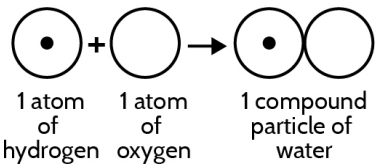
Name: _____ Date: _____

A summary of some historical investigations and discoveries into the particle nature of matter

When you added energy to water by heating it, you found that it did not make a new substance. But, when you added energy to water with electricity, it produced two different substances. By the early 1800s, scientists had also discovered this. They measured the density of the flammable gas produced by adding electricity to water. It had a density of 0.09 g/L. This was much less dense than other flammable gases, like marsh gas (methane). They referred to this very low-density flammable gas as hydrogen. They referred to the other gas that was produced as oxygen.

Dalton developed a new idea to explain these results. He argued that water itself must be made of the same parts that make up each of the two gases. He claimed that each water particle was a compound particle made of smaller parts. He called these smaller parts atoms. His model of a water particle contained one hydrogen atom and one oxygen atom.

He developed a way of representing this idea in a diagram, which is represented to the right. How does his model of a water particle compare to ones you developed and used in previous lessons?



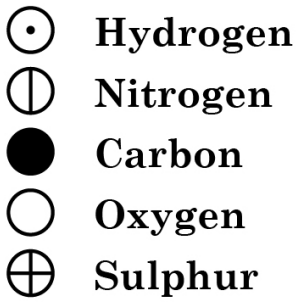
In addition to making hydrogen gas and oxygen gas out of water, other scientists found you can also do the reverse. You can make water out of hydrogen gas and oxygen gas. When scientists combined both gases together and added energy (e.g., a spark) an explosion occurred and water droplets appeared. When they did this in a closed system, the mass of the entire system did not change. This showed scientists that you can also put atoms together to make a compound particle (water). This was the opposite of what happened when they broke water particles into hydrogen and oxygen atoms. Scientists named the way that atoms can be rearranged to make new substances a chemical reaction.

Over time, scientists started referring to compound particles, like water, as molecules. Dalton did additional experiments on more substances to see if they were made of compound particles (molecules) that could be broken apart into atoms. These experiments ended up producing the same type of gases over and over again, from the many different substances that he tested.

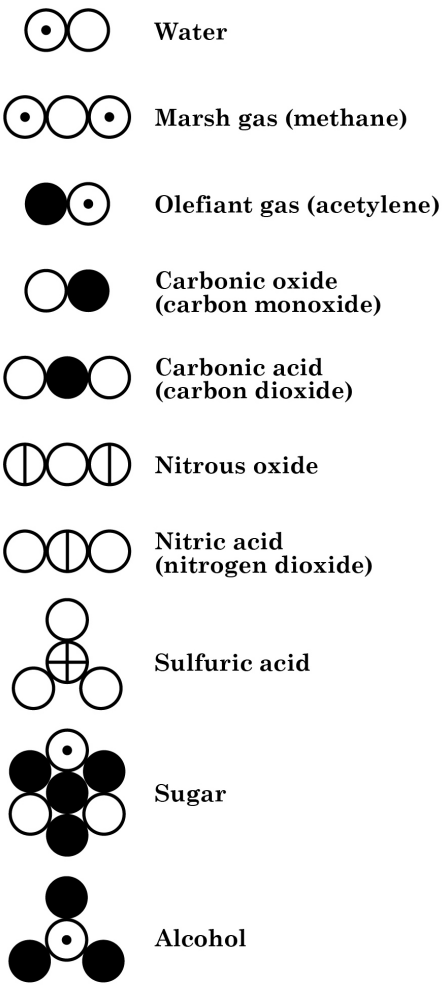
This led Dalton to suggest that all of these different substances were made of only a few different types of atoms. At first, he proposed that all of the substances he tested were made of only five different types of atoms. The diagrams here are replicas of those published by Dalton in 1803. Use these diagrams to see if you can explain how it is possible that just five types of atoms could make up these substances.

Only ten substances are listed in the diagram to the right. How many other substances do you think are made of the types of atoms shown below?

Types of atoms



The compound particles (molecules) that these different substances are made of



Dalton measured the mass of the substances he started with as well as the new substances that were produced in his experiments. This helped him determine that different substances had different amounts of the same types of atoms.

For example, he found that both vinegar and sugar contained only three types of atoms - carbon, hydrogen, and oxygen. But sugar molecules had more carbon atoms in them than acetic acid (vinegar) molecules did. Because the mass of all of the substances in a closed system never changed in his experiments, regardless of what new substances were formed, it led him to propose the idea that atoms cannot be divided and cannot be destroyed.

As Dalton tested more substances, he discovered new types of atoms. He ended up discovering 36 types of atoms all together. These types of atoms included ones like iron, gold, copper, aluminum, and phosphorus.

Atoms are too small to see (an atom is a million times smaller than the thickest human hair). In spite of this, scientists found ways to determine exactly how many atoms made up different substances. One example of this is related to water. Dalton originally proposed that a single water molecule was made of one hydrogen atom and one oxygen atom. Later, scientists were able to show that a water molecule must be made of two hydrogen atoms and one oxygen atom. One piece of evidence that supported this was something you may have noticed when you used a battery to produce bubbles from water. The bubbles that contained hydrogen gas were produced at twice the rate and twice the volume as the bubbles that contained the oxygen gas.

Additional experiments helped other scientists discover even more types of atoms than the most common ones that Dalton found. For example, in 1939 Marguerite Perey discovered a type of atom that she named Francium. This was one of the last types of atoms ever discovered in a natural source. There are now 94 types of atoms that we know of, all of which can be found in natural sources. These few types of atoms make up all of the different substances found in our world today.