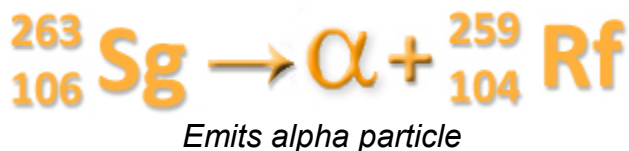


## Alpha and Beta Decay Info Sheet

### Alpha Decay

Alpha particles are a type of ionizing radiation discovered by Ernest Rutherford in 1898. Rutherford named these particles after alpha, the first letter of the Greek alphabet. When an atom experiences an alpha decay, it gives off an alpha particle made up of two protons and two neutrons which come directly from its nucleus. The alpha particle is the equivalent to the nucleus of the helium atom and has a mass number of 4, two protons and two neutrons. Because alpha particles have two neutrons and two protons, alpha particles have a positive electric charge.

An example of alpha decay would be seaborgium-263 which is an unstable radioactive isotope. An atom of seaborgium-263 will at some point, go through an alpha decay and give off a particle and transmute or change into rutherfordium-259 in an attempt to become stable.

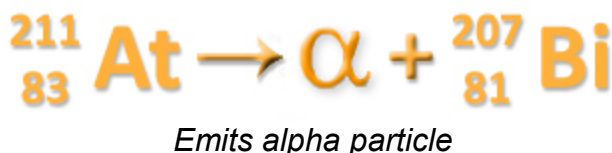


Note the atomic number of rutherfordium is two less than seaborgium-263 because the alpha particle which has just been given off has an atomic number of 2. The mass number is four less because the mass of the ejected alpha particle is 4.

Radioactive decays can be written as equations similar to those used in chemistry for expressing chemical reactions.



As a general rule of thumb, you can find the progeny isotope which has just been created by an alpha decay by finding the element or isotope which has a mass number which is four less than the parent radioactive isotope and has an atomic number that is two less than the parent radioactive isotope. Here's another example. If you look at the periodic table and find astatine (mass number is 210). A radioactive isotope of astatine is astatine-211. It will decay and give off an alpha particle. Now look back two spaces on the periodic table. You will find that the element is bismuth. Thus At turns into Bi. Subtract four from the mass number of astatine-211 and the progeny isotope is bismuth-207.



Again the equation:



Elements and isotopes that give off alpha particles are called alpha emitters. As far as subatomic particles go, the alpha particle is quite heavy so it will only travel a few centimetres in air and will not penetrate skin or clothing, posing little health risk if it remains outside the body. If alpha emitting elements enter the body through cuts or by inhaling them, however, the health risks can be quite severe. People who smoke actually inhale the radioactive isotope polonium-210, a natural occurring alpha emitter found in tobacco, into their lungs, greatly increasing the risk of lung cancer.

### Alpha Emitters

Alpha emitters are radioactive isotopes which emit alpha particles. Below is a list of some alpha emitting radioactive isotopes:

- Americium-241 is used in smoke detectors, measure levels of toxic lead in dried paint samples and in thickness gauges.
- Californium-252 is used to inspect luggage for explosives, in brachytherapy, in moisture gauges and to locate water and oil-bearing layers in oil wells.
- Polonium-210
- Plutonium-236
- Plutonium-239
- Radium-226 is used to make lightning rods more effective.
- Radon-222
- Thorium-220 is used for coloring and fluorescence in colored glazes and glassware
- Thorium-229 helps fluorescent lights last longer.
- Thorium-232
- Uranium-238

The alpha emitters listed above are commonly used in industrial applications. Radium-226 is used to treat cancer and plutonium-236 can be used to produce nuclear weapons.

### Beta Decay

Beta particles are a form of ionizing radiation made up of high-energy, fast-moving and electrically-charged subatomic particles. Henri Becquerel is credited with the discovery of nuclear radiation in 1896. In 1898 Ernest Rutherford, working at McGill University in Montreal, discovered that “Becquerel rays,” as they were then known, consisted of both positively-charged and negatively-charged particles, which he named “alpha” and “beta,” respectively, after the first and second letters of the Greek alphabet. In 1900, Becquerel showed that beta particles were identical to electrons, which had recently been discovered by J.J. Thomson.

In 1903 Rutherford, still working at McGill University in Montreal, proposed the ground-breaking concepts of “radioactive decay” and “half-life.” In 1908 Rutherford’s revolutionary ideas earned him the Nobel Prize – the first awarded for work performed in Canada. The production of beta particles is therefore termed “beta decay.” As it turns out, there are two types of beta particles:  $\beta^+$  and  $\beta^-$ .

$\beta^-$  decay occurs when a neutron in the nucleus of an unstable atom is converted into a proton. During this conversion an electron and an antineutrino are ejected from the nucleus. This type of beta decay is also known as electron emission. An example of  $\beta^-$  decay is:



$\beta^+$  decay, also known as positron emission, is almost the exact opposite.  $\beta^+$  decay occurs when a proton in the nucleus of an unstable atom is converted into a neutron. Typically, when beta decay occurs, a small amount of gamma radiation is also emitted. An example of  $\beta^+$  decay is:



Beta particles can travel a few metres through the air and can be stopped by a thin sheet of aluminum or a piece of wood a few centimetres thick. However, they do travel fast enough to penetrate clothing and do pose a health risk especially if, like alpha particles, they are inhaled or ingested.

Radioactive isotopes which emit beta particles are called beta emitters. Beta emitters exist in our environment from both natural and man-made sources. Some beta emitters such as carbon-14 and potassium-40 exist naturally in your body.

### Beta Emitters

Radioactive isotopes which emit beta particles are called beta emitters. Below is list of some beta emitting radioactive isotopes.

- Carbon-14 is used in carbon dating artifacts and as a medical tracer
- Cesium-137 is used in brachytherapy to treat various types of cancer and to measure the flow of oil in pipelines.
- Cobalt-60
- Hydrogen-3 (tritium)
- Iodine-129
- Iodine-131 is used as a medical tracer
- Nickel-63 is used to detect explosives, and in voltage regulators and current surge protectors in electronic devices.

- Promethium-147 is used in electric blanket thermostats, and to gauge thickness of thin plastics, thin sheet metal, rubber, textile and paper.
- Sodium-24 is used to locate leaks in industrial pipelines, oil well studies, and in medical diagnostics.
- Strontium-90 is used as a power source for weather satellites and navigation buoys.
- Sulphur-35 is used in manufacturing sensors and medical treatments.
- Technetium-99m is used in nuclear medicine as a radioactive tracer.
- Thallium-204 is used to measure the dust and pollutant levels on filter paper, and in gauges it is used to measure the thickness of plastics, sheet metal, rubber, textiles and paper.

The beta emitters listed above are commonly used in medical imaging, diagnoses and treatments as well as industrial applications.