



MISSOURI
STREAM
TEAM

**Stream Team Academy
Fact Sheet Series**

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Collect this entire educational series for future reference! Contact us at 1-800-781-1989 if you'd like copies of previous Fact Sheets and a binder for storing them.

THE PROPERTIES OF WATER

An Educational Series For Stream Teams To Learn and Collect

By Chris Riggert, Stream Team Program Coordinator



One oxygen and two hydrogen atoms. It seems like such a simple equation. But, this "simple" compound and its structure lead to some complex and interesting properties and interactions, some of which are what make life on this planet possible.

Earth is sometimes referred to as the water planet because about 70% of its surface is covered with water. Nearly all of it is contained in our oceans, with only about 3% of earth's water as freshwater, and most of that is frozen in glaciers and polar ice caps. Life as we know it would not be possible without water. It is the only natural substance which can be found as a solid, liquid, and gas at temperatures normally found on Earth. This creates many opportunities for life to flourish.

Water is part of every living organism on the planet. In fact, water makes up to

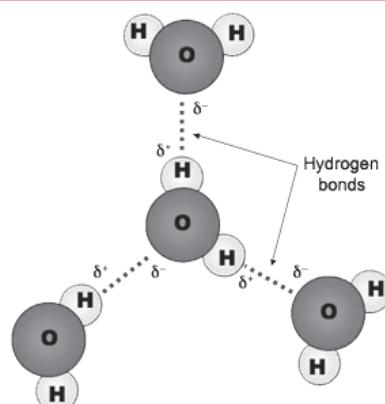
90% of body weight of some organisms. Humans are about 60% water.

HOW MUCH WATER ARE WE?

- ◆ Lungs: about 83%
- ◆ Kidneys: about 79%
- ◆ Brain and heart: about 73%
- ◆ Skin: about 64%
- ◆ Bones: about 31%

Hydrogen ions are positively charged (+) and are attracted to the negatively charged (-) oxygen ion. They attach at a 105° angle through covalent bonds. This molecular structure gives the water molecule **polarity**, or a lopsided electrical charge that attracts other atoms. The end of the molecule with the two hydrogen atoms is positively charged and the end with the oxygen is negatively charged. This positive/negative charge makes the molecule "sticky" and is held together through hydrogen bonds. It is these hydrogen bonds that make water molecules so cohesive and water so special. In fact, water is the most cohesive non-metallic liquid.

Water's hydrogen bonds create tugging forces between water molecules, resulting in a high surface tension, allowing water molecules to clump together in drops. If you look closely at a water droplet, it appears to be coated in plastic. If you were to pour a small amount onto a flat surface, a small mound forms, preventing it from simply running off the edge. This surface tension forms a thin film where organisms such as water striders can "walk" across the water. However, it is this



Polarized hydrogen bonds between water molecules attract water molecules to each other, forming the strongest cohesive non-metallic liquid compound on Earth.

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same surface tension many benthic insects must overcome when hatching into an adult.

Surface tension also allows water to move upwards against the pull of gravity through capillary action. Water's high surface tension also allows water to be held by soil particles, providing a medium for plants to obtain nutrients. Water's adhesive properties are responsible for capillary action, allowing water and dissolved substances to be absorbed into porous materials and move through roots of plants and through tiny blood vessels in our bodies.

Water's many hydrogen bonds give it a high **Specific Heat Index**, or the amount heat per unit mass required to raise the temperature by one degree Celsius. It takes a lot of energy to break water's hydrogen bonds. This means it can absorb a lot of heat before it gets hot, making it an excellent insulator. Because our planet is mostly water, oceans help regulate the rate at which air temperatures change and is the reason why seasonal temperature changes are gradual rather than sudden. This gradual change in temperatures allows organisms to survive by adjusting gradually themselves. It also helps regulate the earth's overall temperatures as well as influences weather patterns.

Water is considered the "**universal solvent**" because it dissolves more substances than any other liquid. Its adhesive properties allow it to pick up valuable chemicals, minerals, nutrients, and waste as water moves through the ground or through our bodies. From a biological standpoint, water brings food into and carries waste away from cells. Water also absorbs heat when it evaporates; allowing humans to regulate body temperatures by releasing water through our skin pores, which then evaporates, cooling us off.

One additional interesting property of water deals with its **density** at different temperatures, or mass per unit volume. Most compounds become less dense as

they warm because molecules move further apart, and become denser when they cool as molecules come closer together. Water does get denser as its temperature decreases. However, it is the densest at 4° C and then begins to expand, with maximum number of hydrogen bonds forming a crystal lattice as it freezes with molecules which are further apart. This allows frozen water (0° C) to float on the slightly warmer water below it. This is very important to aquatic life. If ice were denser than liquid water it would sink and eventually freeze solid. However, by floating, ice creates an insulating layer, preventing the water below from freezing and allowing the living things underneath to survive the winter.

Because water can exist as a vapor, it can be stored in the atmosphere and delivered as rain across the planet.

The next time you take a sip of water, paddle a canoe across the surface, listen to the rain, or watch the snow, think of these properties and their importance to life on the "water planet."



PHYSICAL STATES OF WATER

- ◆ Freezing point at sea level: 32° F
- ◆ Boiling point at sea level: 212° F
- ◆ Boiling point at 14,000 feet: 186.4° F
- ◆ Freezing and boiling points are baselines with which temperature is measured



A water strider is able to "skate" across water due to high surface tension formed by the strong bonds between water molecules.