
# What Dissolves in Water?

from *The Science of Water Teacher's Guide* and for *Mystery of the Muddled Marsh*

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The activities described in this book are intended for school-age children under direct supervision of adults. The authors and Baylor College of Medicine cannot be responsible for any accidents or injuries that may result from conduct of the activities, from not specifically following directions, or from ignoring cautions contained in the text.

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## SOURCE URLS

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U.S. Environmental Protection Agency, Office of Water
www.water.epa.gov

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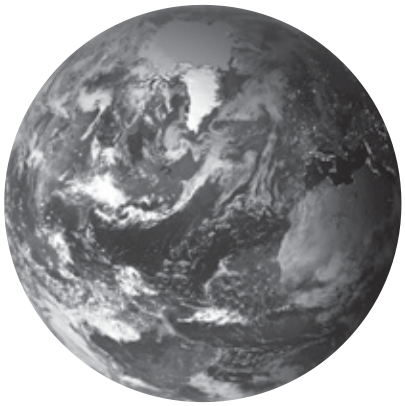
# Properties of Water

Physical Science Basics



In the water (hydrologic) cycle, individual water molecules travel as liquid water in the oceans, water vapor in the atmosphere, water and ice on the land, and underground water.

Source: NASA Earth Observatory.

More than 70% of Earth's surface is covered by water, with about 96.5% of it in the global oceans. This amazing substance is essential for all life on our planet and helps maintain Earth's climate. Water has several unique properties that distinguish it from most other substances.

- **Water has both a high boiling point (100°C; 212°F) and a low freezing point (0°C; 32°F).** Consequently, it can be found naturally as a solid (ice or snow), a liquid (liquid water) and a gas (steam or water vapor), at any given time on our planet.
- **Liquid water changes temperature very slowly.** This characteristic helps animals to maintain their body temperatures. It also keeps large areas of water from warming or cooling rapidly, thereby helping to regulate Earth's climate.
- **Liquid water is an excellent solvent.** This property makes water valuable to living organisms. All of the thousands of chemical processes inside cells take place in water. Water also carries dissolved nutrients throughout the bodies of living organisms and transports wastes. Unfortunately, the same characteristics make liquid water easy to pollute, because so many different chemicals can be dissolved in it.
- **Molecules in liquid water are attracted to one another and, as a result, "stick" very closely together.** This properly explains water's ability to form rounded droplets and to rise within a thin, hollow tube. This characteristic is important for plants, which conduct water and nutrients through very narrow tubes extending from the roots to the branches and leaves.

Water droplets on *Taraxacum officinale*, the common dandelion.

Composite image of Earth by Reto Stöckli, NASA Earth Observatory. Photo of *Tarasacum officinale* by Böhringer Friedrich, Wikimedia Creative Commons 2.5.

- **Liquid water expands when it becomes a solid (ice).** Most substances take up less space when they are transformed from a liquid to a solid. Water, on the other hand, actually takes up more space as a solid because the molecules in ice crystals are farther apart than those in liquid water. Since it is less dense, ice floats on top of liquid water.

Ice, liquid water and clouds at Lake Yellowstone, Teton County, Wyoming.

- **Water is colorless and allows light to shine through it.** Plants can grow underwater because water is transparent to the wavelengths of light needed for photosynthesis.

Most of these properties are related to the structure of the water molecule, which consists of two hydrogen atoms and one oxygen atom. The oxygen atom and the hydrogen atoms share electrons, but the electrons are not shared equally. The electrons are pulled toward the oxygen side of the molecule, which ends up with a slight negative charge. Correspondingly, the hydrogen side of the molecule ends up with a slight positive charge. This separation of positive and negative charges (polarity) causes each water molecule to act like a tiny magnet, capable of clinging to other water molecules and to any other electrically charged particle or surface.

## TEACHER RESOURCES


Downloadable activities in PDF format, annotated slide sets for classroom use, streaming video lesson demonstrations, and other resources are available free at www.k8science.org or www.bioedonline.org

Photo of Lake Yellowstone by J. Schmidt, National Park Service.

# What Dissolves in Water?

Physical Science

## CONCEPTS

- Some liquids and solids will dissolve in water.
- Substances dissolved in water sometimes are invisible.

## OVERVIEW

Students investigate whether several common substances are soluble in water.

## SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Making and recording observations
- Measuring
- Drawing conclusions

## TIME

**Preparation:** 10 minutes
**Class:** 30 minutes

## MATERIALS

Each group will need:

- 6 cups, 9-oz clear plastic
- 6 cups, 2-oz clear plastic (or bottle caps)
- 6 spoons (or coffee stirrers)
- Beaker, 100–250 mL
- Tsp each of salt, sugar, flour, oil (clear), diluted food coloring and ground coffee (not instant)
- Water
- Copy of "Disappearing Act—My Observations" page

When one substance becomes dissolved in another, the atoms or molecules of each substance are mixed evenly together.

One of the most important properties of liquid water is its ability to dissolve many different substances. The same forces of attraction among molecules that account for the "stickiness" of water also act as tiny magnets that pull certain types of molecules (such as table salt) apart or allow some substances (alcohol, for example) to mix uniformly with water. In general, molecules that have a positive end and a negative end, or that can separate into components with positive and negative charges, will dissolve in water. Molecules without these characteristics, such as oils, will not dissolve in water.

The uniform mixture that results when one substance (such as table salt) is dissolved completely in another (such as water) is called a solution. Many common items are solutions. Household vinegar, for example, is a solution of acetic acid in water.

The reactions that take place inside living cells depend on the presence of water. Likewise, organisms require water outside of cells to transport nutrients and other substances from place to place, and to carry waste products away. In our daily lives, we take advantage of water's abilities to dissolve and remove unwanted substances by using it for cleaning and rinsing.

## Unit Links

***Mystery of the Muddled Marsh***
Story, pp. 4–9

***Explorations***
The Great Dissolver, p. 4

## SETUP

Before beginning, prepare a dilute solution of food coloring by adding several drops of any color to a glass of water. This will be one of the substances tested in this activity.

Set all the materials in a central area. Students should work in groups of four.

## PROCEDURE

1. Distribute a copy of the student page to each group. Have Materials Managers pick up materials for their groups.
2. Show the students a clear glass of water. Ask, *Have you ever mixed or stirred something into a glass of water? What happened? Do you think that everything can mix with water?* Tell students that they will observe what happens when they mix different things with water.
3. Before student groups begin, have them predict what will happen when they mix each substance with water.
   You may want to give groups time to discuss criteria for deciding if something has "dissolved." For example, a substance

could be considered dissolved if the water is transparent, not cloudy, after the mixture has been stirred.

4. Have students measure approximately 100 mL of water into each of the six cups. Guide the groups as they conduct their tests, one substance at a time, in separate cups. For each test, ask students to observe the substance. Ask, *Is it a liquid or a solid?* Next, have students measure about one teaspoon of the substance into one of the cups of water and stir until there is no change in the mixture. Finally, they should note what happened and record their observations.
5. When students have completed their investigations, discuss their observations. Project a transparent copy of the "My Observations" sheet or draw a similar table on the board, and call on each group to share its observations for one of the substances. Expect the following results.
   - **Salt.** Will dissolve (disappear), leaving a clear solution.
   - **Sugar:** Will dissolve (disappear), leaving a clear solution.
   - **Flour.** Will not dissolve; the mixture will be cloudy, because the large flour particles will remain suspended in the water (example of a colloid).
   - **Oil.** Will not dissolve; the oil will float on top of the water because the oil is less dense, and because the oil molecules will not mix with the water molecules.
   - **Food coloring.** Will dissolve; the resulting transparent liquid will be colored.
   - **Coffee.** Part of the coffee will dissolve in the water, coloring it brown; the remainder of the coffee (woody parts of the coffee bean) will not dissolve or disperse through the liquid and will float.
6. Conclude with a discussion of the students' observations. Ask, *Which things disappeared into the water when you stirred? Do you think that they (salt or sugar) are still there? How could you figure this out?* Ask about the other substances.
7. Extend the discussion to include students' ideas about how water's role as a "dissolver" is useful in daily life. Have students think about things that remain in water after it is used for cleaning, rinsing, etc. Ask how this might contribute to water pollution. Also ask, *How many substances did you dissolve in (or add to) water today?*

## VARIATIONS

- Create filtering cups by punching holes in the bottoms of disposable cups. Line the cups with coffee filters or paper towels. Have the student groups pour the contents of each cup used for the activity through the filtering cups and report the results.

Substances like alcohol that dissolve easily in water are called hydrophilic, from the Greek words *hydro-* (water) and *-philos* (loving).

### COLLOIDS

When fine particles are dispersed throughout another substance, the mixture is called a colloid. The particles in a colloid usually are greater in size than those in a solution. The easiest way to tell a colloid from a true solution is to shine a light through the mixture. The beam of light will pass through a solution (such as salt mixed in water) without any visible effect. But when light is shone through a colloid (such as a mixture of flour and water), the beam's path will be illuminated clearly.

There are different kinds of colloids. A sol is a solid dispersed in a liquid. An aerosol is a solid or liquid in a gas (fog is an aerosol). An emulsion is small globules of one liquid in a second liquid, and a foam is gas bubbles in a liquid or a solid.

# Disappearing Act — My Observations

| Substance | What do you think will happen? | Describe what happened. |
|---|---|---|
| Salt | | |
| Sugar | | |
| Flour | | |
| Oil | | |
| Food Coloring | | |
| Coffee | | |

# Acto de desaparición—Mis observaciones

| Sustancia | ¿Qué piensas que va a pasar? | Escribe lo que pasó. |
|---|---|---|
| Sal | | |
| Azucar | | |
| Harina | | |
| Aceite | | |
| Colorante | | |
| Café | | |