Chapter 7
Properties of Matter

ALABAMA 8TH GRADE SCIENCE STANDARDS COVERED IN THIS CHAPTER INCLUDE:

6	Define solution in terms of solute and solvent. • Defining diffusion and osmosis • Defining isotonic, hypertonic and hypotonic solutions • Describing acids and bases based on their hydrogen ion concentration

PROPERTIES OF MATTER

SCILINKS THE WORLD'S A CLICK AWAY ABC315 properties of matter

How can we tell one type of matter from another? All matter has properties that make it distinguishable from other kinds of matter. A **property** describes how matter looks, feels or interacts with other matter. To make matter easier to classify, scientists look at it in two different ways — its **physical properties** and its **chemical properties**.

A **physical property** is anything we can observe without changing the identity of the substance we are looking at. Some of the more common physical properties are: melting point, boiling point, electrical conductivity (ability to carry electrical current), thermal conductivity (ability to transfer heat), magnetism, color, odor and hardness. More are listed in Table 7.1.

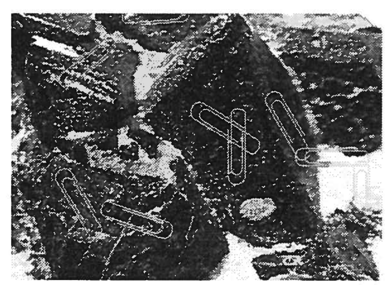


Figure 7.1 Magnetism, a Physical Property

Table 7.1 Physical Properties of Matter

Physical Property	What it Describes
state (or phase)	solid, liquid, gas
melting point	the temperature at which a solid becomes a liquid
boiling point	the temperature at which a liquid becomes a gas
electrical conductivity	the ability to carry electrical current (electricity)
thermal conductivity	the ability to transfer heat
magnetism	the ability to attract or repulse other matter

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

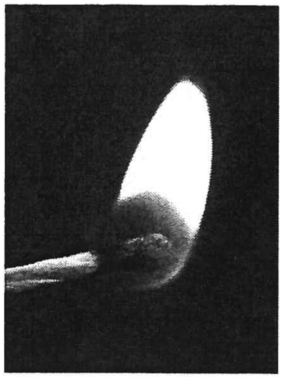


Figure 7.2 Flammability, a Chemical Property

A **chemical property** describes the way a substance may change or react to form other substances. Chemical properties are very different from physical properties because chemical properties describe the interaction of a substance with other matter. Here's an example: A piece of paper burns and turns into a black substance. After the flame goes out, you can no longer burn the black substance. That is because its chemical properties have been changed. Two of the most common chemical properties are: rusting (iron reacting with oxygen) and flammability (the ability of a substance to burn in the presence of oxygen). These and others are described in Table 7.2.

Table 7.2 Chemical Properties of Matter

Chemical Property	**What it Describes**
flammability	the ability to burn
toxicity	how poisonous something is
pH	the acidity of a liquid substance
reactivity	the response of one substance to another
rusting	iron reacting with oxygen

COMPOUNDS

When two or more elements combine chemically, they form a **compound**. The individual units of a compound are **molecules**. How can you tell the difference? Well, you know that elements are represented by chemical symbols. Compounds are represented by chemical formulas. You may have seen many of these in everyday live, but let's look at the difference again.

- The **chemical symbol** for an element describes only one kind of atom.
- The **chemical formula** for a compound describes the ratio of atoms that make up the molecules of that compound.

For example, the chemical formula for water is H_2O. The **subscript**, or small number, after the elemental symbol indicates the number of atoms of the element present in the compound. The chemical formula for water, H_2O, indicates that 2 atoms of hydrogen combine with 1 atom of oxygen. In aluminum oxide, Al_2O_3, 2 atoms of aluminum combine with 3 atoms of oxygen. In sodium chloride, NaCl, 1 atom of sodium combines with 1 atom of chlorine.

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

Practice Exercise: Chemical Formulas

For each chemical formula, give the ratio of atoms present for each element.

Formula	**Number of atoms of each element**
1. HCl	____________________
2. $MgCl_2$	____________________
3. H_2SO_4	____________________
4. C_2H_2	____________________
5. CO_2	____________________

Compounds have completely different properties than their individual elements. Think about this: hydrogen and oxygen are VERY **flammable** (easy to ignite) gases when in their most basic, elemental form. They can chemically combine to form H_2O though! Better known as water, H_2O is so stable it is used to *put out* fires. Another point about compounds: a compound cannot be *physically* separated into its individual components, but it can be *chemically* separated. You will not be able to use a spatula, sieve, filter or magnet to separate hydrogen from oxygen once they have chemically combined to form water, but the chemical bonds that hold water molecules together can be broken in a number of different ways.

MIXTURES

SCILINKS® THE WORLD'S A CLICK AWAY ABC300 mixtures

A **mixture** results when two or more substances (either elements or compounds) combine physically. That simply means that the two substances can be side by side *without changing*. Another way of stating this is that, in a mixture, both substances keep their individual properties. A mixture can usually be separated back into its individual substances. Let's say we were to put a teaspoon of salt and a teaspoon of pepper in a plastic bag, and then shake the bag (AFTER it has been sealed, of course). The result would be a mixture of salt and pepper. The two substances are together, yet they still retain their original properties.

Here's another example. When salt is dissolved into water, it creates a **solution**. A solution is a mixture of one or more substances, called **solutes**, dissolved in another substance, called a **solvent**. In salt water, salt is the substance that dissolves, and water is the substance that does the dissolving. If you drink the salt water, you can taste the salt in the water. The salt is still "salty," and the water is still a liquid, so these substances have not changed chemically. The salt and water can be separated by evaporation (if you wanted to wait that long). When the water vapor evaporates, the salt will be left behind.

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

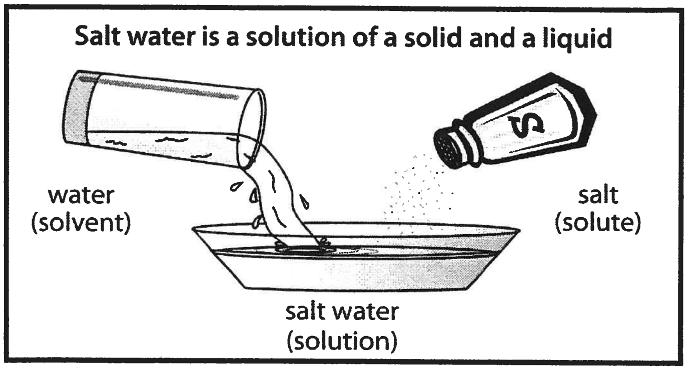


Figure 7.3 Salt Water Solution

There are two kinds of mixtures: homogenous and heterogeneous.

Homogeneous mixtures are mixtures that have a uniform (the same) composition and appearance throughout. If a spoonful of sugar is dissolved in a glass of water, the solution is the same throughout the entire glass. Any sample taken from the glass would have the same combination of water and sugar!

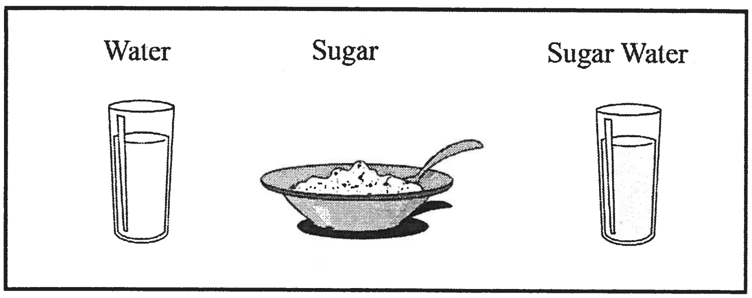


Figure 7.4 Homogeneous Mixture

Heterogeneous mixtures are mixtures that do <u>not</u> have uniform composition and appearance throughout. The individual components stay physically separated and can be seen as separate components. If you put a spoonful of sand into a glass of water, even after stirring it or shaking it, the sand will settle to the bottom of the glass. Any sample you took from the glass would have a different combination of water and sand, and since the sand would settle to the bottom, you could end up with mostly one or the other! More examples of heterogeneous mixtures are oil and vinegar salad dressing, paint, blood and soil.

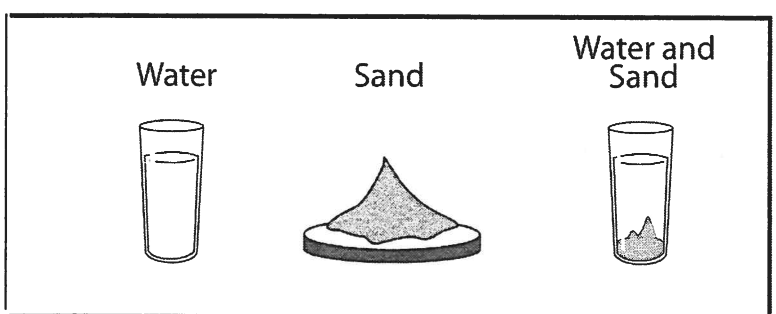


Figure 7.5 Heterogeneous Mixture

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

Table 7.3 compares the two kinds of mixtures.

Table 7.3 Examples of Mixtures

Homogenous mixtures	**Heterogeneous mixtures**
salt and water	salt and pepper
rubbing alcohol and water	oil and water
Ranch or French salad dressing	Oil and Vinegar salad dressing
chicken broth	vegetable soup

TYPES OF SOLUTIONS

The **concentration** of a solution describes the number of molecules of a substance in a given volume. Sometimes, molecules in a solution tend to move spontaneously from areas of higher concentration to areas of lower concentration. This type of movement is called **passive transport**. The two types of passive transport are diffusion and osmosis.

Diffusion is the process by which substances move directly from areas of higher concentration to areas of lower concentration.

Osmosis is the movement of water through a semi-permeable membrane from an area of high water concentration to an area of low water concentration. A semi-permeable membrane means some molecules are prevented from passing into the other area. You can think of osmosis as the diffusion of water.

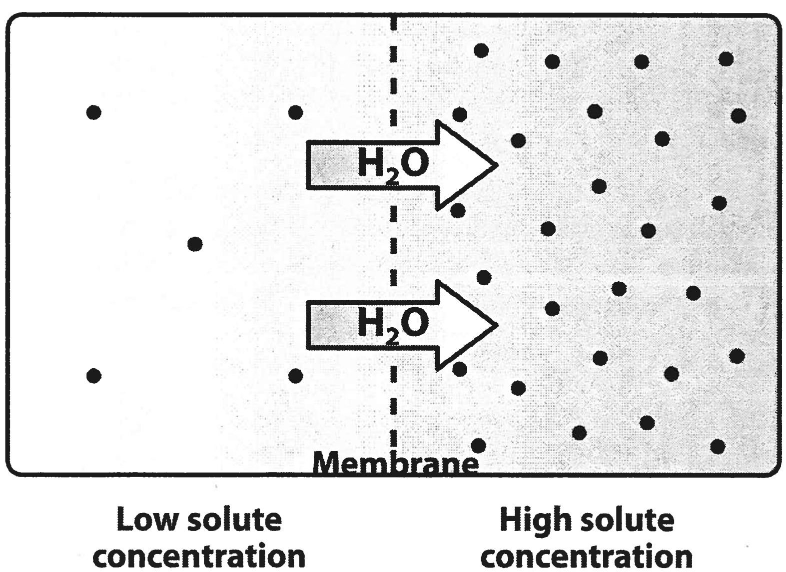


Figure 7.6 Osmosis

Osmosis can occur in either direction in a solution, depending on the concentration of the solute. Defining the solution concentrations relative to one another will help to predict the direction in which osmosis will occur.

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

The concentration of dissolved solutes determines the movement of substances from one solution to another. Systems always attempt to achieve equilibrium, or a balanced state. A **hypertonic** solution has a higher concentration of dissolved solute. This can also be thought of as a lower concentration of water. A **hypotonic** solution has a lower concentration of dissolved solute, or a higher concentration of water. So, substances will tend to flow from hypotonic solutions to hypertonic ones, or from an area of high water concentration to an area of low water concentration. Water is attempting to reach equilibrium by diffusing through the membrane. When the concentration of dissolved solutes is the same in two solutions, the solutions are said to be **isotonic**. Here, there is no net movement of water molecules.

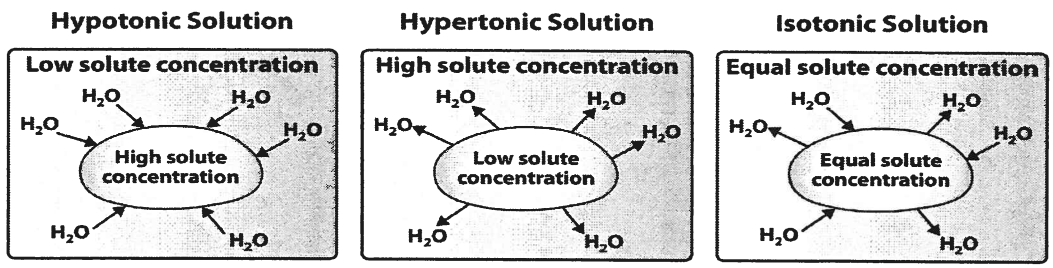


Figure 7.7 Osmosis in Types of Solutions

ACIDS AND BASES

SCILINKS THE WORLD'S A CLICK AWAY ABC285 acids and bases

A solution can also described as being acidic or alkaline (basic). An **acid** is a compound that contains hydrogen and dissolves in water to produce hydrogen ions (H^+ or H_3O^+). So, an acidic solution will have lots of hydrogen ions. **Strong acids** are acids that almost completely dissolve in water. Hydrochloric acid (HCl) is a strong acid. The hydrogen ion separates from the chloride ion in water. **Weak acids** are acids that partially dissolve in water. Most acids are weak. Examples of common acids are citric acid in a lemon, tannic acid in tea, lactic acid in sour milk and acetic acid in vinegar.

A **base** is a compound that dissolves in water and produces hydroxide ions (OH^-). A solution that is basic will contain many hydroxide ions and few hydrogen ions. A solution that contains a base is **alkaline**. Examples of common bases are sodium hydroxide in lye, ammonium hydroxide in ammonia and calcium hydroxide in limewater. Many bases do not dissolve in water, but a few like sodium hydroxide (NaOH) do.

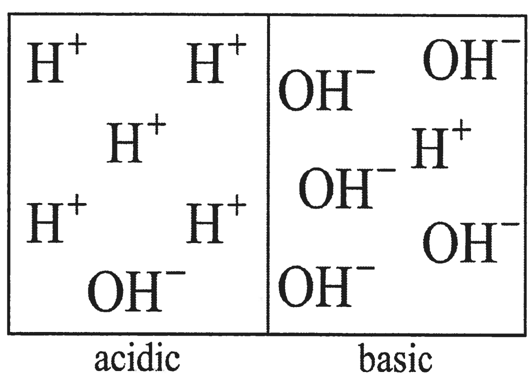


Figure 7.8 Acid and Base Solutions

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

THE pH SCALE

The acidity and alkalinity of a solution is measured using the **pH scale**. pH is short for "potential of hydrogen." The pH scale ranges from 0 to 14 with 0 being acidic and 14 being basic. It is logarithmic, meaning that a difference of one pH unit represents a tenfold change in hydrogen ion concentration. It is not important to know how to calculate pH, but it is important to know how pH changes with hydrogen ion concentration. As the pH values decrease (become more acidic), the concentration of hydrogen ions increases. For instance, a substance with a pH of 2 has 10 times the hydrogen ion concentration as a substance with a pH of 3.

As the pH values increase (become more basic), the concentration of hydroxide ions (OH^-) increases. A substance with a pH of 11 has 100 times (10×10) the hydroxide ion concentration as a substance with a pH of 9. If this seems confusing, just remember that if you hear about a solution having a low pH, it means that it is quite acidic. If a solution has a high pH, it means it is quite basic.

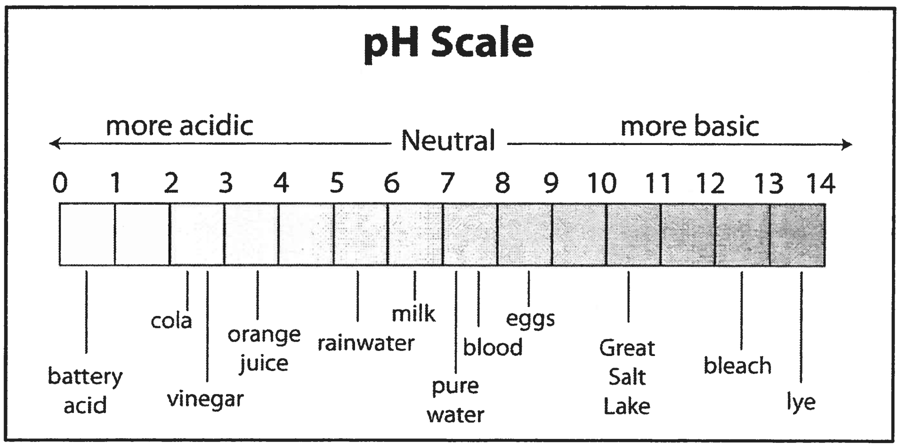


Figure 7.9 pH Scale

Water is a neutral compound. When this is translated to the pH scale, water has a pH of 7. This is considered the neutral point. Acids have pHs lower than 7, and bases have pHs higher than 7. One way to think of this is that for every pH point lower than 7, the solution has 10 times more H^+ floating around than is present in regular water. Likewise, every pH point above 7 means that there is 10 times more OH^- present than in water.

Activity

Make a pH scale similar to Figure 7.9 using the following items: stomach acid, ammonia, sea water, lime juice, over cleaner, coffee, milk of magnesia, tomato juice and drain cleaner.

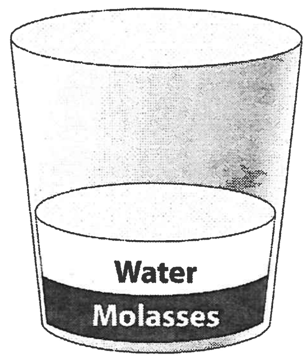
Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.

CHAPTER 7 REVIEW

1. A homogeneous mixture could be described as

   A a pure substance.
   B evenly mixed.
   C chemically bound.
   D unevenly mixed.

2. What does the following figure show?



   A a homogenous mixture
   B a heterogeneous mixture
   C a heterogeneous compound
   D a solution

3. The movement of water across a semi-permeable membrane from an area of high water concentration to an area of low water concentration is called

   A isotonic. B diffusion. C osmosis. D hypotonic.

4. The substance that dissolves the solute is called the

   A solution.
   B solvent.
   C molecule.
   D salt water.

5. Which of the following has the highest concentration of OH^- ions?

   A vinegar
   B pure water
   C rainwater
   D bleach

Copyright © American Book Company. DO NOT DUPLICATE. 1-888-264-5877.