they produce an alkaline mixture from which the solids may then be filtered out. This alkaline water (or lye water) could then be combined with various acids to produce different neutral salts, or mixed with animal fats to make soap. Hence, the lye water was a base for making different substances.

Figure 15.1.2: Phenolphthalein indicator in presence of base.

Properties of Acids and Bases

Acids and bases are distinct classes of compounds because of the properties of their aqueous solutions. Table 15.1.1 provides a comparison of their mostly contrasting properties.

Table 15.1.1: A Comparison of the Properties of Acids and Bases

Acids	Bases
1. Aqueous solutions of acids are electrolytes. Some acids are strong electrolytes because they ionize completely in water, yielding a great many ions. Other acids are weak electrolytes that exist primarily in a non-ionized form when dissolved in water.	1. Aqueous solutions of bases are electrolytes. Some bases are strong electrolytes, dissociating completely into ions in water, while other bases are weak electrolytes that exist primarily in a non-ionized form when dissolved in water.
2. Acids have a sour taste. Lemons, vinegar, and sour candies all contain acids.	2. Bases often have a bitter taste and are found in foods less frequently than acids. Examples are unsweetened chocolate or the alkaloids found in coffee. Many bases, like soaps, are slippery to the touch.
3. Acids change the color of certain acid-base indicators. Two common indicators are litmus and phenolphthalein. Blue litmus turns red in the presence of an acid, while phenolphthalein turns colorless.	3. Bases also change the color of certain acid–base indicators. Red litmus turns blue in the presence of a base, while phenolphthalein turns pink.
4. Acids are called **corrosives**, since they react with active metals and cause slow-healing burns and tissue damage when concentrated. Strong acids may do so even when relatively dilute. This is one of the many reasons why "taste tests" should never be used!	4. Bases are called **alkalis** or **caustics**, since they cause slow-healing burns and tissue damage when concentrated. Strong bases may do so even when relatively dilute. This is one of the many reasons why "taste tests" should never be used!
5. Acids react with bases to produce a salt and water (see Section 7.9). Example: $HNO_3\,(aq) + KOH\,(aq) \rightarrow KNO_3\,(aq) + H_2O\,(l)$	5. Acids react with bases to produce a salt and water (see Section 7.9). Example: $HNO_3\,(aq) + KOH\,(aq) \rightarrow KNO_3\,(aq) + H_2O\,(l)$
6. Acids react with active metals to yield hydrogen gas. Example: $Zn\,(s) + H_2SO_4\,(aq) \rightarrow ZnSO_4\,(aq) + H_2\,(g)$	
7. Acids react with carbonates and bicarbonates to yield carbon dioxide gas (discussed in Section 7.9). Example: $NaHCO_3\,(s) + HCl\,(aq) \rightarrow NaCl\,(aq) + H_2O\,(l) + CO_2\,(g)$	

⚠ Warning!

Tasting chemicals and touching them are NOT good lab practices and should be avoided! In other words, don't do this at home.

It should not be hard for you to name several common acids (but you might find that listing bases is a little more difficult). Section 15.2 examines some common acids and their uses, while Section 15.3 examines some common bases.

Summary

- Acids and bases are distinct classes of compounds because of the properties of their aqueous solutions.

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