

## A neutral atom that loses an electron and becomes a positive ion

**Matter** is anything that occupies space and has mass; when matter is altered, **energy** results. The fundamental unit of matter is the **atom**. The atom consists of two parts:

- A central **nucleus**: is composed of **protons** and **neutrons**. **Protons** carry **positive** electrical charges, whereas **neutrons** carry **no** electrical charge and are slightly heavier than the proton
- Orbiting **electrons**: are tiny **negatively** charged particles that have very little mass; an electron weighs approximately **1/1800 as much** as a proton or neutron. Electrons travel around the nucleus in well-defined paths known as **orbits** or **shells**

An atom contains a **maximum of seven** shells, each located at a specific distance from the nucleus and representing different energy levels. The shells are designated with the letters K, L, M, N, O, P, and Q; the **K shell** is located closest to the nucleus and has the **highest energy level**. Electrons are maintained in their orbits by the **electrostatic force**, or attraction, between the positive nucleus and the negative electrons. This is known as the **binding energy** of an electron. Atoms are capable of combining with each other to form **molecules**.

A **neutral atom** contains an equal number of protons (*positive charges*) and electrons (*negative charges*). An atom with an incompletely filled outer shell is electrically unbalanced and attempts to capture an electron from an adjacent atom. An atom that gains or loses an electron and becomes electrically unbalanced is known as an **ion**. **Ionization** is the production of ions, or the process of converting an atom into ions. Ionization deals with electrons only and requires sufficient energy to overcome the electrostatic force that binds the electron to the nucleus.

**Ionizing radiation** is capable of producing ions and can be classified into two groups:

- **Particulate radiation**: are tiny particles of matter that possess mass and travel in straight lines and at high speeds. There are four types:
  - **Electrons**: can be class classified as **beta particles** (*fast moving electrons emitted from the nucleus of radioactive atoms*) or **cathode rays** (*streams of high-speed electrons that originate in an x-ray tube*)
  - **Alpha particles**: are emitted from the nuclei of heavy metals and exist as two protons and neutrons, without electrons
  - **Protons**: are accelerated particles, specifically hydrogen nuclei, with a mass of 1 and a charge of +1
  - **Neutrons**: are accelerated particles with a mass of 1 and no electrical charge
- **Electromagnetic radiation**: can be defined as the propagation of wave-like energy (*without mass*) through space or matter. Electromagnetic radiations are **man made**, or occur naturally; examples include cosmic rays, gamma rays, **x-rays**, UV rays, visible light, infrared light, radar waves, microwaves, and radio waves. The **particle concept** (*Quantum theory*) characterizes electromagnetic radiations as discrete bundles of energy called **photons** or **quanta**. The **wave concept** characterizes electromagnetic radiation as waves and focuses on the properties of velocity, wavelength, and frequency.