**Types of Nuclear Radiation & The Radiation Foldable Project**

 **Nuclear Radiation** is radiation in the form of elementary particles (or energy) emitted by an unstable atomic nucleus, as alpha particle, beta particles, or gamma rays produced by decay of radioactive substances or by nuclear fission. Some atoms are stable and will remain in-tact for a long time however some atoms are not stable and will decay over time by emitting energy as particles or radiation. The excess energy contained in an unstable atom is release in one of a few basic ways (particles or waves). Different forms of radiation may be emitted from an unstable radioactive nucleus; energy is released from an unstable nucleus and a new, more stable nucleus is formed. The three types of radiation considered in this paper are: Alpha, Beta, and Gamma.

 **Alpha Radiation** – an alpha particle has two protons, two neutrons, and a positive charge (this is essentially the nucleus of a helium atom) and it is produced from large nuclei. When an atom emits an alpha particle the atom’s atomic number decreases by two (as a result of the loss of two protons) and the atom’s mass number decreases by four (as a result of the loss of two-protons and two-neutrons) and the atom becomes a new element. Alpha particles are emitted from unstable nuclei at a speed of 16,000 km/sec (around a tenth the speed of light). The alpha particle is relatively large and heavy and as a result are not very penetrating and are easily absorbed, a sheet of paper or three-centimeters of air is sufficient to stop alpha particles. Alpha particles will not penetrate human skin however, if inhaled alpha particles are hazardous.

 **Beta Radiation** – beta radiation is the emission of high-speed electrons from the nuclei of decaying radioisotopes (beta particles leave the nucleus at a speed of 270,000 km/sec). Since these are electrons they have a negative charge and an extremely small mass (the mass is so small it is approximated as 0 AMU). Beta particles may travel 2 or 3 meters through air. Heavy clothing, thick cardboard, aluminum, and wood will provide protection from beta particles by stopping/absorbing them. Beta emission occurs in elements with more neutrons than protons through the process of a neutron splitting into a proton and an electron, the proton stays in the nucleus and the electron is emitted. Because of this process the atomic number increases by one and the mass number stays the same.

 **Gamma Radiation** – gamma radiation is the emission of a very-high energy ray of light called a “gamma-ray”. Gamma radiation is very much like an X-ray (high-energy electromagnetic waves) therefore it has no charge, a very short wavelength, extremely high energy, and is emitted at the speed of light (300,000 km/sec). The emission of gamma rays does not alter the number of protons or neutrons in the nucleus but instead has the effect of moving the nucleus from a higher to a lower energy state (unstable to stable). Gamma radiation is the most penetrating form of radiation considered here. It travels great distances through air (500 meters). To be protected from gamma emission requires thick sheets of lead or concrete are required. Gamma rays can be used to find flaws in pipes, vessels, and to check the integrity of welds in steel.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Alpha** | **Beta** | **Gamma** |
| **Composition** | Alpha particles (two protons & two neurtons | Beta particles (an electron) | High energy electromagnetic radiation (light) |
| **Symbol** | α or (42He) | β or (0-1e) | γ |
| **Charge** | 2+ | 1- | 0 |
| **Penetrating Power** | Blocked by paper | Blocked by metal foil | Partially blocked by lead or concrete |
| **Particle Emitted** | 42He | 0-1 β or 0-1e | 00 γ |
| **Change in Mass #** | Decrease by 4 | No change | No change |
| **Change in Atomic #** | Decrease by 2 | Increase by 1 | No change |
| **Equation Example** | 21084 Po → 20682 Pb+42He | 146 C → 147 N + 0-1 e | 23892 U\* → 23892U + 00 γ |

Half-Life: the half-life of a substance is defined as the time required for one-half of the atoms (in any size sample) to radioactively decay. The equation is: **Nt = N0 × (1/2)^(t/t1/2)** where **Nt** is the remaining quantity of the radioactive sample, **N0** is the initial quantity of the radioactive sample, **t** is the time elapsed, and **t1/2** is the half-life of the decaying sample.

**Define the following terms (using your notes, the front board, the textbook or an online source):**

1. Atomic Mass –
2. Mass Number –
3. Isotope –
4. Radioisotope –
5. Nucleus –
6. Proton –
7. Neutron –
8. Nucleon –
9. Electron –
10. Half-Life –
11. Stable –
12. Unstable –

Alpha, Beta, and Gamma Radiation will respond to an electric field in the following way:



The following image represents the “penetrating power” of Alpha, Beta, and Gamma Radiation:



**Instructions for Foldable:** For each side of your “Nuclear Radiation Foldable” use the information below. Be creative in using colors, images, and designs to make your foldable unique. When you are ready to fold your “cube” cut on the solid lines and fold on the dashed lines. Use glue or tape to assemble your cube.

**Side 1 –** Title: Alpha Radiation. Include the definition, composition, symbol, charge, and particle name.

**Side 2 –** Title: Penetrating Power. Include “penetrating power” image above.

**Side 3 –** Title: Beta Radiation. Include the definition, composition, symbol, charge, and particle name.

**Side 4 –** Title Response to Electric Field. Include the “electric field response” image from above.

**Side 5 –** Title: Gamma Radiation. Include the definition, composition, symbol, charge, and radiation type (particle or wave).

**Side 6 –** Title: Nuclear Equations. Include example equations for Alpha, Beta, and Gamma decay along with the half-life equation (found on page one).