

PROPERTIES OF ALPHA, BETA & GAMMA RADIATIONS

All substances are made of atoms. These have electrons (e) around the outside, and a nucleus in the middle. The nucleus consists of protons (p) and neutrons (n), and is extremely small. (Atoms are almost entirely made of empty space).

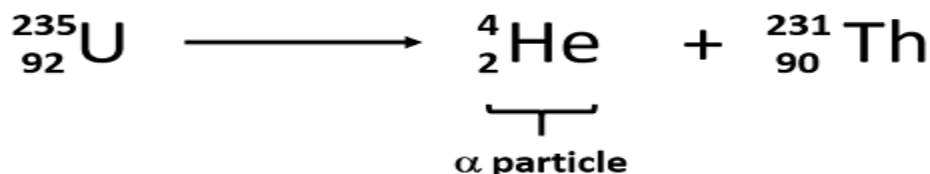
In some types of atom, the nucleus is unstable, and will decay into a more stable atom. This radioactive decay is completely spontaneous.

When an unstable nucleus decays, there are three ways that it can do so. It may give out:-

1. An alpha particle (α)
2. a beta particle (β)
3. a gamma ray (γ)

1. Alpha particles:

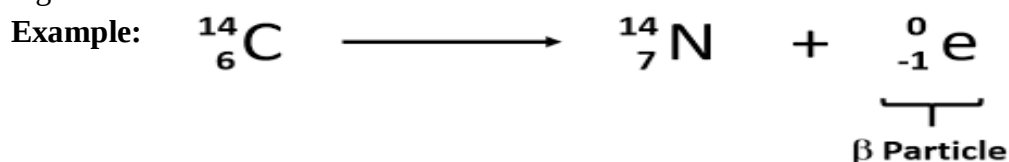
- Alpha particle radiation consists of two neutrons and two protons, as they are charged they are affected by both electric and magnetic fields.
- The speed of the α - particle depends very much on the source, but typically are about 10% of the speed of light.
- The capacity of the α particle to penetrate materials is not very great, it usually penetrates not more than a few centimeters in air and is absorbed by relatively small thickness of paper or human skin. However because of their speed and size, they are capable of ionizing a large number of atoms over a very short range of penetration
- This makes them relatively harmless for most sources that are about a meter or more away, as the radiation is easily absorbed by air.
- But if the radiation sources are close to sensitive organs α - particle radiation is extremely dangerous. **Example:**



2. Beta particles:

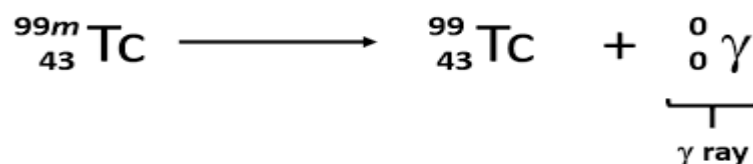
- Beta- particle radiation consists of fast moving electrons. Every β – particle carries either one negative or one positive electronic charge ($\pm 1.6 \times 10^{-19}$ coulomb: -e, +e). They are affected by electric and magnetic fields.
- The speed depends on the source, but it can be up to 90% of the speed of light.

- B particles can penetrate up to 1 m of air. They are stopped by a few millimeters of aluminum or Perspex.
- Their ionizing capacity is much less than that of α –radiation. They are very dangerous if ingested.



3. Gamma particles:

- Gamma radiation does not consist of charged particles; it is a form of very short wavelength electromagnetic energy.
- They travel at a speed of light (3×10^8 m/s).
- Gamma radiation is very difficult to stop; it takes up to 30mm of lead. Although the ionizing capacity of γ radiation is considerably smaller than that of beta-radiation.
- Their high penetration power means that they are dangerous even at a distance.
- They can penetrate in to our bodies and hit sensitive organs.
- They are particularly dangerous if ingested or inhaled.



Property	α –ray	β -ray	γ -ray
Nature	Positive charged particles, ${}^4_2\text{He}$ nucleus	Negatively charged particles (electrons).	$\sim 0.01\text{Å}$, γ Uncharged electromagnetic radiation
Charge	+2e	–e	0
Mass	6.6466×10^{-27} kg	9.109×10^{-31} kg	0
Natural sources	By natural radioisotopes e.g. ${}^{238}_{92}\text{U}$	By radioisotopes e.g. ${}^{60}_{27}\text{Co}$	Excited nuclei formed as a result of α , β decay