**Nuclear Reactions & Radioactivity**

**Instructions**: create a poster using the information found in your “Group” below.

**Group 1 – Nuclear Fission**

* Definition: fission is the splitting of large atoms into smaller atoms and particles.
* Natural Occurrence: fission reactions rarely occur in nature.
* Byproducts: fission produces many highly radioactive particles
* Required conditions: critical mass of the substance and high-speed neutrons.
* Energy Requirement: fission requires a small amount of input energy.
* Energy Released: fission is used in nuclear power plants and produces a large amount of energy.
	+ Example: one kilogram of uranium contains 2 million times the energy in one kilogram of coal.
* Fuel: uranium is the primary fuel used in power plants (nuclear fission)
* Example Equation: 23592U + 10n → 9038Sr + 14354Xe + 310n
* Image:



**Group 2 – Nuclear Fusion**

* Definition: fusion is the process of combining two smaller atoms into a larger atom.
* Natural occurrence: fusion occurs in stars.
* Byproducts: fusion produces an extremely small number of radioactive particles (mostly from the fission trigger)
* Conditions: high density and extremely high temperatures are necessary for fusion to proceed.
* Energy Requirement: very high energy is needed to overcome the electromagnetic repulsive force.
* Energy Released: the energy released by fusion is 3 times that of fission so 1 kg of fused atoms would produce 6 million times more energy compared to 1 kg of coal.
* Fuel: Hydrogen isotopes, deuterium and tritium, are the primary fuel in earth-based fusion reactions.
* Example Equation: 21H + 21H 🡪 42He + Energy
* Image:



**Group 3 – Alpha Decay/Radiation**

* Definition: alpha decay is the release of 2-protons and 2-neutrons (an alpha particle) from the nucleus of a large, unstable atom.
* Particle: the alpha particle consists of 2-protons and 2-neutrons with an overall 2+ charge. This is a helium nucleus (helium is an alternative name for an alpha particle.)
	+ Particle Symbol: 42He2+ or
* Changes to Nucleus: The mass number is reduced by 4. The atomic number is reduced by 2. This means that an atom undergoing alpha decay literally turns into a different atom (transmutation)
* Example Equation: 23392U 🡪 22990Th + 42He2+
* Image:



**Group 4 – Beta Decay/Radiation**

* Definition: beta decay is the release of a high energy electron from the nucleus of an unstable nucleus. A neutron in the nucleus splits into a proton and an electron. The proton stays in the nucleus, the electron is emitted as a beta particle.
* Particle: a beta particle is a high-energy electron.
	+ Particle Symbol: 0-1e or 0-1β
* Changes to Nucleus: when beta decay occurs the mass number of the atom stays the same however, the atomic number increases by one. (this means the atom is turned into a different atom, known as transmutation)
* Example Equation: 23490Th 🡪 23491Pa + 0-1e
* Image:



**Group 5 – Gamma Decay/Radiation**

* Definition: a large unstable nucleus emits energy in the form of electromagnetic radiation (gamma rays).
* Particle: gamma ray/particles can be thought of as a photon or as a wave of light.
	+ Particle Symbol: ɣ or 00 ɣ
* Changes to Nucleus: there is no change in mass for the nucleus instead a high-energy nucleus changes to a lower-energy nucleus after emitting energy in the form of a gamma ray.
* Example Equation: 23592U\* 🡪 oo ɣ + 23492U
	+ Note: in the above equation, the asterisk (\*) next to the first Uranium indicates a “high-energy” nucleus. Notice in the second Uranium there is not asterisk (\*), indicating a “relaxed” or “lower-energy” nucleus.
* Image:



**Continued on the next page 🡪**

**Group 6 – Radioactivity & Half-Life**

* Definitions
	+ Radioactivity: the emission of energy and/or particles from the nucleus of a large, unstable atom.
		- Stable: in terms of radioactivity, stable means a nucleus will stay together for a long time (in other words if an atom is stable it is not radioactive)
		- Unstable: in terms of radioactivity, unstable means a nucleus is likely to emit energy and/or particles. (in other words, if an atom is unstable it is radioactive)
	+ Half-Life: the amount of time it takes for a radioactive sample to lose half of its original mass through radioactive decay. (note: there are different symbols used in the half-life equation however, they all perform the same calculation. For example the “A” and A0” are sometimes written as “Nt” and “N0”.
* Half-Life Equation:



* Half-Life Example Graph:



* Radiometric dating: a method of dating geological or archeological specimens by determining the relative proportions of particular radioactive isotopes present in a sample.