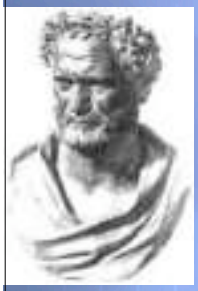
Atomic Theory Part1

Chem 10

The Atom: From Philosophical Idea to Scientific Theory

- Pre 450 B.C.
- All matter is composed of 4 basic elements
  1. Earth
  2. Air
  3. Fire
  4. Water

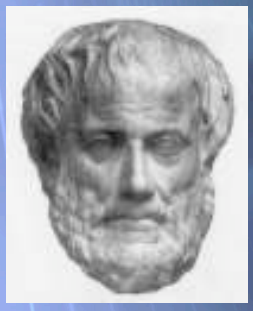
Democritus (~400 B.C.)



- 1st person to theorize that all matter is composed of tiny particles that are *atomos* (indivisible)
- These particles are indivisible and indestructible

Aristotle (384-322 B.C.)

- Did not believe matter was composed of atoms.
- Believed matter was continuous (could be divided into smaller pieces forever)
- Aristotle was more famous than Democritus, therefore his theory was widely accepted.



Foundations of Atomic Theory

3 Important "Laws" of Chemistry discovered with improved technology

1. Law of Conservation of Mass

   Mass is not created or destroyed in ordinary chemical reactions or physical changes
   - *Mass before and after a reaction is the same*
2. Law of Definite Proportions

   *A chemical compound **always** contains the same elements in the same ratio regardless of the sample size*
   - Sodium chloride, NaCl, is **always** 39.34% Na and 60.66% Cl by mass
3. Law of Multiple Proportions

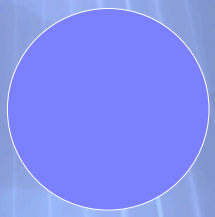
   Two elements can combine in different ratios of whole numbers to form different compounds
   - CO_2 (1g of Carbon always combines with 2.66g of Oxygen)
   - CO (1g of Carbon always combines with 1.33g of Oxygen)

Dalton (1766-1844)

- Developed 1st atomic theory based on experimental evidence
  - Attempting to incorporate the 3 previous laws
- 5 main points to his theory

1. All matter made of tiny particles called atoms
2. Atoms of one element are chemically and physically identical
3. Atoms can't be subdivided, created, or destroyed
4. Atoms of different elements combine in simple whole-number ratios to form compounds
5. Atoms combine, separate, or rearrange in chemical reactions

Dalton's Model

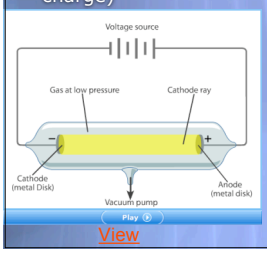


Chapter 3 Section 2

The Structure of the Atom

Discovery of the Electron

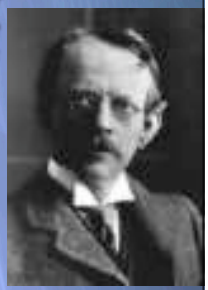
- Electricity passed through glass tube filled with gas at low atmospheric pressure (cathode ray tube)
- Cathode rays deflected by negative end and attracted by positive end of a magnet (particles have a negative charge)



View

J.J. Thomson (1856-1940)

- *Ratio of charge to mass of cathode ray was the same regardless of metal or gas used*
- *Named the negatively charged particles electrons*
- ***Atoms are divisible!!***



J.J. Thomson's Theory

1. Atoms are electrically neutral, so a positive charge must be present to balance out the negative electrons
2. Electrons are so small other particles must account for the mass of the atom
3. Atom is a sphere of "diffuse positive charge with negative electrons embedded"
   - Plum-pudding model

Discovery of the Atomic Nucleus

- Ernest Rutherford, a student of Thomson, (along with Geiger and Marsden) discovered the nucleus
- Performed the Gold Foil Experiment to test Thomson's model
  - Extremely important experiment in Chemistry

Describing the Gold Foil Experiment

- A Beam of alpha particles (2+, 4x heavier than a hydrogen atom, moving near the speed of light) was shot at a thin piece of gold foil
  - According to Thomson's model, charge and mass are evenly distributed
- What was expected to happen and why?
  - Expected particles to pass through with minimal deflection
  - Not what happened!!

Gold Foil Results

View

Atomic View

- 99% of the particles passed through
- 1 in 8000 were deflected back at the source!
  - Totally unexpected
  - *"it was as if you had fired a 15-inch shell at a piece of tissue paper and it came back to you."*
  - A new theory had to be developed to explain these results

Rutherford's new atomic theory

- Dense nucleus of positive charge and most of the atom's mass
- Majority of the atom is empty space where the electrons exist but didn't know exactly where they were
  - Location later discovered by Bohr (a student of Rutherford)
- Suggested the existence of a neutron in the nucleus (Discovered by Chadwick)
  - What was the reason for this suggestion?

Rutherford's "Empty Space" atomic model