

NUCLEAR CHEMISTRY WORKSHEET

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Most nuclear reactions involve changes in the number of protons and/or neutrons in the nucleus of an atom. These changes are called *transmutations* because an atom of one element is changed into an atom of a different element. During these changes, nuclear particles may be absorbed and/or emitted along with a release of energy.

There are four types of nuclear reactions:

- 1) *natural radioactive decay*: transmutations occur by natural radioactivity (the ability of a nucleus to emit a nuclear particle and energy without external stimulation);
- 2) *artificial transmutation*: transmutations occur by nuclear disintegration caused by external stimulation as a scientist bombards a nucleus with a particle (the addition of another nuclear particle makes the nucleus unstable);
- 3) *fission*: certain nuclei having a large mass are bombarded with special particles that cause the nuclei to split into two nuclei each having a smaller mass;
- 4) *fusion*: nuclei of light elements are combined to form heavier nuclei.

Nuclear reactions are written using symbols in the A_ZX notation. The symbols for the major nuclear particles involved in nuclear reactions are given below.

Alpha particle	${}^4_2\text{He}$ (an alpha particle is a helium nucleus)
Proton	${}^1_1\text{H}$ (the most common hydrogen nucleus is a proton)
Neutron	${}^1_0\text{n}$
Electron	${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$ (also called a beta particle)
Positron	${}^0_1\text{e}$ or ${}^0_1\beta$
Gamma ray	${}^0_0\gamma$

The table below contains information about nuclear reactions involving the emission of radiation.

NUCLEAR CHANGES

Type of Reaction	Radiation (Particle)	Effect on the Atomic Number	Effect on the Atomic Mass
Alpha emission (α)	${}^4_2\text{He}$	decrease by 2	decrease by 4
Beta emission (β)	${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$	increase by 1	no change
Positron emission (β^+)	${}^0_1\text{e}$ or ${}^0_1\beta$	decrease by 1	no change
Gamma emission	${}^0_0\gamma$	no change	no change
Electron capture (EC)	${}^0_{-1}\text{e}$ or ${}^0_{-1}\beta$	decrease by 1	no change

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