Introduction

Nuclear chemistry is a vast and very important branch of science that offers a solution, in a less expensive way, to our energy needs. Besides this, our other two main energy sources are chemical reactions (redox reactions) and fossil fuels (coal, fuel oil, or natural gas). The field began with the discovery of radioactivity in 1896 by French scientist Henri Becquerel and later the work of Marie Curie, Pierre Curie, and Ernest Rutherford.

One aspect of nuclear chemistry is to derive the energy for our needs, and the other aspect involves the **transmutation** of elements, i.e., creating a new element from existing one bombarding with some particle. The idea of converting one metal into another metal is not new; it goes way back to **alchemists** (600 BC – Mid 17th century), whose dream (fake pursuit) was transmutation of base metals (metals which oxidize when heated in air, e.g. lead, copper, tin, zinc, as opposed to noble metals such as gold and platinum) such as lead into gold. They had the idea, but did not have either the knowledge or the "know how". The science of transmutation has to wait until the 19th century.

The word *nuclear chemistry* means the chemistry of the nucleus. The atom consists of two parts, the central part known as a nucleus and the outer part. The outer part contains electrons that are responsible for chemical reactions. On the other hand, nuclear reactions involve nucleus but not the outer electrons. There are great differences between nuclear reactions and chemical reactions that are summarized in the following table.

Nuclear Reaction	Chemical Reactions
1. Nucleons, such as, protons, neutrons, electrons may be involved.	1. Electrons outside the nucleus are involved.
2. Elements are converted from one to another or one isotope of the same element to another.	2. Bonds are broken and reformed thereby rearranging atoms.
3. Tremendous amount of energy either released or absorbed.	3. Only small amount of energy is either released or absorbed.
4. There is no influence of temperature, pressure and catalysts.	4. There is a great influence of temperature, pressure and catalysts.

What is Radioactivity?

Radioactivity is the spontaneous emission of some kind of particle or energy from the nucleus.

Types of Radioactivities

There are basically two types of radioactivities; (a) natural radioactivity, and (b) artificial radioactivity. Natural radioactivity is the radioactivity that exists or occurs in nature. Very often, a sequence of nuclear reactions takes place that ultimately results in the formation of a stable isotope. Artificial radioactivity is the man-made, i.e., created in the laboratory.

Before you take a journey into this chapter, you have to be familiar with few terminologies and symbols.

Nucleus: Central part of the atom.

Nuclei: Plural of nucleus.

Nuclide: A nucleus containing specific number of protons and neutrons.

Nuclides: Plural of nuclide.

Nucleons: Particles residing in nucleus.

Isotopes: Two or more nuclei of the same element containing the same number of protons (same atomic number) and different number of neutrons (different mass number).

Isotopes are usually indicated by the isotopic symbols, which are quite different from other symbols that you have come across in chemistry. Below are the chemical (needed in chemical reactions) and isotopic symbols (needed in nuclear reactions):

Chemistry

Symbol for a single atom:	H,	O,	Cl,	Cu,	etc.
Symbol for more than one atom:	H_2,	O_2,	O_3,	P_4,	etc.
Symbols for ions:	H^{-1},	O^{-2},	Al^{+3},	N^{-3},	Hg_2^{+2}, etc.
In general, symbol involving atom:	$E_n^{\pm m}$				

Number of atoms (n) is written as a subscript and charges as super subscript on <u>right side of the atomic symbol.</u>

Nuclear chemistry

Isotopic symbol: $^{A}_{Z}E$

E = nucleus of an atom
Z= atomic number = number of protons (p)
A = mass number = number of protons (p) + number of neutrons (n).

The number of neutrons (n) = A-Z

Particle symbol $^{mass}_{charge}p$

p = particle symbol

Atomic number is written as subscript and mass number as super subscript on left side of the atomic or elemental symbol as oppose to chemical symbols.
