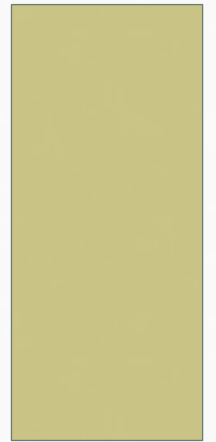


CHAPTER 3

EARLY ATOMIC THEORY



THE ATOM: FROM PHILOSOPHY TO SCIENTIFIC THEORY

- **400 BC – Democritus**

- came up with the idea of the _____
 - Nature's basic particle
 - _____
- His ideas were not useful in explaining chemical behavior because _____.

- **Aristotle**

- Thought matter was _____
 - Did not believe in atoms
- Resulted in delaying the progress of science for about 2000 years.

DEMOCRITUS' ATOM

DEVELOPMENT OF SCIENTIFIC LAWS

18th Century (1700s)

Antoine Lavoisier

- Law of Conservation of Mass –

- Total mass of reactants = Total mass of products

Proust

- Law of _____ – a chemical compound contains the same elements in exactly the same proportions by mass regardless of the size of the sample or source of the compound. (p. 68)

Dalton

- Law of _____ – (fig. 3)
same elements combined in different ratios to make different compounds

Law of Conservation of Mass



Antoine Lavoisier

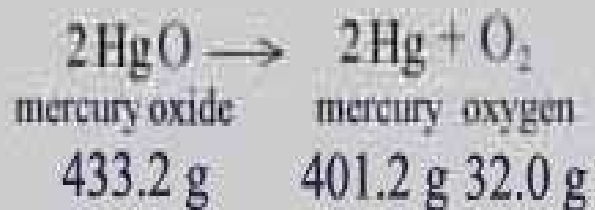
Mass is neither created nor destroyed during chemical or physical reactions.

Total mass of reactants
=
Total mass of products

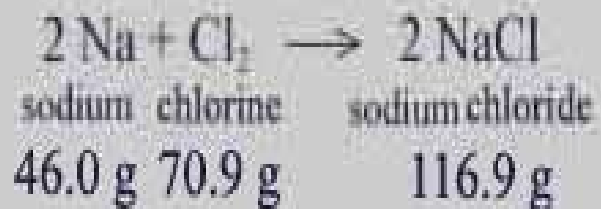
LAW OF CONSERVATION OF MASS

**Atoms making up
compounds can be
separated, or combined**

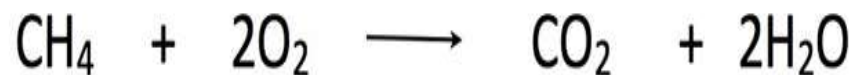
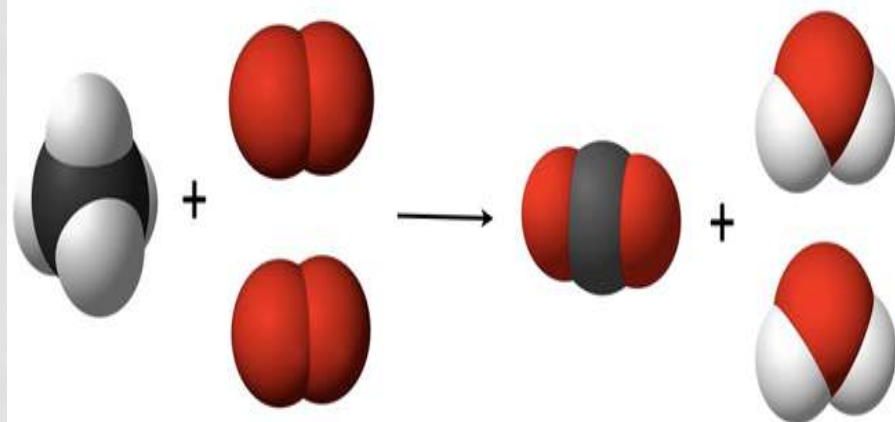
This equation describes Lavoisier's experiment:



Another example of how mass is conserved:



.... Or rearranged, but never
created or destroyed.



law of definite proportions:

Joseph Proust (France 1799)



- states that ' In a chemical compound the elements are always present in a definite proportion by mass',
- **Eg 1:** Water (H_2O) always contains two elements (atoms) of hydrogen and one atom oxygen combined together in the same ratio of 2:16 or 1:8 by mass. If 9 g of water is decomposed we get 1 g of hydrogen and 8 g of oxygen.

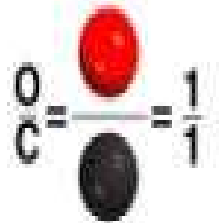


LAW OF MULTIPLE PROPORTIONS

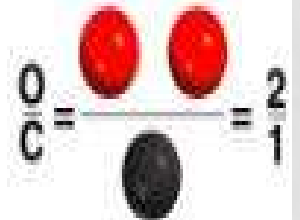
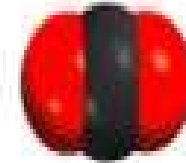


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Carbon monoxide



Carbon dioxide



Ratio of oxygen in
carbon monoxide to
oxygen in carbon dioxide: 1:2

DALTON'S ATOMIC THEORY

1808 – Dalton's Atomic Theory

- 1.
- 2.
- 3.
4. Atoms of different elements combined in whole-number ratios to form chemical compounds.
5. In chemical reactions, _____

- Dalton's theory helped explain the law of conservation of mass because it stated that atoms could not be created or destroyed.
- Modifications have been made to the theory to explain new observations.

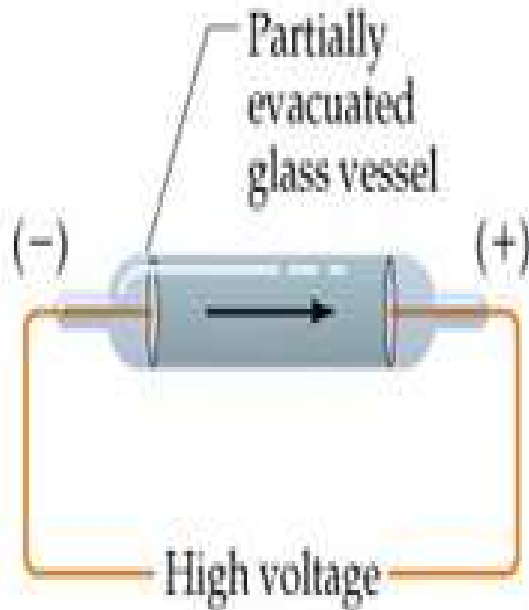
DALTON'S ATOMIC MODEL

THE STRUCTURE OF THE ATOM

- **Atom -**
- **Nucleus -**
- **Subatomic particles**

| Particle | Location | Charge | Symbol | Mass |
|----------|----------|--------|--------|------|
| Proton | | | | |
| Neutron | | | | |
| Electron | | | | |

CATHODE RAY TUBE (CRT)



(a)



(b)



(c)

GOLDSTEIN'S EXPERIMENT

1886 - Goldstein

° detected the presence of a positive charge.

- used a cathode ray tube (CRT) with holes in cathode and disc with a slit.

- placed metal sample inside tube; connected it to electric current.

- particles ("rays") went _____ of cathode rays.

- Therefore, concluded that there was a _____.

However, Goldstein's work went _____.

GOLDSTEIN'S CRT EXPERIMENT

THOMSON'S EXPERIMENT

1897 - JJ Thomson

° used CRT to discover the electron.

-modified CRT with poles (magnetic field) to attract cathode rays.

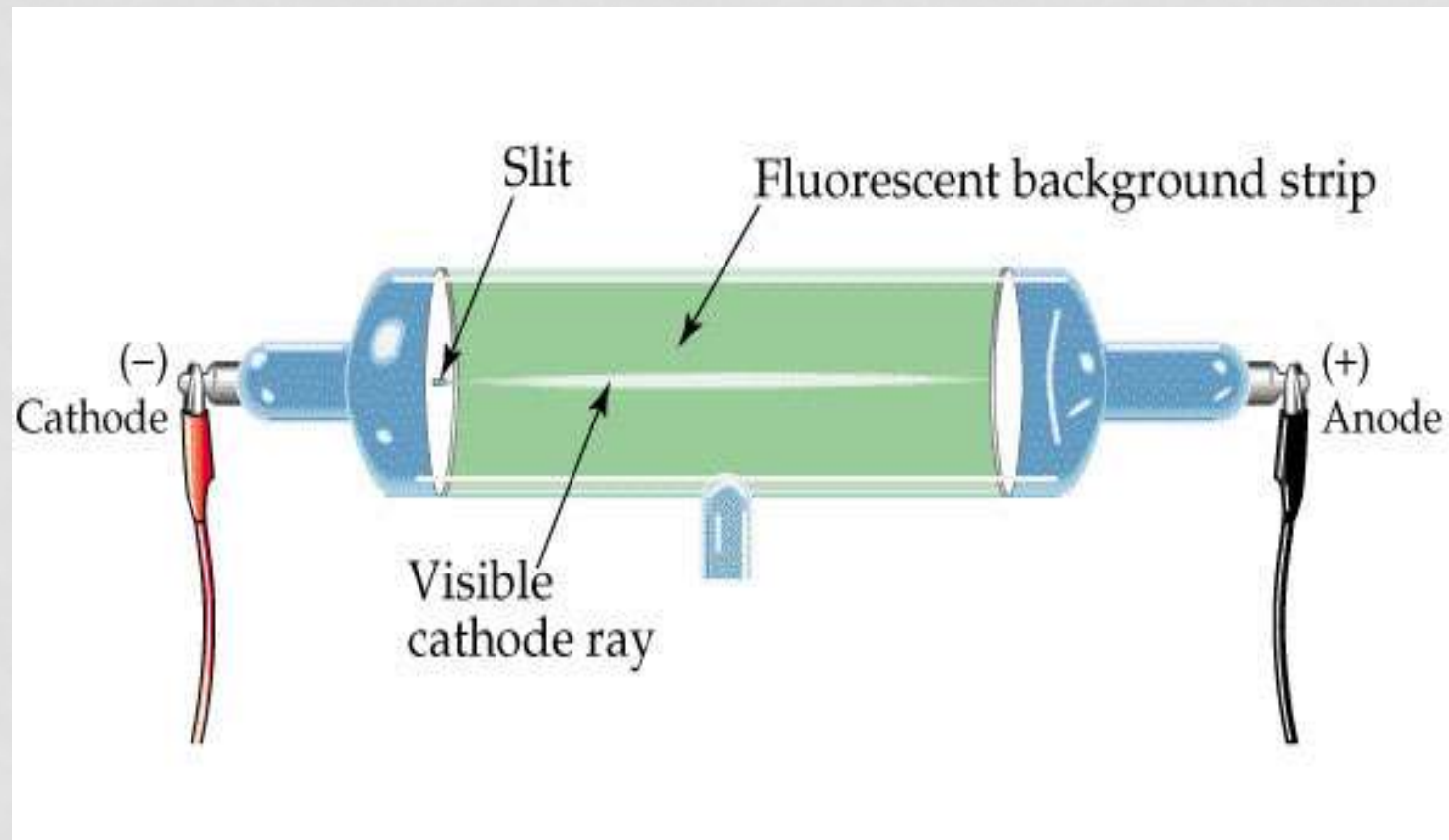
- passed electricity through a gas at first; then used several samples of other elements.

-behavior was same for all elements - rays were attracted to the anode (+). (_____)

- Concluded that

_____ > **electrons.**

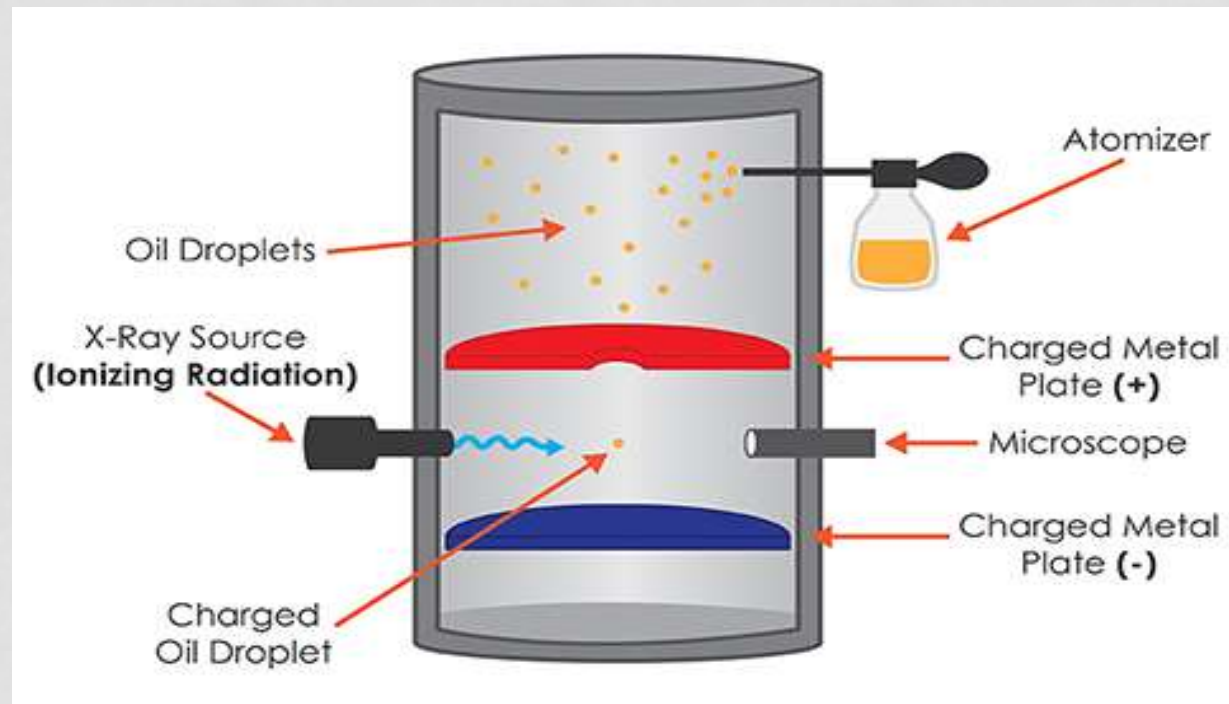
Became known as **Plum Pudding, Raisin Bun, or Chocolate Chip Cookie Model** of the atom in which (-) particles are randomly floating inside a (+) charged sphere.



MILLIKAN'S EXPERIMENT

1909 - Robert Millikan - Oil Drop Experiment

- ° confirms electron has (-) charge
- ° determines e^- has mass; but it is very small.



CONCLUSIONS FROM THE STUDY OF THE ELECTRON

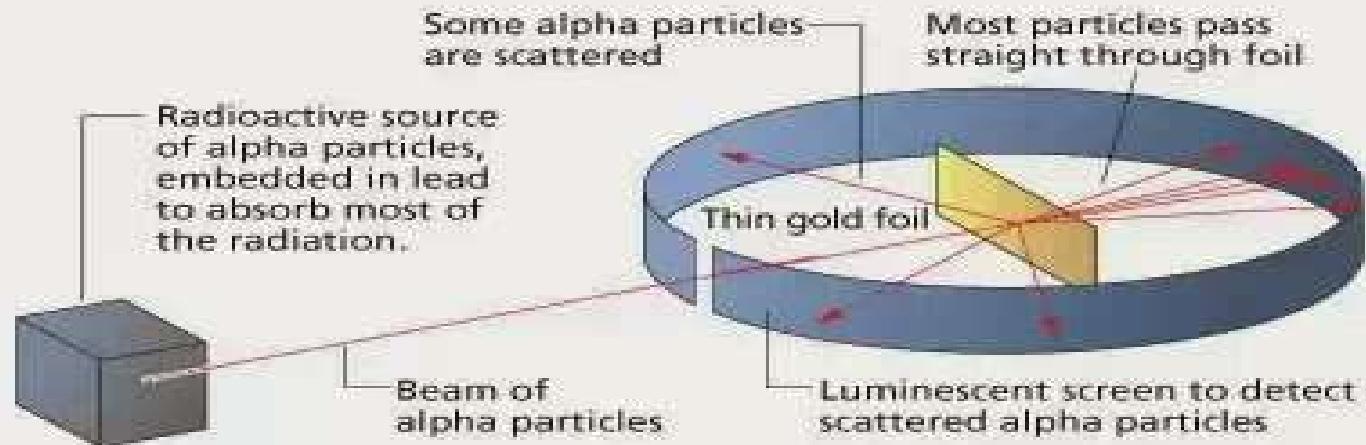
- Atoms are
- Electrons have
- Atoms are

THOMSON'S ATOMIC MODEL

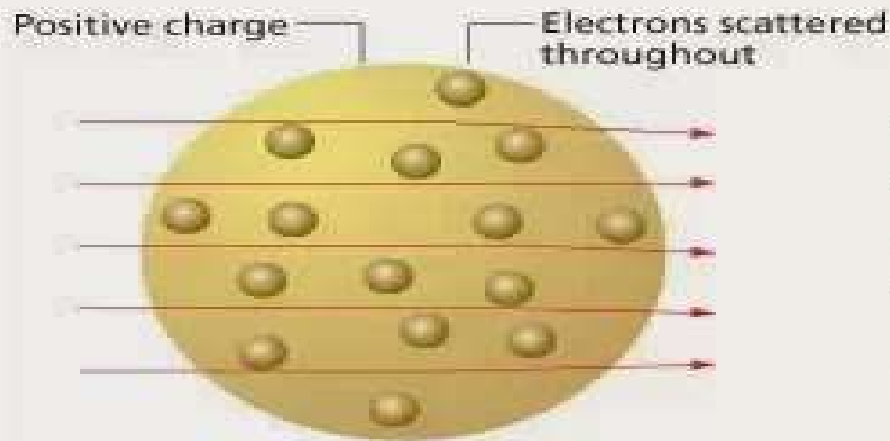
ERNEST RUTHERFORD

- **1911 – Ernest Rutherford**

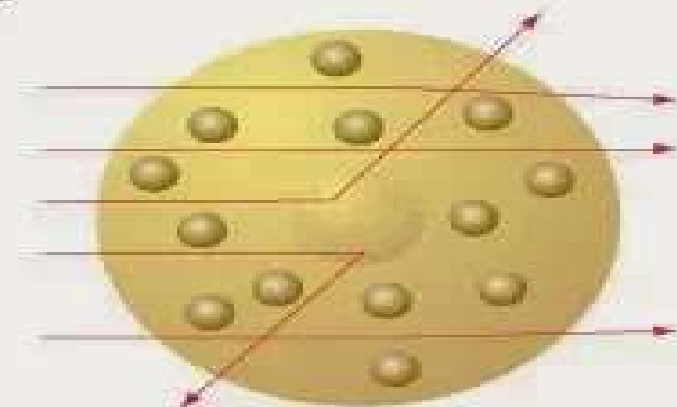
- ---
- Used info from previous experiments conducted by Henri Becquerel (1896) that determined types of radioactive particles.
- Bombarded thin metal foil with alpha particles and recorded “hits” on detecting screen.



Rutherford's experiment on alpha particle bombardment of gold foil



Expected results of Thomson's model



Actual results of Rutherford's experiment

RUTHERFORD'S GOLD FOIL EXPERIMENT

- **Findings:**

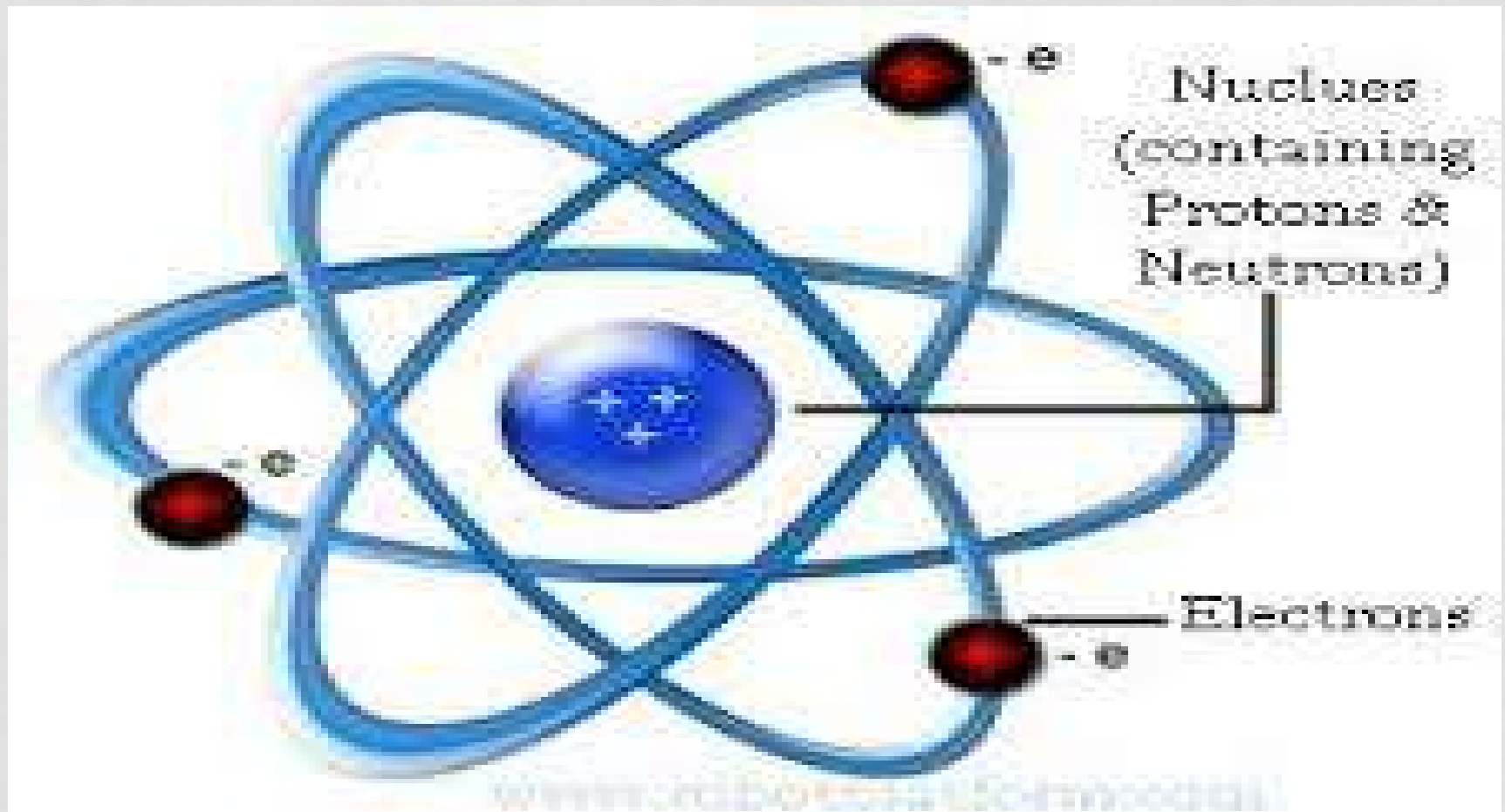
Conclusions:

RUTHERFORD'S ATOMIC MODEL

THE BOHR MODEL

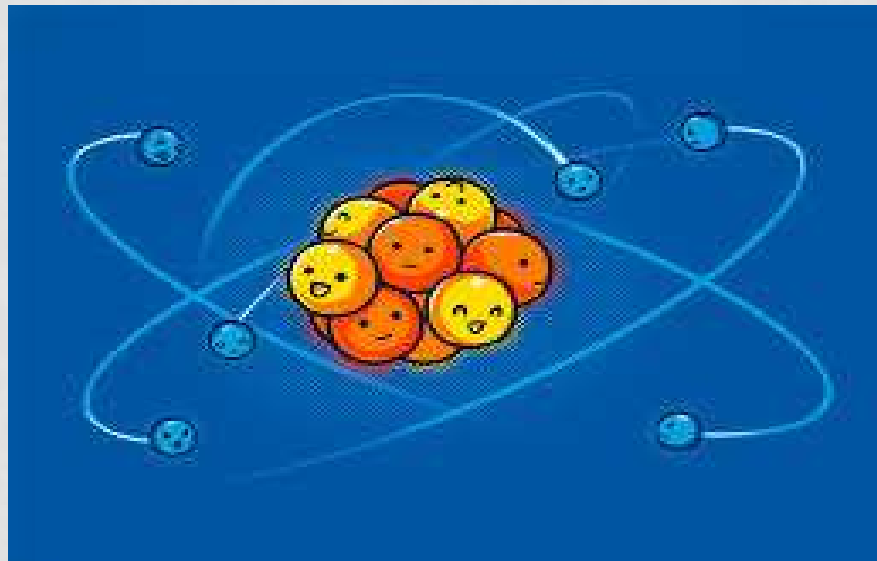
- **1913 – Niels Bohr**
 - - absorption and emission of light energy.
 - - **spectra** – colors emitted by e- at different energy levels.
- **1932 – J. Chadwick** – discovered the neutron.
- **-Bohr Model** – atoms are divisible units composed of positive and neutral particles (_____) concentrated inside the _____, with (-) particles (_____) orbiting around in electron shells or energy levels.

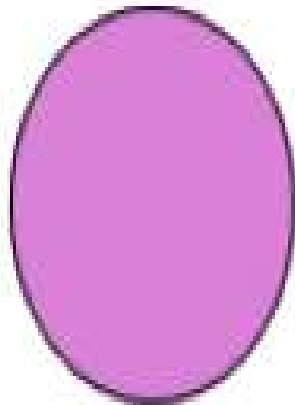
BOHR MODEL OF THE ATOM



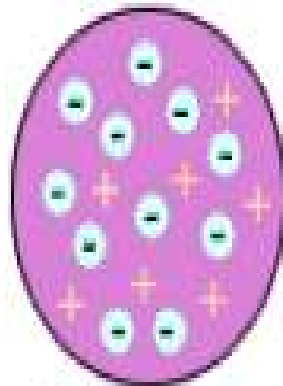
QUANTUM MECHANICAL MODEL

- **Present**
- Quantum Mechanical Model -

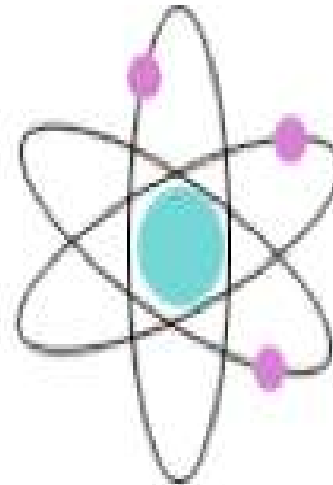




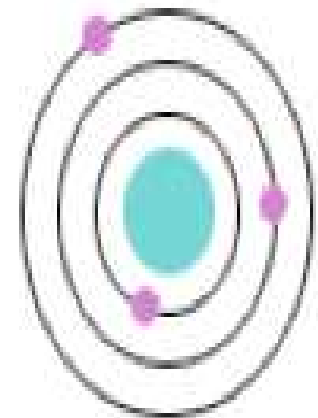
Dalton
"Billiard Ball" Model



Thomson
"Plum Pudding" Model



Rutherford Model



Bohr Model



Quantum Mechanical
Model