

Tutorial 15: An Introduction to Nuclear Chemistry

Goals:

- ✓ Understand the band of stability, and know that radioactive isotopes undergo changes in the nucleus.
- ✓ Know how to write reactions for alpha and beta decay, including alpha and beta decay that is accompanied by the release of gamma radiation.
- ✓ Understand the basics for how radioisotopes are used in nuclear medicine.

Stable Vs Unstable Isotopes

- For lighter atoms, a 1:1 ratio of neutrons to protons is stable.
- For larger atoms, it takes a greater number of neutrons to maintain stability.
- Beyond atomic number 83 (Bismuth), all atoms are radioactive (unstable).
- We call atoms that are radioactive radioisotopes.

Some Types of Nuclear Decay

- Nuclear chemistry involves a change to an atoms nucleus.
- Nuclear reactions are accompanied by tremendous energy changes.
- Some types of nuclear decay include:
 1. **Alpha decay:** An atom emits an alpha particle, thus the nucleus loses 2 protons and 2 neutrons. The atomic number decreases by 2, and the mass number decreases by 4.
 2. **Beta decay:** An atom emits a beta particle in the form of an electron when a neutron is changed into a proton. The atomic number increases by 1 while the mass number remains the same.
 3. **Gamma decay:** Usually accompanies other forms of radioactive decay as an energy release. Gamma rays cause no change in atomic or mass number since it is a form of energy only.

Rate of Decay

- Nuclear decay is measured in half-life ($t_{1/2}$), the time it takes for one half of a sample to decay.
- There is no known way to affect the half-life of a radioactive isotope.

Nuclear Medicine

- Diagnostic Imaging: radioisotope is administered (via ingestion, injection or inhalation) and allowed to circulate to an organ or area of interest in order to assess function.
- Radiation Therapy:
 - Internal RT: radioisotope is administered (via injection, ingestion, inhalation or surgical implantation) with the intent to release a dose of ionizing radiation high enough to kill malignant cells.
 - External RT: beam of radiation is aimed at the site of malignancy with the intent to cause death to malignant cells.