Unit IV: Nature of Matter

Lesson 1

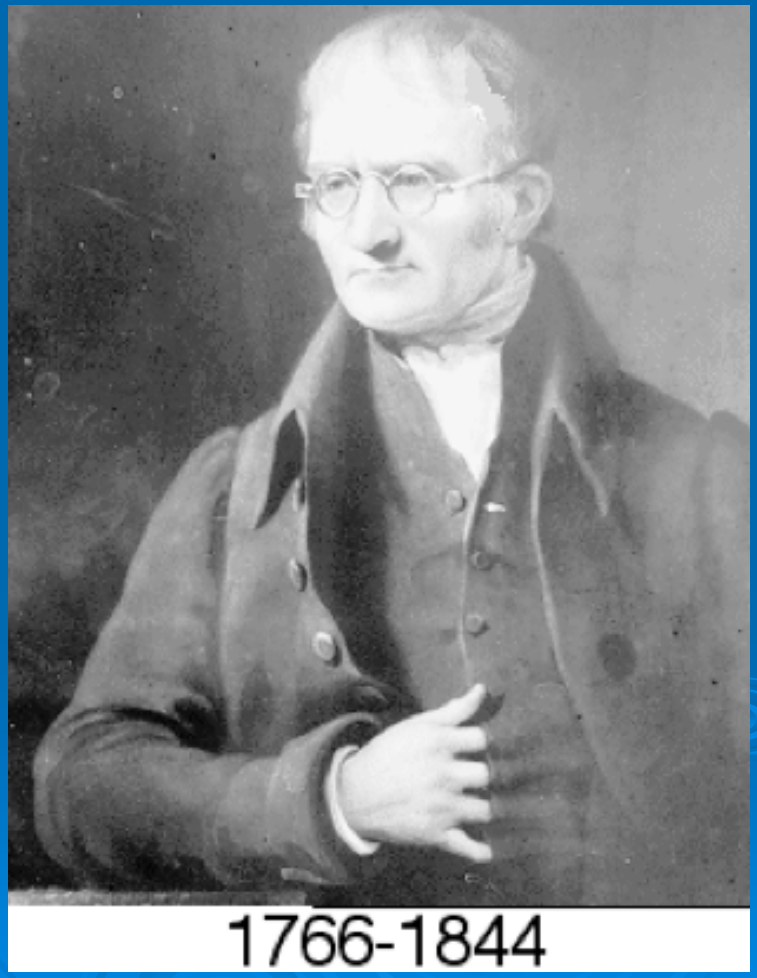
Atomic Theories

Objectives

- You will be able to
  - – Explain how the discovery of cathode rays contributed to the development of atomic models
  - – Explain JJ Thomson's experiment and the significance of it to the understanding of the atom.

Dalton's Model

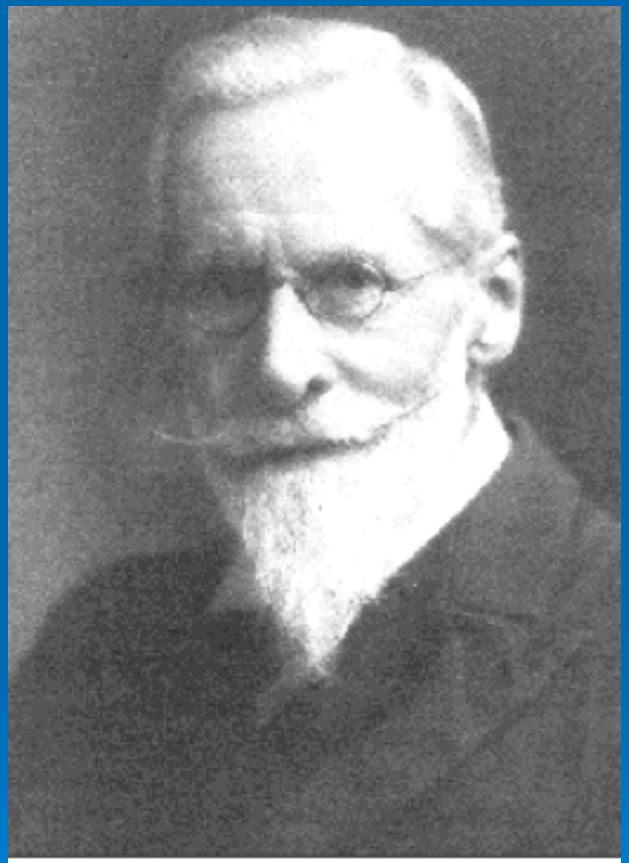
- John Dalton took what was known about chemical reactions at his time and proposed the first atomic model.
  - – Conservation of Mass
  - – Law of Multiple Proportions
  - – Law of Definite Composition



Billiard Ball Model

- Dalton combined the observations into one theory which stated that all matter was composed of small indivisible particles that he called atoms.
- Demitri Mendeleev used this theory when he constructed the first working periodic table.

Cathode Rays



Sir William Crookes
1832-1919

- Crookes worked in the areas of chemistry and physics. He had many accomplishments, one of which was the discovery of cathode rays.

Crookes Tube

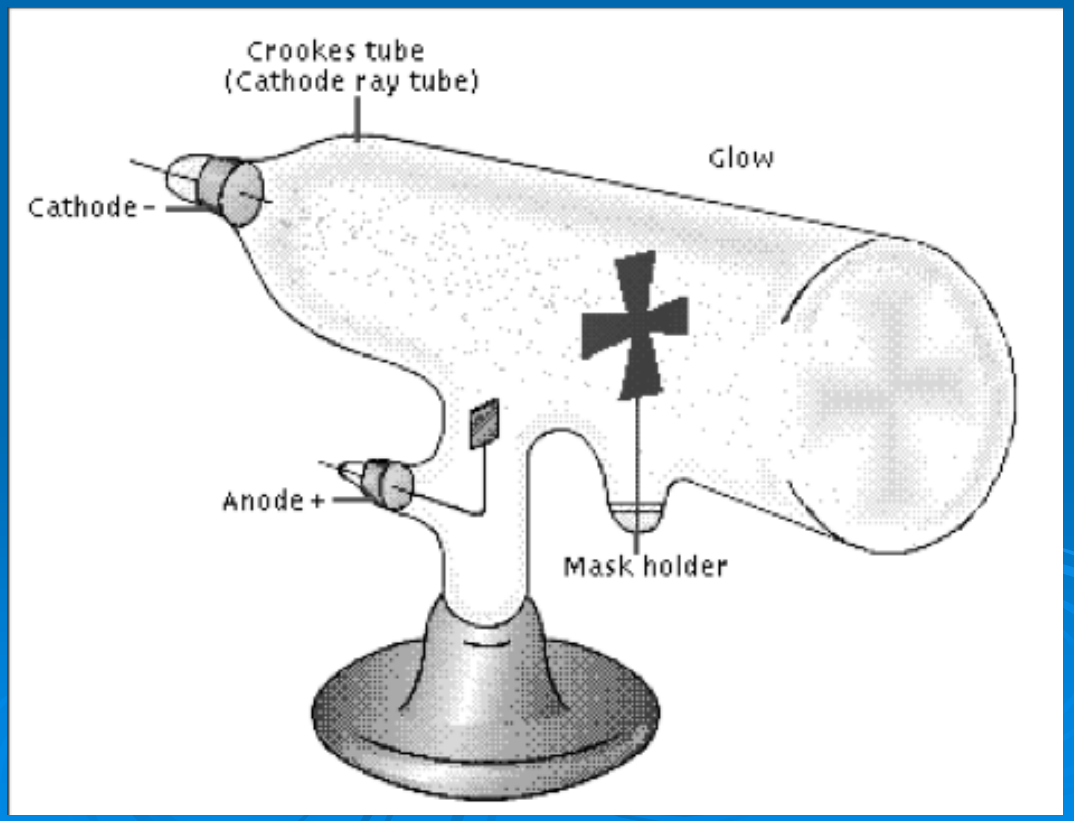
- A source of high potential difference was placed across the cathode of a glass tube that had gas at a very low pressure inside.
- Noticed a glow coming from the negative terminal

Properties of Cathode Rays

- A wide variety of cathodes (different metals) were tested and all produced same results.
- Magnetic fields deflected the rays.
- The rays produced some chemical reactions similar to those produced by light.

Properties of Cathode Rays

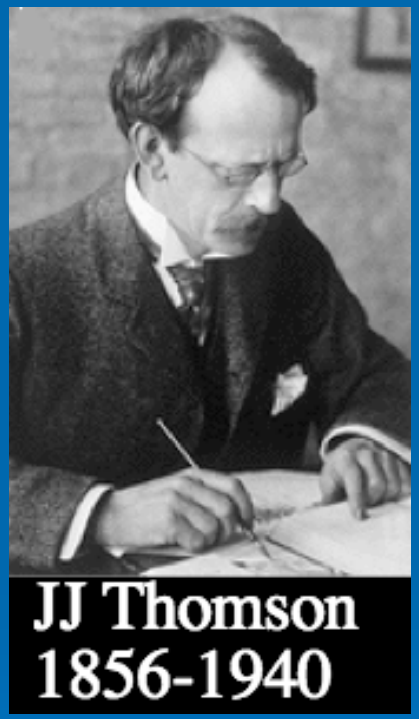
- The rays traveled in straight lines, perpendicular to the surface of the cathode



Properties of Cathode Rays

- Had trouble showing that electric fields caused deflection of the beam. This was eventually accomplished by J.J. Thomson.
- The rays were believed to be streams of particles. Thomson named them electrons and changed the model of the atom.

Thomson's Charge to Mass Ratio



- **It was noticed that the beam of electrons could be bent by a magnetic field. This means that Fnet = Fm, so :**
- $mv^2 = Bqvr$
- So $q/m = v/Br$

Derivation of Equation

- **Thomson did not have a way of measuring the velocity directly, but he knew that he could keep the beam traveling in a straight line if he balanced the electric and magnetic forces acting on it. Fe = Fm**

$$|E|q = Bqv \text{ so :}$$

$$v = |E|/B$$

Derivation of Equation

- **By substituting these results into the first equation he came to;**

$$q/m = v/Br = |E|/B^2r$$

- Thomson calculated the charge to mass ratio of the electron to be 1.76×10^{11} C/kg. This ratio is constant for all materials.

The Raisin Bun Model

- Thomson was able to show that electrons had the following properties:

  1. Emitted by a wide variety of cathodes

  2. About 2000 times smaller than hydrogen

- The new atomic model had the negative electrons (raisins) embedded in a sea of positive charge (bun). Sometimes called the Plum Pudding Model.