Republic of Iraq
Ministry of Higher Education & Scientific research
Al-Mustaqbal University
Science College
Biochemistry Department

Introduction in Chemistry

For

First Year Student

Lecture 3

By

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The Atomic Theories

1- John Dalton

In 1808, John Dalton created the very first atomic theory. Dalton was an English school teacher who performed many experiments on atoms.

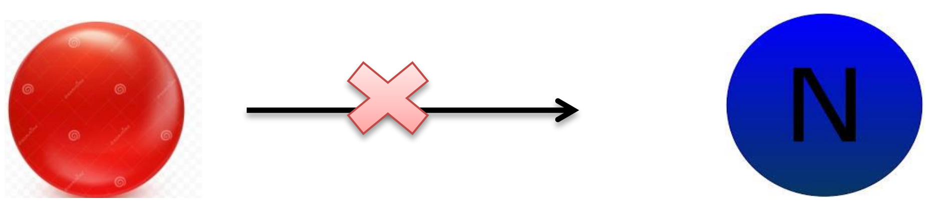
Dalton's Theory (1808)

1. All matter is composed of tiny and indivisible particles, called atoms.

an atom of the element of oxygen

an atom of the element of nitrogen

2. An atom cannot be created, divided, destroyed or converted to any other type of atom .

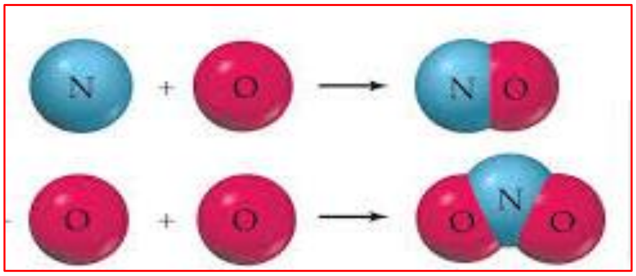


Oxygen Nitrogen

3. Atoms of a particular element have identical size, mass and other properties;

atoms of different element differ in size, mass and other properties.

4. Atoms of different elements combine in simple whole-number ratios to form chemical compounds.



5. In chemical reactions, atoms are combined, separated or rearranged.

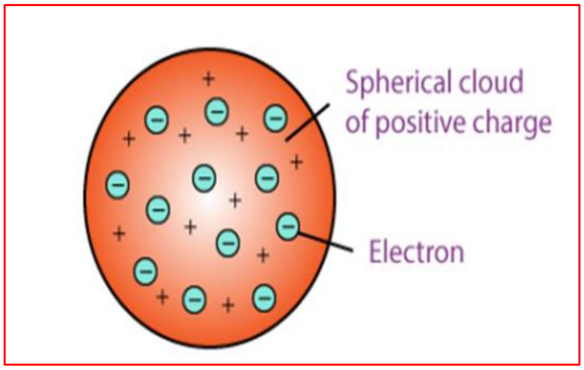
Limitations of Dalton's atomic theory

Dalton's atomic theory suffered from the following drawbacks:

- Atoms of the same or different types have a strong tendency to combine together to form a new 'group of atoms'. For example, hydrogen, nitrogen, oxygen gases exist in nature as 'group of two atoms'. This indicates that the smallest unit capable of independent existence is not an atom, but a 'group of atoms'.
- With the discovery of sub-atomic particles, e.g., electrons, neutrons and protons, the atom can no longer be considered indivisible. Discovery of isotopes indicated that all atoms of the same element are not perfectly identical. At least, they differ in their masses. Atoms of the same element having different masses are called isotopes.

Dalton's atomic theory could not explain why certain substances, all containing atoms of the same element, should differ in their properties. For example, charcoal, graphite and diamond all are made up of only Carbon -atoms, but still their properties are quite different.

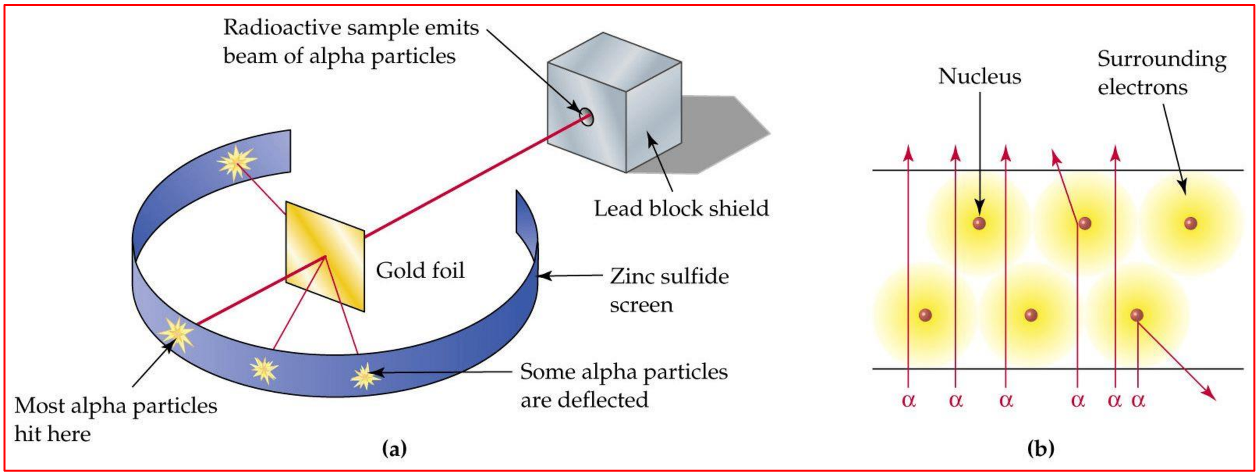
2-**Thomson's Model** (1856-1940) He proposed that an atom consists of a positively charged sphere with electrons filled into it. The negative and positive charge present inside an atom is equal and as a whole, an atom is electrically neutral.



This model of atom failed to explain how a positive charge holds the negatively charged electrons in an atom. Therefore, it failed to explain the stability of an atom.

3-Ernest Rutherford (1911) He discovered the concept of nucleus in atom. His research is based on the experiment with alpha particles. Alpha particles are helium atom particles. He did bombardment of positive alpha particles on thin foil of gold approx. 8.6 x 10^{-6} centimeters thick and took the observations on the screen of zinc sulphide which was behind the gold foil. He observed the

deflection of these bombarded alpha particles on the photographic film.



After performing his experiment he made observations:

1- Almost all the alpha particles did pass through the foil.

2- Some alpha particles were deflected off at different angles as observed at the screen of the detector.

3- Very few of the alpha particles (one or two) even bounced backwards after hitting the gold foil.

Rutherford made the following conclusions

1. Most of the space within the atoms is empty.

2. Approximately all the mass of the atom is concentrated at the center of atom which is now called nucleus.

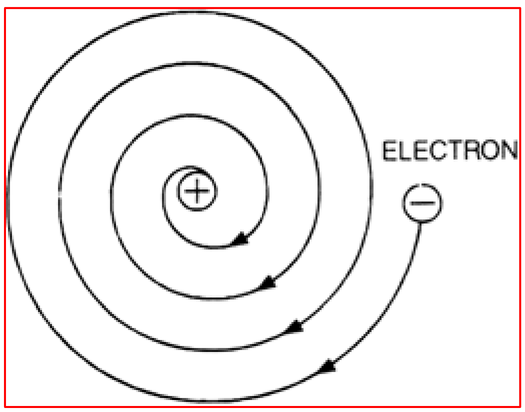
3. In the central region of atom, the positively charged particles are present.

4. The negatively charged particles i.e. electrons revolve around the central positive portion in different circular orbits.

5.Central region (nucleus) is very small in size if compared to the size of atom.

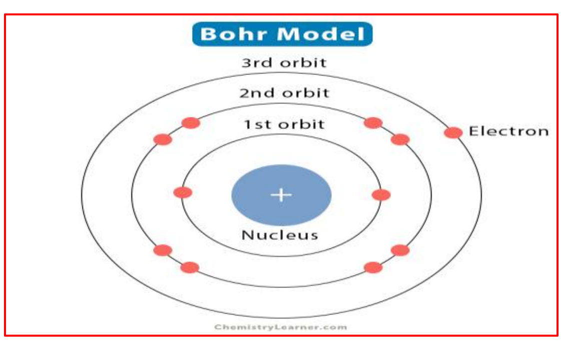
Weakness of Rutherford's Model

The assumption that the electrons were orbiting around the nucleus was unfortunate. According to the classical electromagnetic theory, if a charged particle accelerates around oppositely charged particles, the former will radiate energy. If an electron radiates energy, its speed will decrease and it will go into spiral motion, finally falling into the nucleus. This does not happen as then the atom would be unstable which it is not. This was the chief weakness of Rutherford’s Atomic Model.



4- Bohr's model

This model was improved when he studied the line spectrum of hydrogen. He observed that when hydrogen is heated, only a few precise wavelengths of light are emitted. The spectrum produced when this light is passed through a prism is call the Line Or Emission Spectrum.



Bohr postulated that:

1. Electrons can occupy only certain orbitals that were a specified distance from the nucleus (a circular path in which the electron can move around the nucleus).
2. Each orbital corresponds to a certain energy level.
3. Electrons could possess only certain quantities of energy (the energy is quantized).
4. The only way that an electron could change its energy value is to “jump” from one allowed energy level to another. The electrons could do so by absorbing or emitting energy only in whole numbers of photons.

- The movement of an electron from one energy level to another is called a transition.
- The ground state is the lowest energy state for an atom. 5 General chemistry lecture two
- When an atom gains energy it moves into an excited state.
- The transition from a lower energy level to a higher energy level requires a quantized amount of energy (which corresponds to a photon of a specific wavelength).
- The transition from a higher energy level to a lower energy level releases a quantized amount of energy (which corresponds to a photon of a specific wavelength).