

BareBones Chemistry

Nuclear Chemistry

Gamma rays and X-rays are both types of electromagnetic radiation. Just like light but a lot more powerful

Alpha radiation has the least penetrating power because it has a very large mass of 4 amu. Beta particles are more powerful and gamma rays are the most powerful.

The γ is the symbol for gamma radiation.

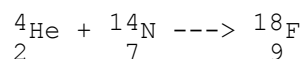
The stability of the nucleus of an atom depends upon the ratio of protons to neutrons.

If an atom is unstable because it has too many protons it is most likely to change a proton to a neutron by capturing an electron and turning into a neutron. This is because a neutron is thought to be a proton which has combined with an electron.

An unstable atom with too great a mass is most likely to lower its mass by emitting an alpha particle since the alpha particle is the radiation with the largest mass.

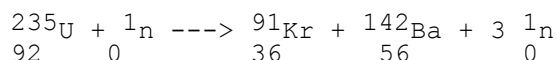
Artificial transmutation is hitting a nucleus with another type of particle, such as a proton, neutron or an alpha particle. In the first artificial transmutation, nitrogen-14 atoms were hit and combined with alpha particles. That reaction would produce an element with 2 more protons (F) and 4 more amu.

A typical transmutation reaction is shown below as a nitrogen nucleus is bombarded with alpha particles, causing the nitrogen to change into an isotope of fluorine.



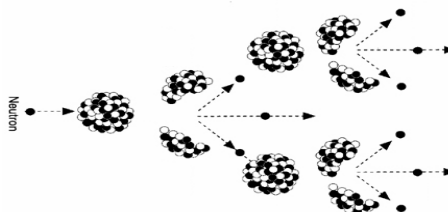
Nuclear fission is the splitting of a heavy nucleus like uranium nuclear fusion is the combining of lighter nuclei like hydrogen to form helium. Even though they are opposite types of reaction, energy is given off in both reactions.

A typical FISSION reaction is



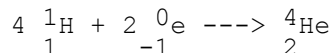
The neutrons that are released in the fission reaction are absorbed by other uranium nuclei and make the reaction keep on increasing.

This is called a CHAIN REACTION

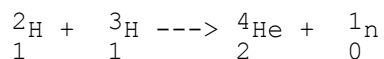


A nuclear power plant is a CONTROLLED FISSION reaction. The reaction is controlled by things called CONTROL RODS that absorb neutrons. If the neutrons are absorbed by these rods they are unable to go and hit other uranium nuclei, thus the reaction is "controlled" by decreasing the number of slow moving neutrons.

A typical SOLAR FUSION reaction is



While a typical NUCLEAR BOMB FUSION REACTION is



You **absolutely need to know the nuclear symbols** for the following.

Positron $\begin{matrix} 0\text{e} \\ 1 \end{matrix}$ Proton $\begin{matrix} 1\text{H} \\ 1 \end{matrix}$ neutron $\begin{matrix} 1\text{n} \\ 1 \end{matrix}$

beta $\begin{matrix} 0\text{e} \\ -1 \end{matrix}$ alpha $\begin{matrix} 4\text{He} \\ 4 \end{matrix}$

When an atom emits an alpha particle, the atomic mass decreases by 4 and the atomic number decreases by 2.

When an atom emits a beta particle the atomic number increases by 1 and the atomic mass remains the same.

When an atom emits gamma radiation both the atomic number and the atomic mass remain the same.

There are some other facts you should know about these nuclear particles.

A positron is a particle with the mass of an electron but a positive charge.

Radioisotopes are isotopes of an element that have an unstable nucleus. Therefore, radioisotopes are radioactive and give off some of the kinds of particles written above.

When one type of atom changes into another element it is transmutation

You ABSOLUTELY need to know how to write nuclear equations, very similar to the kind we did in class.

A substance has a half-life of 25 days. If you start out with 20 grams, it would decay as follows. After 25 days, there would be 10 grams left. After 25 more days there would be 5.0 grams left. Then, after 25 more days, you would have 2.5 grams left. In a nuclear reactor, the function of a control rod is to absorb neutrons, thus giving the operator control over how fast the reaction is occurring.

All atoms with an atomic number greater than 83 are radioactive.

If 2 grams of a substance decays to 0.5 grams in 40 days you know that there have been a total of 2 half-lives. Therefore, in this case, the half-life would be 20 days.

When naturally occurring radioisotopes are used for dating objects, you want to use radioisotopes whose half-life is reasonably close to the expected age of the object.

Since transmutation means changing one element into another, there MUST always be a change in the atomic number, that is, a change in the number of protons in the nucleus of the atom.