Radioactivity [Radioactive disintegration]

Radioactivity is defined as the emission of particles and electromagnetic rays from the nucleus of an unstable atom in order to gain stability.

Radioactive decay is a highly exoergic, statistically random, natural process that occurs with a small amount of mass being converted to energy.

As a result of radioactivity, either α −particle or β −particle or γ −radiation is emitted from the unstable nucleus resulting relatively more stable nucleus.

Radioactive disintegration can be divided into following three types:

1. **Alpha decay:** The process in which an unstable atom emits alpha particle from its nucleus is called as alpha decay.
   During this decay, a new nucleus is formed in which atomic number decreases by 2 and mass number decreases by 4.

$$_zX^A \longrightarrow {}_{z-2}Y^{A-4} + {}_2He^4 + Q \text{ (energy)}$$

2. **Beta decay:** The process in which an unstable atom emits electron from its nucleus is called as beta decay.
   During this decay, a new nucleus is formed in which atomic number increases by 1 but mass number remains same.

$$_zX^A \longrightarrow {}_{z+1}Y^A + {}_{-1}e^0 + \bar{\nu} + Q \text{ (energy)}$$

Beta decay is classified into two categories:

a. **Negative β −decay:** The process in which an unstable atom emits electron from its nucleus is called as negative beta decay.
   The $Negative\ \beta$ -particle is not present initially in the nucleus but it is produced due to the conversion of a neutron into a proton.

$$_0n^1 \longrightarrow {}_1p^1 + {}_{-1}e^0 + \bar{\nu} \qquad [\ \bar{\nu} = anti\ neutrino\ ]$$

b. **Positive β −decay:** The process in which an unstable atom emits positron (antiparticle of electron) from its nucleus is called as positive beta decay.
   The $Positive\ \beta$ -particle is not present initially in the nucleus but it is produced due to the conversion of a proton into a neutron.

$$_1p^1 \longrightarrow {}_0n^1 + {}_{+1}e^0 + \nu \qquad [\ \nu = neutrino\ ]$$

3. **Gamma decay:** After alpha or beta decay, the new nucleus (daughter nucleus) formed will be in excited state. The process in which the excited atom emits radiation (γ −ray) from its nucleus is called as gamma decay.
   During this decay, no new nucleus is formed (i.e., atomic number and mass number remains the same as before the emission of γ −rays.

$$(_zY^A)^* \longrightarrow {}_zY^A + \gamma \text{ (energy)}$$

Types of Radiations

Spontaneous disintegration of a radioactive substance takes place with the emission of three types of radiation. They are: ∝-rays, β-rays, and γ-rays.

1. **∝-particle (rays):** Alpha Particles are the helium nuclei having 4 units mass and 2 units charge. It is represented by $_2He^4$.
   The fast-moving stream of α- particle (a double charged ionized helium nucleus) is called α- rays.

$$_{92}U^{238} \longrightarrow {}_{90}Th^{234} + {}_2He^4 \text{ (α − rays)}$$