Warm - Up

Fill in the Table Below

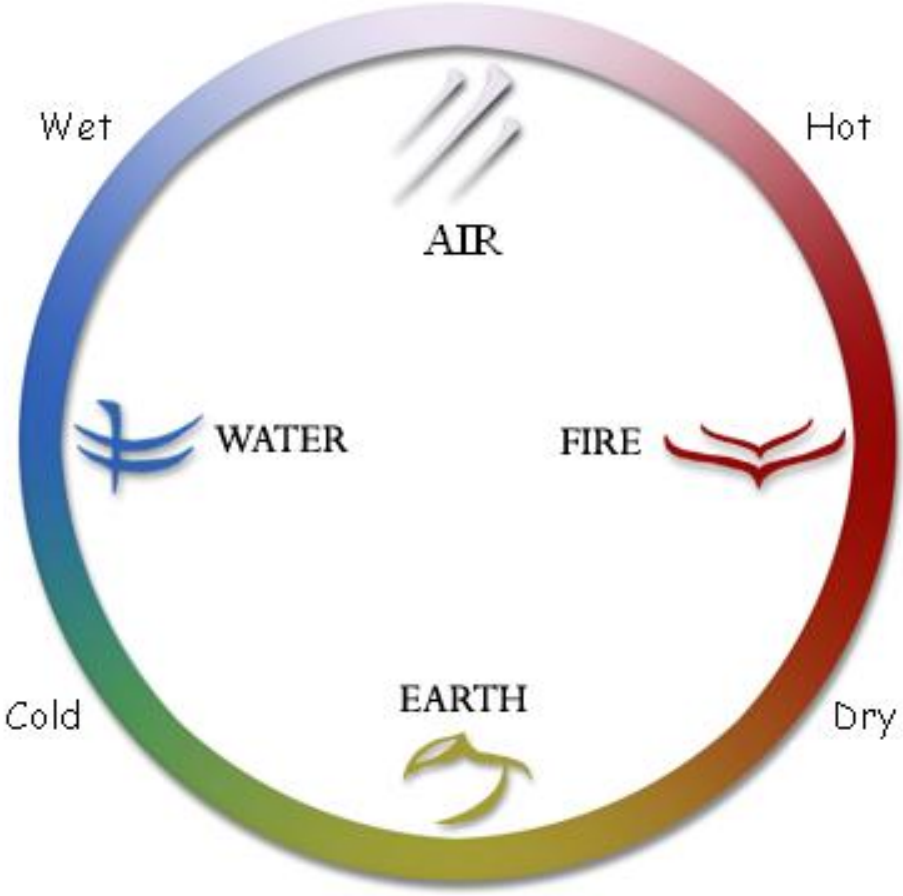
Element	Atomic Number	Atomic Mass	Standard Atomic Notation	Number of Protons	Number of Electrons	Number of Neutrons
Oxygen						
		55				
				30		
						0
					88	

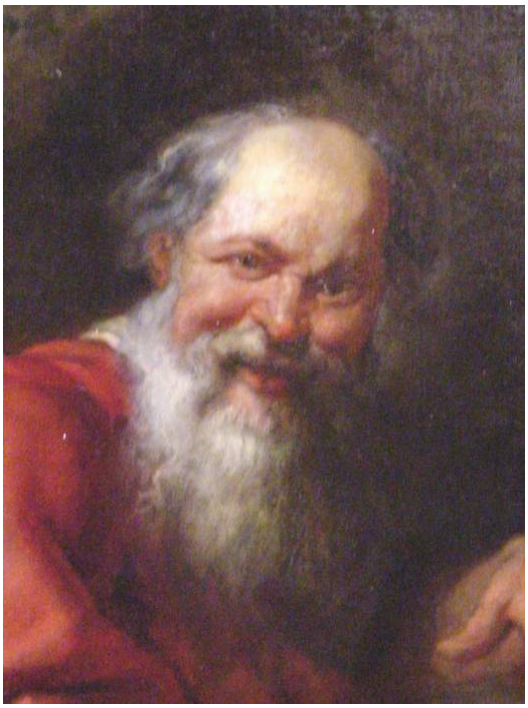
Atomic Theory

DEVELOPING MODELS OF MATTER

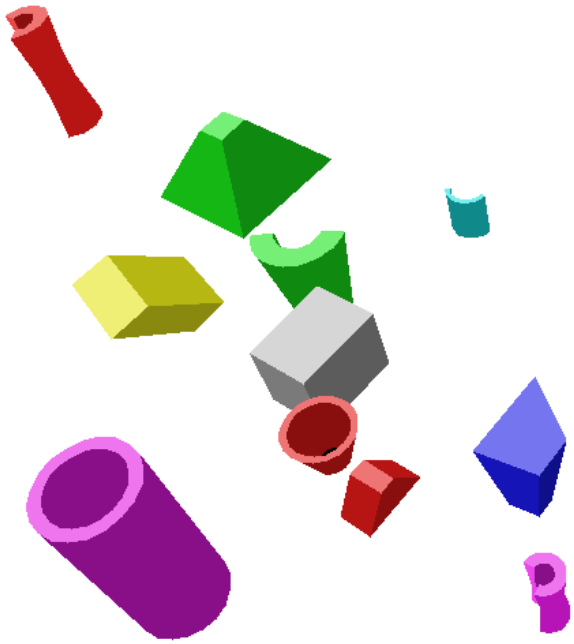
- Scientists have observed, questioned and theorized for centuries about matter.
- In an attempt to explain the evidence around them, many models of matter were developed. They have been modified, combined, or rejected as new evidence was discovered:
  - About 450 B.C. - the **Four-Element Model**
    - Greek scholar Empedocles believed that all matter was composed of four fundamental substances: earth, air, fire and water.
    - This view was accepted for almost 2000 years.
  - About 400 B.C.
    - Democritus suggested that all matter was made of tiny particles that could not be broken down further. He called the particles *atomos*, which is Greek for "indivisible".
    - Different elements were composed of different atoms, all of which were believed to be different sizes, have a variety of geometric shapes, and were in constant motion.

Empedocles

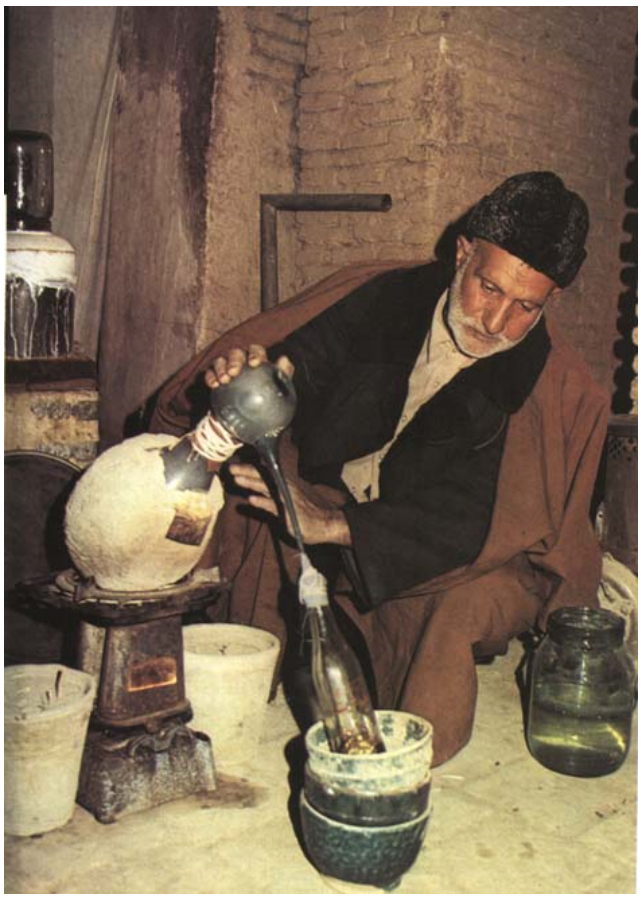


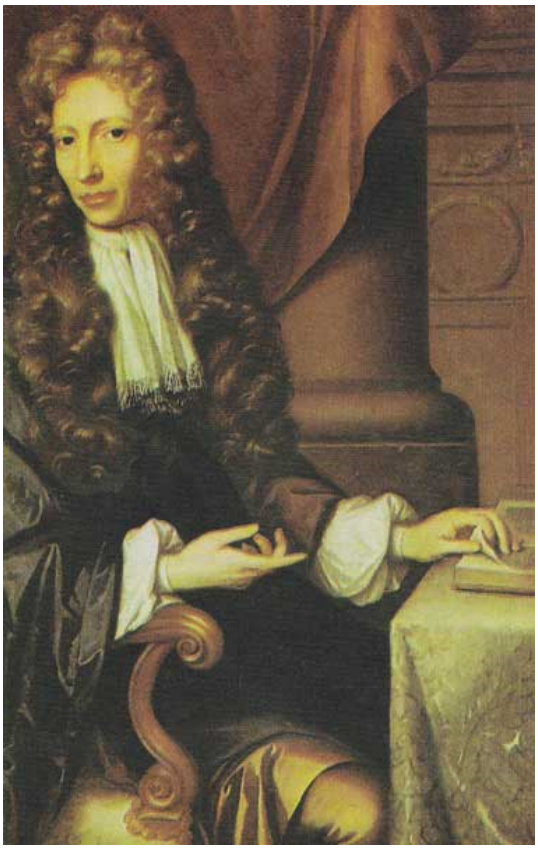


Democritus



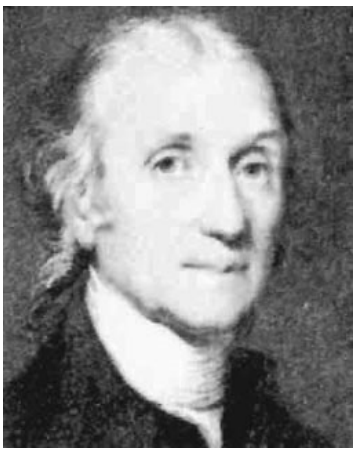
- A.D. 500 - 1600
  - **Alchemists** (combination of philosopher, magician, and chemist) believed that metals grow like plants into gold.
  - Tried for centuries to turn cheap metals, like iron and lead, into gold by performing various experiments.
  - Devised chemical symbols for elements and compounds, and invented laboratory tools that we still use today (beakers, filters, stirring rods, etc).
- 1650
  - Robert Boyle devised a new definition for the word *element*: a pure substance that can not be chemically broken down into simpler substances.
  - Boyle also didn't believe that air was an element, but rather a mixture.
- Late 1700's
  - Joseph Priestly may have isolated oxygen, but he did not realize that it was an element.
  - Henry Cavendish discovered the flammable gas hydrogen by mixing a metal with acid. He discovered that hydrogen would react with oxygen in the presence of enough energy and water was produced. Up until then, scientists had believed that water was an element.





Robert Boyle

Joseph Priestly



Henry Cavendish

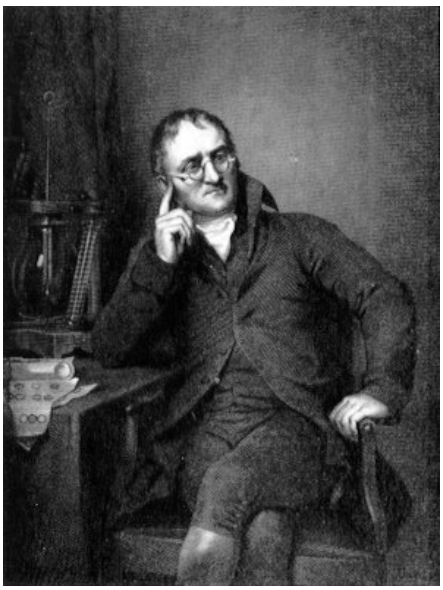
- 1808 - the **Atomic Model**
  - By this time, it was generally accepted that matter was made of elements.
  - John Dalton published a theory, called the atomic model, of why elements differ from each other and from non-elements:

- All matter is made of atoms, which are particles too small to see.
- Each element has its own kind of atom, with its own particular mass.
- Compounds are created when atoms of different elements link to form molecules.
- Atoms can not be created, destroyed, or subdivided in chemical changes.

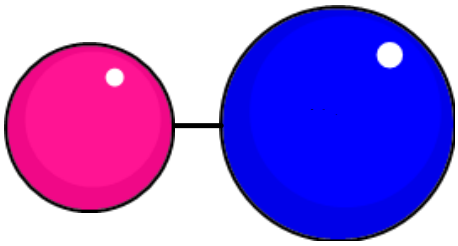
  - In Dalton's atomic model, an atom is a solid sphere.

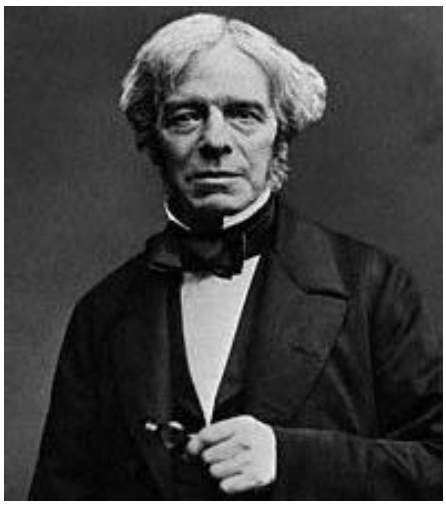
- 1800's - the modified atomic model
  - Matter was observed to produce positive and negative charges. A model was created that suggested that negatively charged particles could be separated from their atoms and move to other atoms.
  - Michael Faraday found that an electric current could cause chemical changes in some compounds in solution. By gaining electric charges, these charged atoms are called **ions**.
  - In this modified version of Dalton's model:

- Matter must contain positive and negative charges.
- Opposite charges attract and like charges repel.
- Atoms combine to form molecules because of electrical attractions between atoms.

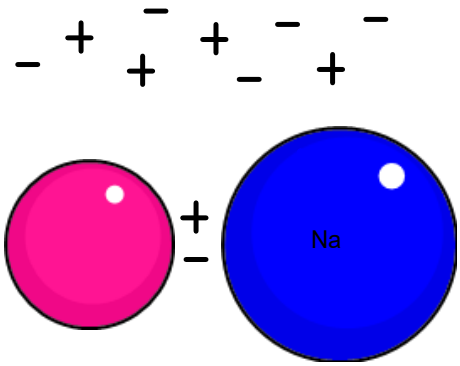


John Dalton





Michael Faraday



- 1904 - the **Raisin-bun Model**
  - J.J. Thomson discovered that these negatively charged particles were far lighter than the heavier positive particles. The new raisin-bun model was born.

- Atoms contain very light, negatively charged particles called electrons.

- The rest of the atom is a sphere of positive charge.

- The electrons are embedded in the sphere, making the atom uncharged overall.

  - H. Nagaoka modeled the atom as a large positive sphere surrounded by a ring of negative electrons. The atom is compared with the planet Saturn.

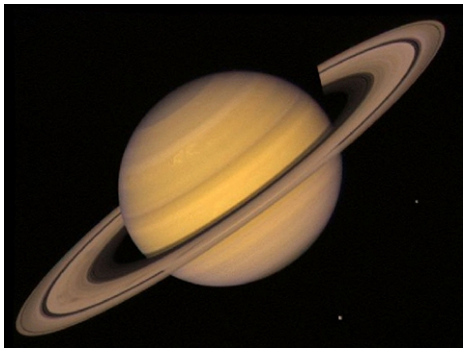
- 1911 - the **Nuclear Model**
  - Ernest Rutherford (McGill University, Montreal) came up with a new model to explain his experiment that was designed to test the raisin-bun and "Saturn" models.
  - Rutherford fired alpha particles (positively charged) at a thin sheet of gold foil. A number of the alpha particles were reflected and some even bounced straight backward.
  - He explained his results by creating a new model called the nuclear model:

- An atom has a tiny, dense positive core called the nucleus that contains positive particles.

- The nucleus is surrounded mostly by empty space, containing rapidly moving electrons.

J.J. Thompson

Hantaro Nagaoka



- 1913 - the **Planetary Model**
  - Different colors of light have different energies,

ue being the strongest. When
nts are heated in a flame, they show a few
c colors. These definite energies of
light could not originally be explained.

  - Neils Bohr came up with the planetary model of the atom by suggesting that:

- Electrons move around the nucleus in nearly- circular paths called orbitals.

- Each electron in an orbitals has a definite amount of energy.

- The farther away the electron is from the nucleus, the more energy it has.

- The order of filling the electrons in the first four orbits is 2, 8, 8, and 8.

- Electrons are more stable when they are at a lower energy, closer to the nucleus.

  - This model explains that electrons "jump" to a higher orbitals when energized by heat, electricity, or light. We say they are in an **excited state**. These unstable, excited electrons fall back into their normal, more stable, low-energy orbitals; they fall back to their **ground state**. The amount of energy given off, which corresponds to a very specific color, is equal to the difference in energy between the higher and lower energy levels.

An almost colorless ethanol flame, without any chemical colorants

Lithium Chloride and Lithium Carbonate color an ethanol flame.

Strontium Chloride and Strontium Carbonate used in ethanol flame.

Calcium Chloride used to in an ethanol flame.

Sodium Chloride imparts a bright, strong, yellow color to an ethanol flame.

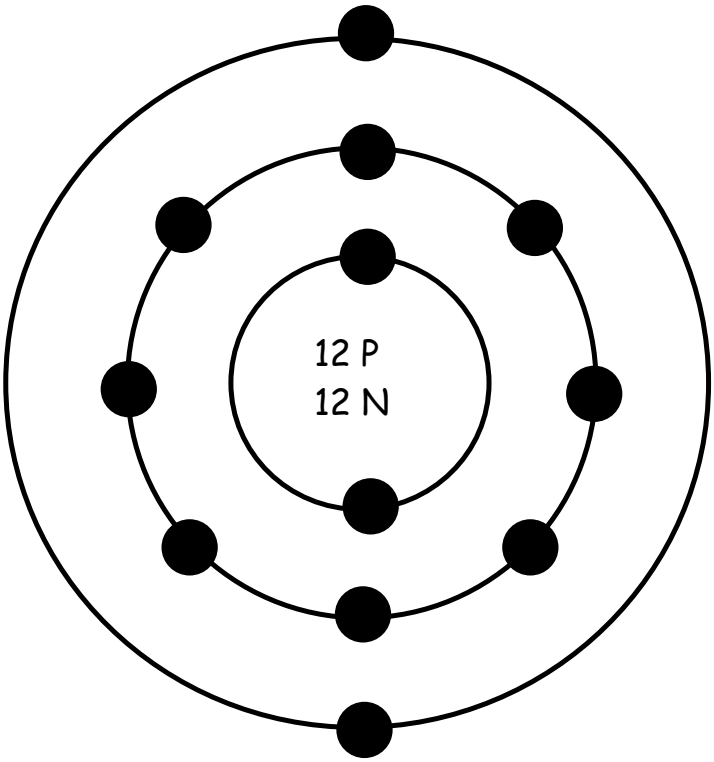
Borax (Sodium TetraBorate) colors the ethanol flame a light yellow-green.

Copper(II) Chloride colors a cool ethanol flame a vivid green.

A very hot, butane flame is colored a bright blue by Copper(II) Chloride.

An ethanol flame is colored a light purple / lilac by Potassium Chloride.

Small Magnesium metal turnings burn above a butane flame (Left) and ethanol flame (Right).


12 P
12 N


Ground State
Excited State
Ground State