Al-Mustaqbal University

College of Engineering and Engineering Technologies

Department of Chemical Engineering and Petroleum Industries

Name of the substance: Analytical chemistry

Lecture number: First

--------- First stage-------

Lecture content:

- Introduction of atom (theories of discovering atom)
- Experiments of scientist (Defects of some theories and solutions)

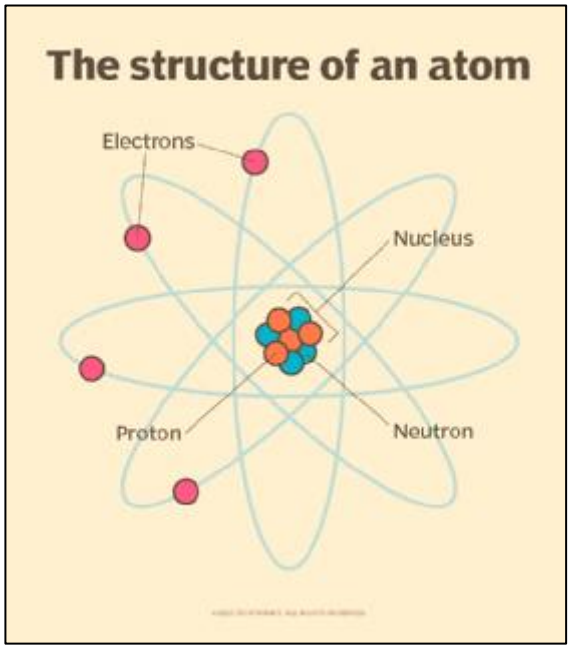
Assist. Lec. Zainab Imad Abdul Sattar

Introduction of Atom

An atom is a particle of matter that uniquely defines a chemical element. An atom consists of a central nucleus that is surrounded by one or more negatively charged electrons. The nucleus is positively charged and contains one or more relatively heavy particles known as protons and neutrons. Atoms are the basic building blocks of matter. Anything that takes up space and anything with mass is made up of atoms.

Protons and neutrons are subatomic particles that make up the center of the atom, or its atomic nucleus.

- A proton is positively charged. The number of protons in the nucleus of an atom is the atomic number for the chemical element. Different elements' atomic numbers are found in the Periodic Table of Elements. For example, sodium has 11 protons, and its atomic number is 11. A proton has a rest mass, denoted mp, of approximately 1.673 x 10-27 kilogram (kg).
- A neutron is electrically neutral and has a rest mass, denoted mn, of approximately 1.675 x 10-27.
- The mass of a proton or neutron increases when the particle attains extreme speed, for example in a cyclotron or linear accelerator.
- The total mass of an atom, including the protons, neutrons and electrons, is the atomic mass or atomic weight. The atomic mass or weight is measured in atomic mass units.



Electrons contribute only a tiny part to the mass of the atomic structure, however, they play an important role in the chemical reactions that create molecules. For most purposes, the atomic weight can be thought of as the number of protons plus the number of neutrons. Because the number of neutrons in an atom can vary, there can be several different atomic weights for most elements.

Protons and electrons have equal and opposite charges. Protons have a positive charge and electrons a negative charge. Normally, atoms have equal numbers of protons and electrons, giving them a neutral charge.

An ion is an atom with a different number of electrons than protons and is electrically charged. An ion with extra electrons has a negative charge and is called an anion and an ion deficient in electrons has a positive charge and is called a cation.

Atoms having the same number of protons but different numbers of neutrons represent the same element and are known as isotopes of that element. An isotope for an element is specified by the sum of the number of protons and neutrons. For example, the following are two isotopes of the carbon atom:

Carbon 12 is the most common, non-radioactive isotope of carbon.

Carbon 14 is a less common, radioactive carbon isotope.

Atomic power

A strong nuclear force holds together the protons and neutrons in the nucleus of an atom. That force overcomes the repulsive force between the positively charged particles. Strong nuclear force -- sometimes referred to as strong force or strong interaction -- only works at very close distances. Strong force is the strongest of the four fundamental forces in nature; the other three are gravitational, electromagnetic and weak nuclear forces.

When the bond between particles in the nucleus is broken, a large amount of energy is released. The process of breaking these bonds is known as nuclear fission. Nuclear power plants use fission to split uranium atoms and generate electricity. Uranium is used for fission because its atoms split relatively easily.

Nuclear power is considered a clean energy source because fission does not emit greenhouse gases. It is a possible energy source for IT data centers looking to reduce their carbon footprint.

List of Atomic Theories

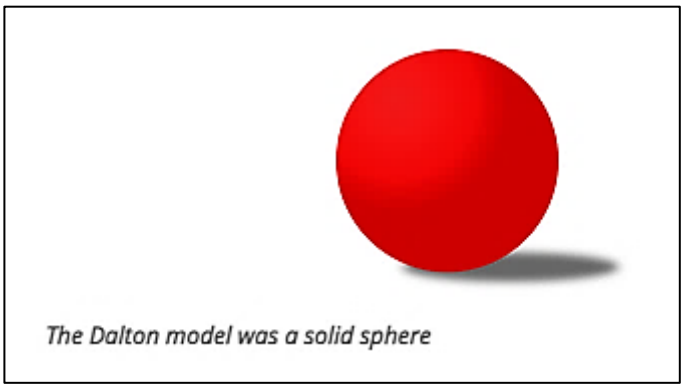
1- Ancient Greek Beliefs

"All the matter is made up of tiny units called atoms" this was first proposed by Leucippus and Democritus, in the fifth century B.C., that all matter is made of tiny units called atoms.

In addition, they tell that these were solid particles without internal structure, and came in a variety of shapes and sizes. Moreover, they also made some intangible qualities such as taste and color.

2- Dalton's Atomic Theory

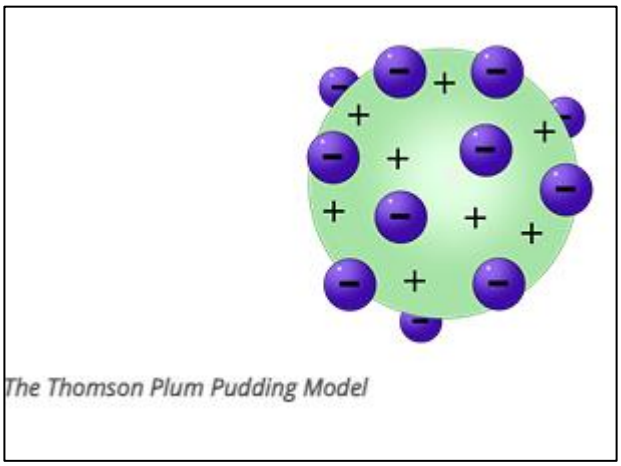
English chemist John Dalton subsequently made on the Greek notion of atoms in 1808. He postulated that matter is made of atoms, which are small indivisible particles. He also proposed that while all atoms of one element are identical, they are totally different from those that make up other elements.



The Dalton model was a solid sphere

3- J.J. Thomson's Theory

In 1904, English physicist Joseph J. Thomson proposes the "plum pudding" theory of the divisible atom. He does so after discovering electrons in 1897.



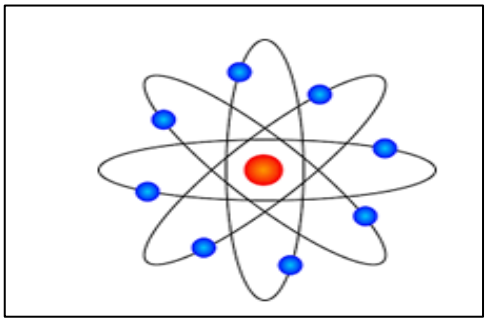
The Thomson Plum Pudding Model

Also, his model suggested that atoms consist of a big positively-charged sphere studded with negatively charged electrons (he called them "corpuscles") like fruit in a plum pudding.

Furthermore, he put forward that the charge of the positive sphere's charge is equal to the negative charges of the electrons. Today we call the positive charged particles protons and the negative one's electrons.

4- Rutherford's Hypothesis

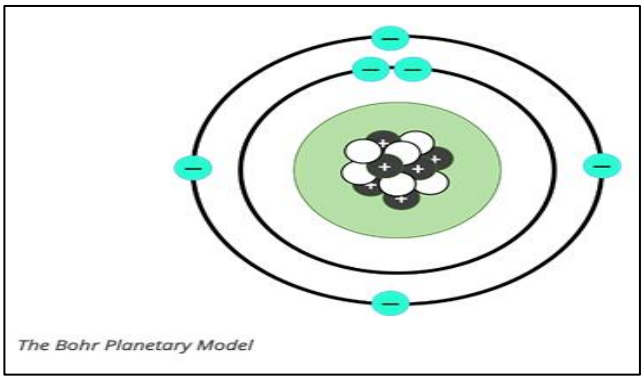
In 1911, Ernest Rutherford (British physicist) proposed a nuclear model on atoms. An atom in which a nucleus exists. In the past, he discovered the part of activity such as the movement of protons and electrons within the central part of the atom. He further hypothesized that the number of protons and electrons are equals in an atom.



5- Bohr's Theory

In 1913, Danish physicist Niels Bohr proposed a planetary model, which states that electrons revolve about the nucleus just as the planets orbit the sun. When the electrons are in orbit, they possess "constant energy".

When these atoms grasp the energy and move into a higher orbit, this theory refers to them as "excited" electrons. At the time of returning to their original orbit, they leave this energy as electromagnetic radiation.



The Bohr Planetary Model

6- Einstein, Heisenberg and Quantum Mechanics

As far as the earlier theories are concerned, the atom consists of a central and heavy nucleus centered by a number of electrons. Earlier theories used to treat electrons, and other tiny particles as fixed solid "lumps."،

.

Atomic defect

Atomic or point defects are disturbances of the periodicity of the crystal lattice extending over only a few atomic distances. Many physical and mechanical properties of solids are sensitive to their presence.

The discovery of subatomic particles, electrons, protons and neutrons inside the atom is the major reason for the failure of Dalton's atomic theory. The discovery of sub-atomic particles suggested that the atoms are divisible. Also, smaller particles than atom were discovered.

Rutherford's atomic model failed to explain the stability of electrons in a circular path. He stated that electrons revolve around the nucleus in a circular path, but particles in motion would undergo acceleration and cause energy radiation. Eventually, electrons should lose energy and fall into the nucleus.

Thomson model of an atom could not explain the stability of an atom, i.e., how a positive charge in the atom holds the negatively charged electrons. It could not explain the position of the nucleus in an atom and the scattering of alpha particles. One of the major drawbacks of his model is that there were no experimental pieces of evidence provided by him. The movement of electrons was not specified by him and was expected to be unstable.