DALTON'S ATOMIC THEORY

- 1808: Publication of Dalton's "A New System of Chemical Philosophy", which contained the atomic theory

- Dalton's theory attempted to explain two things:

1. **CONSERVATION OF MASS**
   - The total amount of mass remains constant in any process, chemical or physical!

2. **LAW OF DEFINITE PROPORTIONS** (also called the LAW OF CONSTANT COMPOSITION): All pure samples of a given compound contain the same proportion of elements by mass
The parts of Dalton's theory

1. Matter is composed of small, chemically indivisible ATOMS.

2. ELEMENTS are kinds of matter that contain only a single kind of atom. All the atoms of an element have identical chemical properties.

3. COMPOUNDS are kinds of matter that are composed of atoms of two or more ELEMENTS which are combined in simple, whole number ratios.

Most importantly,

4. CHEMICAL REACTIONS are REARRANGEMENTS of atoms to form new compounds.

   - Atoms are not gained or lost during a chemical reaction.
   - Atoms do not change their identity during a chemical reaction.
   - All the atoms that go into a chemical reaction must go out again!
Another look at chemical reactions

The decomposition of hydrogen peroxide over time (or when poured over a cut) works like this:

HYDROGEN PEROXIDE $\rightarrow$ WATER $\oplus$ OXYGEN GAS

implying: $\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$

... but wouldn't this mean that somehow an extra oxygen atom would form? Not according to Dalton's theory. Dalton's theory would predict a different RATIO of water and oxygen would form:

$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$
Dalton's theory sets LIMITS on what can be done with chemistry. For example:

1. Chemistry can't convert lead (an element) into gold (another element). Sorry, alchemists!

2. You can't have a compound form in a chemical reaction that contains an element that was not in your starting materials.

3. You can only make a certain amount of desired product from a fixed amount of starting material.
Atomic structure
- Until the early 20th century, chemists considered atoms to be indivisible particles.
- The discovery of SUBATOMIC PARTICLES changed the way we view atoms!

The subatomic particles

PROTON
- a small, but relatively massive particle that carries an overall unit POSITIVE CHARGE

NEUTRON
- a small, but relatively massive, particle that carries NO CHARGE
- slightly more massive than the proton

ELECTRON
- a small particle that carries an overall unit NEGATIVE CHARGE
- about 2000 times LESS massive than either protons or neutrons
- In the early 20th century, there was a debate on the structure of the atom.

**RUTHERFORD EXPERIMENT**

(1911)

Radioactive material

Where do the particles go?

Most particles pass through foil, undeflected

A few particles slightly deflected

A few bounce back

Thin gold foil

* This experiment was performed after the discovery of the electron, but before the discovery of the proton or neutron! (1919) (1932)
- Atoms are mostly empty space
- **NUCLEUS**, at the center of the atom, contains protons and neutrons. This accounts for almost all the mass of an atom
- Electrons are located in a diffuse **ELECTRON CLOUD** surrounding the nucleus

Why are atoms stable (why don’t they change identity) during a reaction? The nucleus of an atom is not involved in chemical reactions, and the nucleus controls what kind of atom you have!
Atomic terms

- **ATOMIC NUMBER**: The number of protons in the atomic nucleus. Each ELEMENT has the SAME NUMBER OF PROTONS in every nucleus. In neutral atoms, the number of ELECTRONS is also equal to the atomic number.

  Example: Helium has an atomic number of 2. Every helium atom has two protons in its nucleus.

- **MASS NUMBER**: The number of protons PLUS the number of neutrons in the atomic nucleus. Atoms of the same element may have DIFFERENT mass numbers.

- **ISOTOPES**: are atoms of the same element with different mass numbers. In other words, they have the same number of protons but different numbers of neutrons.
Isotopes
- Have identical CHEMICAL properties
- Differ in MASS
- May differ in stability. Elements may have some isotopes that are RADIOACTIVE