



Islamic University / Najaf
College of Medical Technology
Department of Radiology Techniques



Radiation Protection 1

Stage 2

Lecture 1

By

Taghreed Najah, Ali Saeed, Ali Jafer

The Atom

The atom is the smallest unit of matter, an atom consists of a **nucleus**, and the nucleus consists of positively charged **protons** and neutrally charged **neutrons**, the nucleus is surrounded by negatively charged **electrons**. It is known that negative charges will be attracted by any positive charge, so in an atom negative electrons are not attracted by the positive nucleus.

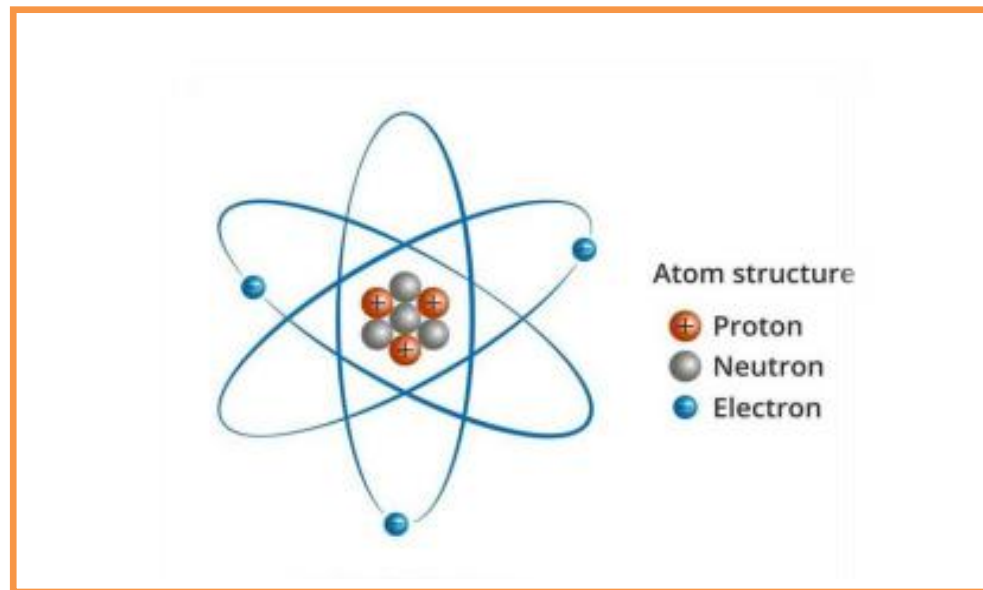


Figure (1): Atom diagram

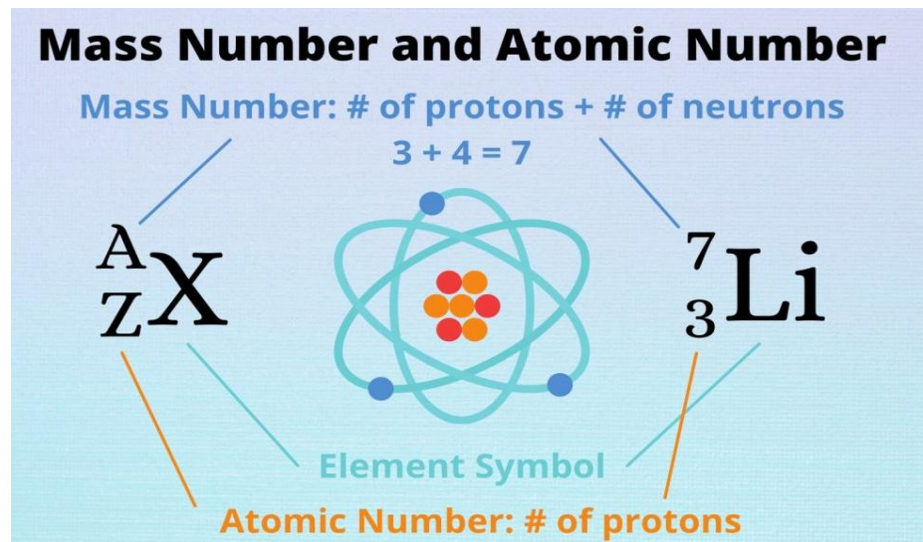
Table 1: Charge and mass of three sub atomic particles

Particle	charge	Mass (grams)
Electrons	-1	9.1093×10^{-28}
protons	+1	1.6726×10^{-24}
neutrons	0	1.6749×10^{-24}

The number of protons in the nucleus of an atom is called the **(atomic number)** and at the same time, it represents the total number of electrons in a neutral atom, the atomic number determines the type of chemical element on the periodic table. The number of protons and neutrons in the nucleus is called the **(mass number)**.

Mass number (A) = number of protons (Z) + number of neutrons (N)

The number of electrons in a neutral atom (that is, the atomic number) gives the element its unique identity. No two different elements can have the same atomic number. In contrast to the atomic number, different forms of the same element can have different masses. They are called **isotopes**.



The electrons around the nucleus occupy different orbits, normally referred to as shells. The shell closest to the nucleus can contain a maximum of two electrons, the second can have up to eight, and the outer shells have gradually greater numbers. The inner shell is known as the **K** shell, the second is called the **L** shell, the third the **M** shell, the fourth the **N** shell and so on. The maximum numbers of electrons in the **K**, **L**, **M** and **N** shells are 2, 8, 18 and 32, respectively.

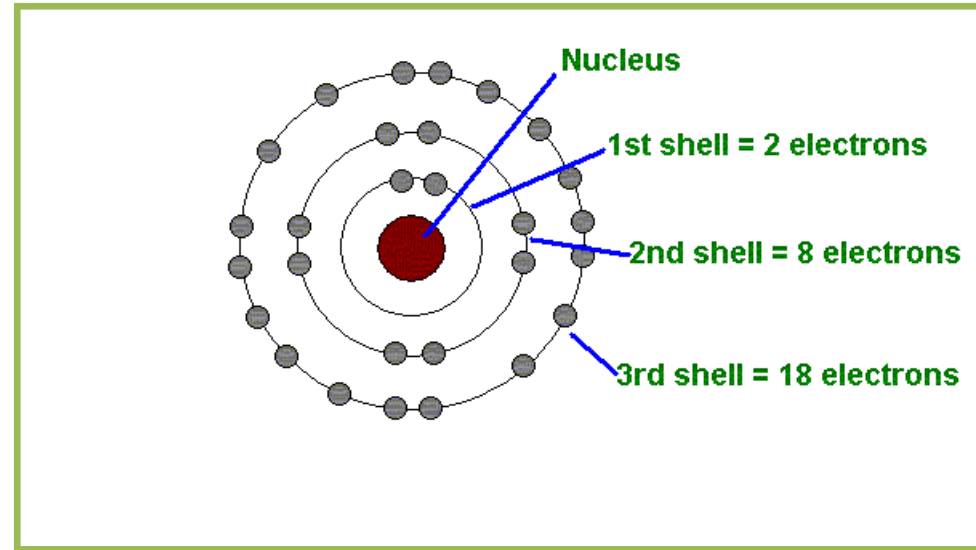


Figure (2): Electronic Orbitals

The transition of an electron from one energy level to another within an atom is known as **electron transitions**. Electron transitions cause the emission or absorption of electromagnetic radiation in the **excitation** of the atoms. But if the energy is enough to form photons. Transmission process causes separate the electron from the nucleus, then the electron leaves the atom and this process is called **ionization** of atoms, when the atom loses an electron it is called a **positive ion**, and when it gains an electron it is called a **negative ion**.

Auger Electrons

If a substance is exposed to high energy or gamma rays, an electron may be removed from the inner orbital and as a result a positively charged ion is formed. And this ion will decay to its stable state by moving an electron from the outer orbital to the inner orbital. The energy released in the transition may result in the emission of a photon. Instead of that, the energy may be released in the form of a second electron which is ejected from the atom to form a charged ion. Emitted electron known as the **Auger Electron**.

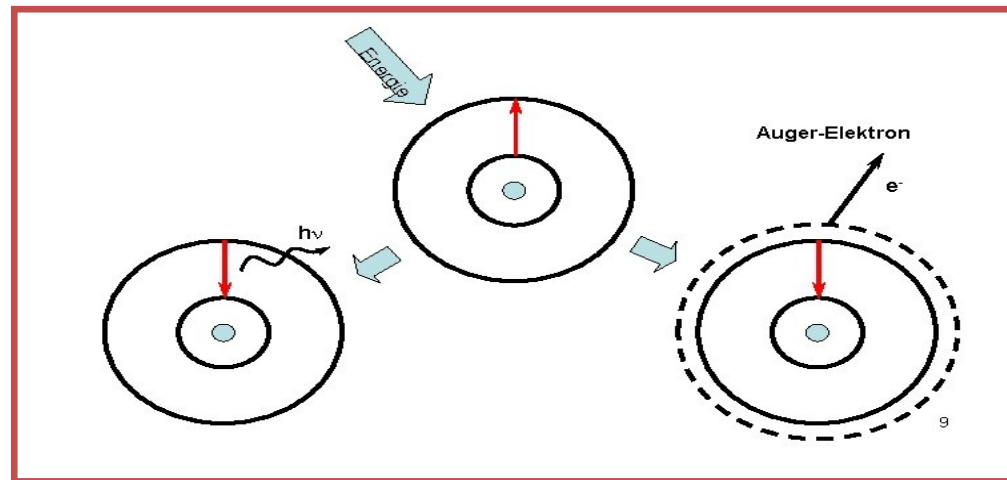


Figure (3): Auger Electron

Binding Energy

It is the energy that is released when the nucleons combine to form the nucleus, or it is the energy required to separate all the nucleons of the nucleus from each other. This nuclear binding energy is due to the sum of the masses of the nucleons, which are discrete from each other is greater than the mass of the, nucleus resulting from their assembly.

Mass Defect

It is the difference between the sum of the masses of individual protons and neutrons and the sum of their masses bound together within the atomic nucleus (the formed nucleus is always smaller than the sum of the masses of the nucleons before they are bound in the nucleus). This difference in mass is also called mass defect.

Nuclear Force

The nuclear force acts between all of the particles in the nucleus, between two neutrons, between two protons, and between a neutron and a proton. It is attractive in all cases. The nuclear force is about 10 millions times stronger than the chemical binding that holds atoms together in molecules. This is the reason why nuclear reactors produce about a million times more energy per kilogram fuel as compared to chemical fuel like oil or coal.