**Chapter 12: Nuclear Transformations**

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## 12.1 Radioactive Decay

When a nucleus undergoes alpha or beta decay, its atomic number changes and it becomes the nucleus of a different element. The energy liberated during this decay comes from inside the individual nuclei without external excitation, from the mass lost during the decay.

The five types of radioactive decay are alpha (Helium nucleus), beta (electrons) and gamma (high-energy photons), positron emissions and electron capture.

Gamma decay - occurs if nucleus has too much energy

Alpha decay - occurs if nucleus is too large

Beta decay - occurs if nucleus has too many neutrons

- a neutron can emit an electron and turn into a proton

Electron capture - occurs if nucleus has too many protons

- a proton can capture an electron and turn into a neutron

Positron Emission - occurs if nucleus has too many protons

- a proton can emit a positron and turn into a neutron

## 12.2 Half-life

Radioactivity decreases exponentially with time. Every radionuclide has a characteristic half-life, i.e. a time-period in which the activity of the radio-nuclide halves.

The formula is followed, where is the decay constant, which is different for every radionuclide.

From here,

A similar formula can be found for the number of undecayed nuclei at the time :

Radioactive decay follows probability. Every nucleus in a sample has a certain probability of decaying, but there is no way to know which nucleus will decay. The actual fraction that decays will be very close to the probability of an individual nucleus decaying.

Radioactive decay can be used to determine the age of different materials. This is called radioactive dating.

## 12.9 Nuclear Fission

When a very nucleus, such as is struck by a neutron, it absorbs the neutron and becomes very unstable. This results in the nucleus splitting into two smaller more stable nuclei. This process is called nuclear fission.