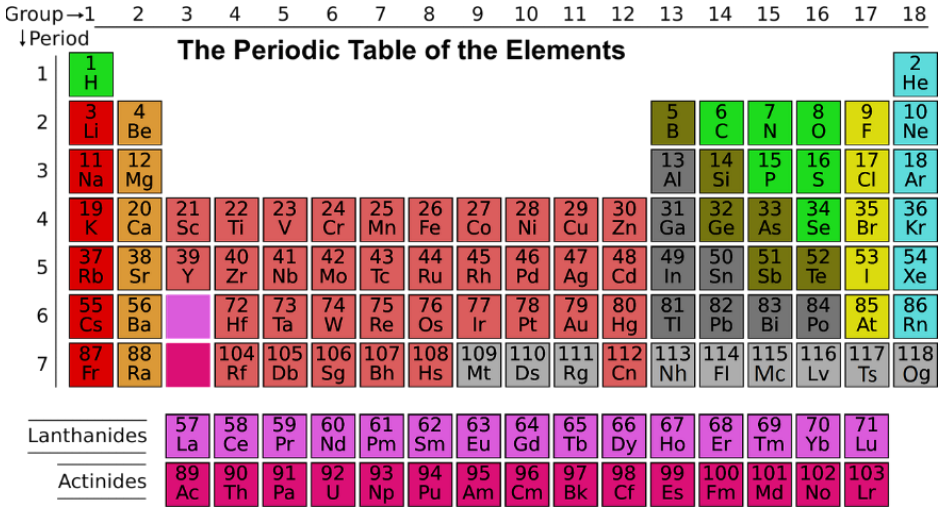
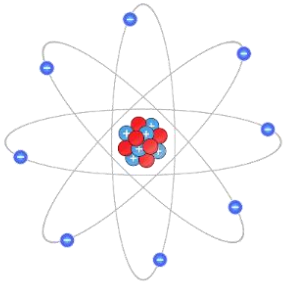
ATOMS AND MOLECULES

What is the tiniest thing you can imagine? **Atoms** and **molecules** are probably even smaller than that! The largest atom is about a million times smaller than the width of a human hair.

Atoms are building blocks that make up every kind of matter in the universe. An atom is the smallest unit of an **element**, which is a substance made up of only one kind of atom. Atoms of each element are different. In chemistry, the **Periodic Table of Elements** (shown below) contains 118 **elements.** The Periodic Table is a way of listing all of those elements based on the structure of their atoms.

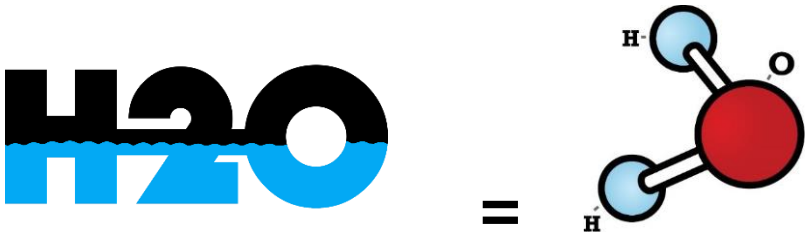


Atoms are made up of even smaller particles called **protons**, **neutrons**, and **electrons**. Different **substances** (particular kinds of matter with uniform properties) have different numbers of protons, neutrons, and electrons.



The image above is a model of an atom. The **protons** and **neutrons** are in the center of the atom. Together they are called the **nucleus**. The **electrons** move about in a cloud around the nucleus. Protons have a positive (+) electrical charge. Neutrons do not have a charge, and electrons have a negative (-) charge. The negative electrons are attracted to the positive charge of the protons.

When atoms use their electrons to join together in a particular order, or **bond**, they form **molecules.** When two hydrogen (H) atoms and one oxygen (O) atom join together, they form water. You may have heard of water referred to as **H_2O**.

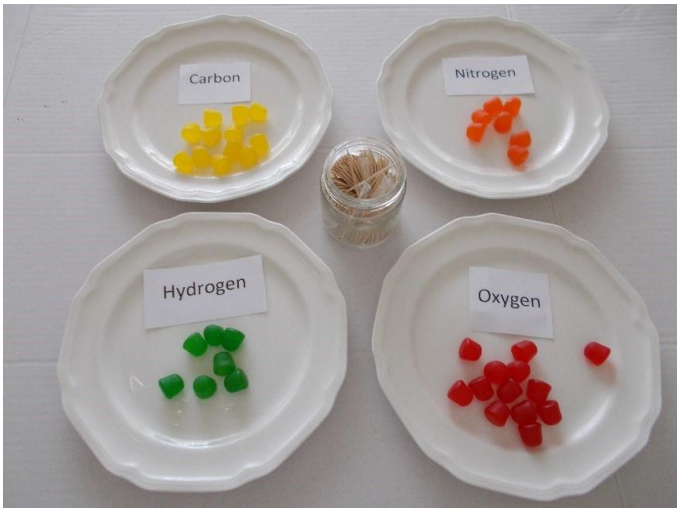


The branch of science that studies what everything is made of is called **chemistry. Chemists** are the scientists that study chemistry, and they can work almost anywhere. The kind of work they do depends on where they work. Often their work is done in a laboratory where they conduct research and perform experiments.

ACTIVITY: Building models of molecules

Materials

- Toothpicks
- Some kind of soft candy in various colors to represent atoms
- Four bowls or dishes to separate the candy by color
- Four labels made of paper or masking tape: carbon, nitrogen, hydrogen, and oxygen



1. Using the information listed below, construct models of different molecules using the candies to represent different atoms.
2. Count out the number of candies (atoms) needed for each molecule.
3. Connect (bond) the candies together by sticking the toothpicks into the correct color and number to form a model of the molecules.

Construct these molecule models:

Oxygen – 2 oxygen atoms (O_2)

Oxygen is the 8th element on the Periodic Table. It is a colorless, odorless gas at room temperature. Oxygen is in the air you breathe; you are breathing in oxygen right now. Most living things need oxygen to survive. Oxygen is also found in plastics, in water, and in rocks and soil. Oxygen was discovered by chemist Joseph Priestly in 1774.

Hydrogen peroxide – 2 hydrogen atoms and 2 oxygen atoms (H_2O_2)

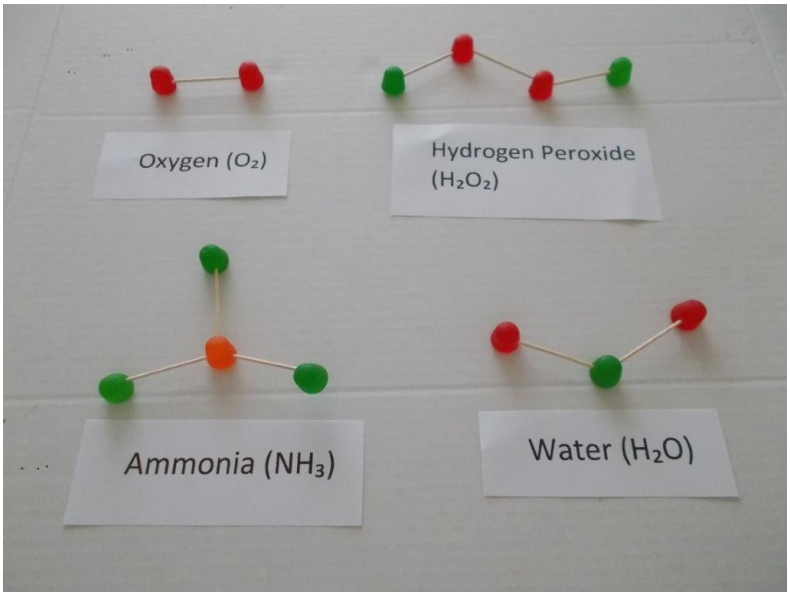
Hydrogen peroxide is a colorless liquid often used to kill germs and bacteria and to help wounds heal. It is also used for bleaching, to produce other chemicals, and has been used to propel rockets. Hydrogen peroxide was discovered by a scientist named Louis Auguste Thenard in 1818.

Ammonia – 1 nitrogen and 3 hydrogen atoms (NH_3)

Ammonia is a colorless gas and is one of the most commonly produced chemicals. It is used to manufacture many things people use every day including fertilizers (ammonium nitrate), and cleaning products (ammonium hydroxide). Ammonia occurs naturally in the air, soil, and water. Ammonia is found in the human body when the body breaks down foods containing protein. It is also produced from the decomposition of plants, animals and animal waste and has a very distinct, strong, and irritating odor.

Water – 1 hydrogen and 2 oxygen atoms (H_20)

Water is one of the most plentiful and essential compounds that is found in liquid, gas, and solid states. It is tasteless, odorless and colorless. Water is essential for life on Earth. Up to 60% of the human body is made of water. Water forms rain, rivers, lakes, and oceans.



Molecule models

Greenhouse gases - gases that trap heat in the atmosphere**:**

Ozone – 3 oxygen atoms (O_3)

Ozone is a highly reactive gas that occurs naturally and as a manmade product in the Earth's upper (**stratosphere**) and lower (**troposphere**) atmosphere.

Ozone pollution is what we commonly experience as smog. Some sources of pollutants include chemical plants, gasoline pumps, power plants and motor vehicles.

Nitrous Oxide – 2 nitrogen atoms and 1 oxygen atom (N_2O)

Nitrous oxide is a colorless gas that can be used as an anesthetic, especially by dentists. It is an atmospheric pollutant produced by combustion (burning) of fossil fuel, wastewater treatment, and industrial processes. It occurs naturally in the Earth's atmosphere as part of the nitrogen cycle.

Carbon Dioxide –1 carbon atom and 2 oxygen atoms (CO_2)

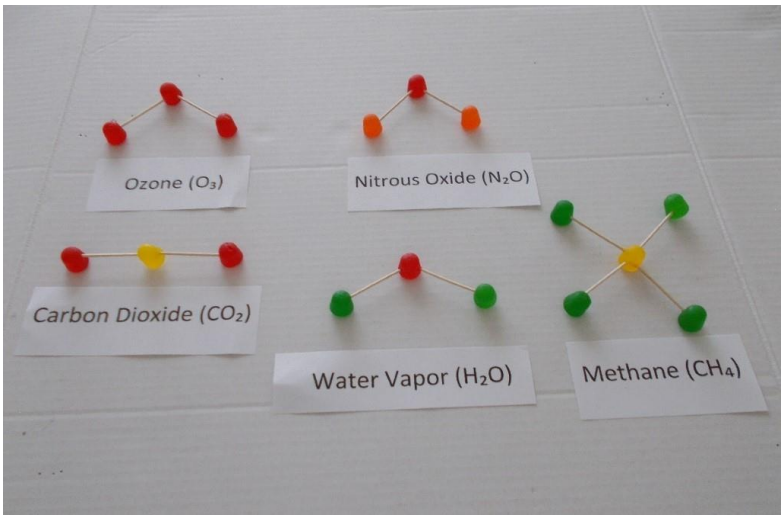
Carbon dioxide gas is released by natural processes such as volcanic eruptions and breathing. Human activities, such as the burning of fossil fuels, (coal, natural gas, and oil), the burning of trees, waste, and certain industrial chemical reactions have caused an increase in CO_2 in the atmosphere. It is the primary greenhouse gas released by human activity. Carbon dioxide can be removed by plants as part of the carbon cycle through photosynthesis.

Water vapor – 1 hydrogen and 2 oxygen atoms (H_20)

Water vapor is the most abundant greenhouse gas in the atmosphere. This increased water vapor is part of a "feedback process". Warm air holds more moisture. As the climate get warmer, there is more evaporation of water from bodies of water and land, which increases the moisture content in the air. This absorbs more energy from the Earth and further warms the atmosphere. Increased water vapor in the air has been said to double the greenhouse effect when compared to carbon dioxide.

Methane – 1 carbon atom and 4 hydrogen atoms (CH_4)

Methane is released naturally in the environment as a biological process in places like swamps. Human activities, such as the production of gas, coal, oil and natural gas, cattle raising, and farming add methane to the environment.



Models of five greenhouse gasses

Congratulations! You now have a basic understanding of molecular structure and how atoms fit together to form molecules.

ADDITIONAL RESOURCES:

Books available from the Washoe County Library System:

Atoms by Chris Oxlade

Chemistry by Ann Newmark

Chemistry: Investigate the Matter that Makes Up Your World by Carla Mooney and Samuel Carbaugh

Chemistry: the Story of Atoms and Elements by Bryson Gore

Climate Change: a Hot Topic by Dan Green and Simon Basher

The Electron by Alfred Bortz

The Periodic Table: Elements with Style by Adrian Dingle, Simon Basher, and Dan Green

Queen of Physics: How Wu Chien Shiung Helped Unlock the Secrets of the Atom by Teresa Robeson and Rebecca Huang

Your Guide to the Periodic Table by Gill Arbuthnott and Marc Mones

Videos

CERN, "Voyage into the World of Atoms" https://youtu.be/7WhRJV_bAiE

Disney Educational Productions, Bill Nye the Science Guy, "Atoms" https://youtu.be/aNK1mQfNeik

European Space Agency, ESA Kids, "Paxi – The Greenhouse Effect" https://youtu.be/Ke140nuy15E

TED-Ed, "Just How Small is an Atom?" https://youtu.be/yQP4UJhNn0I

Websites

Dorling Kindersley, DK find out!, Molecules https://www.dkfindout.com/us/science/solids-liquids-and-gases/molecules/

NASA, Climate Kids, Meet the Greenhouse Gases! https://climatekids.nasa.gov/greenhouse-cards/

National Institute of Environmental Health Sciences, Kids Environment Kids Health, Greenhouse Gases and the Greenhouse Effect https://kids.niehs.nih.gov/topics/natural-world/greenhouse-effect/index.htm