HISTORY OF ATOM NOTES

Thousands of years ago no one had the scientific equipment to perform actual chemistry experiments as we do today. It was only through intellectual thought that "discoveries" of our world could be made. Two famous Greek philosophers came up with some very interesting theories.

Democritus (460-370 B.C.) invented a surprising correct theory of matter.

i) Matter was made up of tiny particles he called "atomos".
ii) Atomos were solid, homogeneous, and indivisible.
iii) Different matter is made up of atomos that have different shape and size. For example, honey would be made up of atomos that are smooth and round because it is pleasing and vinegar would be made up of atomos that were pointy because it is bitter.
iv) Changes in matter is caused by a changing of the grouping of atomos, not in a changing of the atomos themselves.

Unfortunately **Democritus** had no way of proving his theory with everyday observations, so when a very famous philosopher named **Aristotle** (384-322 B.C.) invented a (incorrect) theory that seemed to explain everyday life, most people believed him.

*All matter is comprised of one of the four elements: earth, fire, wind, and water.
*When given the opportunity, the matter will split apart into their elements. For example, wood must be made of earth and wind because when fire is added part of the wood rises to become wind again (smoke) and part falls to become part of the earth again (ash).
*Even though we now know Aristotle's theory to be completely wrong, it could be used to explain most of the things people experienced in their lives. Plus he was famous for other theories that were correct, so his theory was believed for many hundreds of years.

Around a thousand years after Aristotle, the mystery of what made up matter again became important to some people. These people were called Alchemists, and were looking for the Philosopher's Stone, magical matter that could turn lead into gold, and give eternal life.

*The alchemists were the first to use the term element in reference to real chemicals, but thought there were only three - mercury, salt, and sulfur (and salt we now know is not an element).
*The alchemists did try analyzing matter with special equipment and invented techniques like distillation and crystallization that we still use today.

The alchemists didn't want just anyone to benefit from their work, so they often used riddles and words with secret meanings to talk about their experiments. This meant real chemistry progressed slowly until hundreds of years later chemists decided to openly share their experimental results with anyone who would listen.

The theory of the atom had changed during the time of the alchemists, but a huge advance was made by **John Dalton** (1766-1844). Dalton's theory seems a lot like Democritus's, because it is, but Dalton could now prove the theory through experimentation.

*All matter is made up of very tiny particles called "atoms."
*Atoms of the same element are identical in size, mass, and chemical properties.
*Atoms of different elements are different in size, mass, and chemical properties
*Atoms cannot be created, destroyed, or divided.
*Atoms combine in whole-number ratios to form compounds.
*During a chemical reaction, atoms can only be separated, combined, or rearranged with each other.

Modern nuclear chemistry has now proven points 2 and 4 false, as we have discovered isotopes and particles inside the atom, but the rest of Dalton's theory is still correct.

Our current scientific definition of an atom is this – an atom is the smallest piece of an element that still is like that element. For example, a gold atom would be just like a chunk of gold. They would

have the same density, the same color (if we could see the atom), they would both be shiny, and the gold atom would look as different from a silver atom as a chunk of gold looks different than a chunk of silver.

1) In the 1800s scientists were experimenting with electricity in glass tubes that contained a vacuum. It was found that hooking this tube to a battery caused a ray to travel from the cathode (negative) end of the battery to the other side. Thus these tubes became known as Cathode Ray Tubes, or CRTs (now used as TVs and computer monitors).

   A) **Robert Millikan** (1868-1953) found these cathode rays were made of particles that were repelled by a negative charge and attracted to a positive charge.

   B) **J. J. Thomson** (1856-1940) found that these particles existed in all matter and found they were much, much smaller than an atom.
      i) Thus these particles that came from electricity were called electrons, and had a negative charge. It was also found that the mass of one electron is .00000000000000000000000000091 grams. (We will call it zero for the rest of the year.)

      ii) Thomson decided the atom must look like "plum pudding" where the positive charge of the atom was spread evenly in the atom (like pudding evenly fills a bowl) and the negative electrons are just randomly stuck in (like the plum pieces in the pudding).

2) Thomson's plum pudding model was only believed for two years before it was proven wrong by **Ernest Rutherford** (1871-1937) in 1911.

   Rutherford set up an experiment where he shot radioactive alpha particles (helium atoms without electrons) at a piece of gold foil (only a few atoms thick). He surrounded the foil with a screen that is like the film in a camera. Where the alpha particles hit the film, it would leave a mark.

      i) Rutherford expected all the particles to fly through the atoms, as the electrons should not really do anything to the alpha particle, and the even positive charge of the atom should only slow down the particles, but not change their direction.
      ii) Instead, he found that sometime the particles were turned to the right or to the left, and some even bounced off the foil back to where they came from.

   The only way Rutherford could explain these results was to make a model of the atom with all the positive charge just at the center, which he called the nucleus.

Later experiments by Rutherford showed that not only did the positive charge exist in the nucleus, it was contained in particles which he called protons.

James Chadwick (1891-1974) showed in 1932 that there was a third particle in the nucleus that had the same mass as a proton, but had no charge. As it was neutral in charge, he called the particle a neutron.

Once the particles that make up the atom were discovered, **Henry Moseley** (1887-1915) discovered that the number of protons (positive charge) in each atom was different. This meant each atom could be identified by the number of protons it had, and so this number was called the "atomic number".

Neils Bohr (1885-1962) – invented the Bohr model, in which electrons assumed only certain orbits around the nucleus and each orbit has a certain energy associated with it.

We currently believe in the **electron cloud model**.

*The periodic table was first invented by **Dimetri Mendeleev** (1834-1907), who ordered the periodic table by atomic mass, and was later changed by Henry Moseley, who reordered it by atomic number as it is today.