solid/liquid/gas

what water is and how it behaves

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Water is not only the most common substance on earth, it is also one of the most unusual. No other substance can do all the things that water can do. Water is an exception to many of nature's rules because of its unusual *properties* (qualities).

**The Chemistry of Water.** Water consists of tiny particles called *molecules*. A drop of water contains many millions of molecules. Each molecule, in turn, consists of even smaller particles called *atoms*. Water molecules consist of atoms of hydrogen and oxygen. Hydrogen and oxygen by themselves are gases. But when two atoms of hydrogen combine with one atom of oxygen, they form the chemical compound $H_2O$—water.

Even the purest water contains substances besides ordinary hydrogen and oxygen. For example, water contains very tiny portions of *deuterium*, a hydrogen atom that weighs more than the ordinary hydrogen atom. Water formed by a combination of deuterium and oxygen is called *heavy water*

Water is actually a combination of several different substances, but they make up only a small fraction of it.

**The Properties of Water.** Water can be a solid, a liquid, or a gas. No other substance appears in these three forms within the earth's normal range of temperature. The molecules that make up water are always moving, and the form water takes depends on how fast they move. The molecules in solid water (ice) are far apart and almost motionless. The molecules in liquid water are close together and move about freely. The molecules in water vapor, a gas, move about violently and bump into one another.

*Ice.* Most substances contract as they grow colder. But when water reaches 32° F. (0° C.) and freezes into ice, it expands. For this reason, ice floats on liquid water. If water contracted upon freezing, any volume of ice would be heavier than an equal volume of liquid water. **Ice would then sink. If ice sank, the earth would become a lifeless arctic desert.** Each winter, more and more ice would pile up on the bottom of lakes, rivers, and oceans. In summer, the sun's heat could not reach deep enough to melt the ice. Water life would die. The hydrologic cycle would slow down. In time, all the earth's waters would be solid ice, except perhaps for a thin layer of water over the ice during summer.

*Liquid.* Water is a liquid at temperatures found in most places on the earth. No other common substance is liquid at ordinary temperatures. In fact, the temperatures at which water is a liquid are unusual. Water is a liquid between 32° F., its freezing point, and 212° F. (100° C.), its boiling point. But substances that have a structure like that of water are not liquid within this temperature range. These substances include gases with the formulas $H_2Te$, $H_2Se$, and $H_2S$. As their formulas show, they are closely related to water ($H_2O$). Each has two atoms of hydrogen, plus an atom of the elements tellurium, selenium, or sulfur. If water behaved like these close relatives, it would be a liquid between about −148° F. (−100° C.) and −130° F. (−90° C.). In that case, there would be no liquid water on earth because the earth's temperatures are far higher than −148° F.

A cubic foot of water weighs about 62.4 pounds. Scientists compare the weight of other substances with the weight of water to find the *specific gravity* of the substance

*Vapor.* If an uncovered glass of water stands in a room for a few days, the water will gradually disappear. This is because the water molecules are moving constantly. Those at the surface break free of those below and enter the air as vapor. The warmer the water is, the faster it evaporates, because the molecules move faster.

Water can also be turned into vapor by boiling it, and creating *steam*. It takes an enormous amount of heat to produce steam. Water boils at 212° F. But when water reaches the boiling point, it does not immediately turn into steam. First there is a pause, during which the water absorbs additional heat without any rise in the temperature. This heat is called *latent heat*. More than five times as much heat is required to turn boiling water into steam as to bring freezing water to a boil. Thus, steam holds a great amount of latent heat energy. Man uses this energy to run machinery.

Water vapor in the air also holds a tremendous amount of latent heat energy. This energy is released when the vapor cools and condenses, and falls as rain. The high latent heat of water is related to water's remarkable heat capacity.

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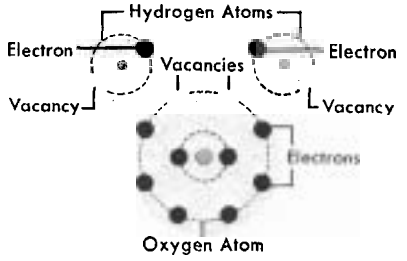
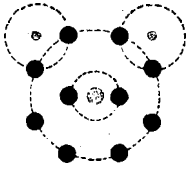
**THE WATER MOLECULE**




A water molecule consists of two hydrogen atoms and one oxygen atom. Each hydrogen atom has room for another electron around its nucleus. The oxygen atom has room for two more electrons.



Water Molecule

The two hydrogen atoms and one oxygen atom fill their empty spaces by sharing electrons. The resulting water molecule is an extremely tight structure because its atoms share their electrons.

name _____

class _____ date _____

team _____ seat _____

**water** solid- ice
liquid
gas - vapor

Explain the mistake made in the artide when it talks about the molecules of solid, liquid and gas forms of $H_2O$.

Why would it be really bad for the Earth if ice did not float?

Explain why water is an "Unusual" substance.

Draw a diagram / picture of a water molecule



What is the difference between a molecule and an atom?

What are properties?

How can we force water to become a gas?