

Heat: An Agent of Change

Atoms and Molecules in Motion:
States of Matter

STUDENT TEXT



Everything in the universe is either matter or energy. All matter is made of combinations of about one hundred basic building blocks, the chemical elements on the periodic table. Going a step further and breaking these elements down to atoms, all the elements are made of the same pieces, too!

Scientists have named the parts of the atom *protons*, *neutrons*, and *electrons*. Incredible as it may seem, the difference among the elements on the periodic chart is simply the number of these particles that make up the various atoms. For example, chlorine is a deadly poisonous, greenish gas. Sodium is a metal that reacts so violently with water, it must be stored in a jar of oil so that it doesn't make contact with the water vapor in air. Chlorine has 17 protons and electrons, and sodium has 11. That causes huge differences in their properties.

Atoms combine with each other in special ways to form compounds. Compounds are completely different from the elements that make them. The deadly poisonous gas chlorine combines chemically with the highly explosive sodium to create the compound NaCl, sodium chloride.

Sodium chloride sounds like a dangerous combination. It's not. We eat sodium chloride. It's table salt! Compounds can be completely different from the elements from which they are made.



Two atoms of the element hydrogen and one atom of the element oxygen combine to make one molecule of water, H₂O. You will study more about chemical compounds in chemistry at another time. For this activity, consider that everything that is matter is made up of atoms or molecules.

Molecules are always moving. Scientists say they vibrate (jiggle), rotate (spin), and translate (move from place to place). The molecules in your pencil, your paper, and even your chair are in motion right now.

Matter commonly exists on earth in three forms: solid, liquid, and gas. These three forms are called the **three states of matter**. Water is unusual, because it can be readily found on earth in all three states. Other matter is usually found in only one form.

The main difference between a solid and a liquid, or between a liquid and a gas, is how fast its molecules are moving. In a solid, the molecules are tightly packed and cannot move very much. In a liquid, the molecules have more space and can move about more. Gas molecules are moving very fast and are even farther apart.



Water can change into ice (liquid to solid), or into water vapor (liquid to gas). Ice can melt (solid to liquid), and water vapor can condense (gas to liquid). What makes something change from one state of matter to another? Heat energy.