NUCLEAR CHEMISTRY

There are three different types of nuclear reactions: fusion, fission, and radioactive decay. **Radioactive decay** is a type of nuclear reaction which involves atoms that undergo radioactive (alpha, _____, and gamma) decay. Unstable nuclei _____ emit radiation to attain more stable atomic configurations. During radioactive decay, unstable atoms lose _____ by emitting one of several types of radiation. Nuclear decay is a _____ event.

TYPES OF RADIATION

NAME	SYMBOL	FORMULA	MASS	CHARGE	DESCRIPTION
alpha		$^{4}_{2}He$			
	β			-1	
			0		High energy radiation

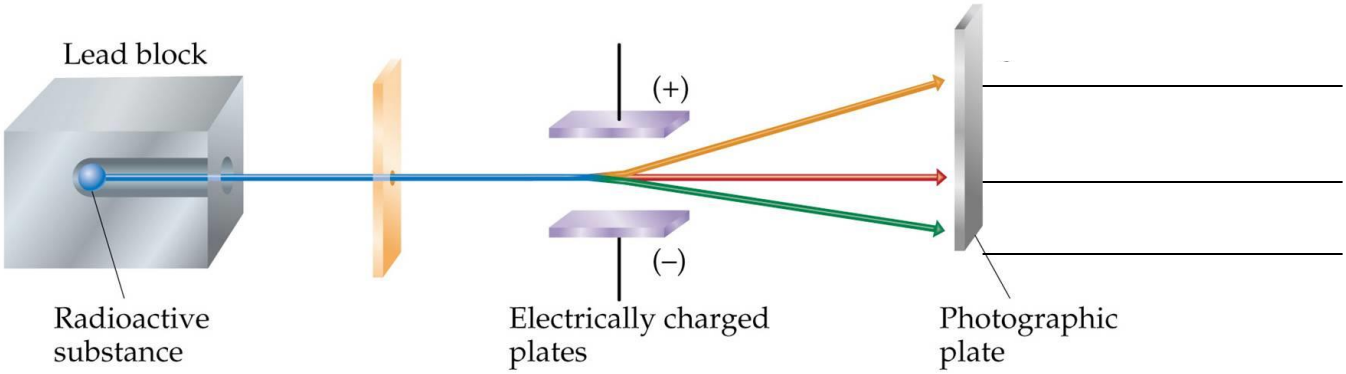
An **ALPHA** particle (α) has the same composition as a _____ nucleus - two protons and _____ neutrons - and is therefore given the symbol _____. The charge of an alpha particle is 2+ due to the presence of the two _____.

Because of their mass and charge, alpha particles are relatively slow-moving compared with other types of radiation. Thus, alpha particles are not very _____ - a single sheet of paper stops alpha particles.

A **BETA** particle is a very-fast moving _____ that has been emitted from a neutron of an unstable nucleus. Beta particles are represented by the symbol _____. The zero superscript indicates the insignificant mass of an electron in comparison with the mass of a _____.

The –1 subscript denotes the _____ charge of the particle. Beta radiation consists of a stream of fast-moving electrons. Because beta particles are both lightweight and fast moving, they have _____ penetrating power than alpha particles. A thin metal foil is required to stop beta particles.

GAMMA rays are high-energy (_____ wavelength) electromagnetic radiation. They are denoted by the symbol _____. As you can see from the symbol, both the subscript and superscript are zeroes. Thus, the emission of gamma rays does not change the _____ number or mass number of a nucleus. Gamma rays are the _____ penetrating. Concrete, _____, or steel must be used to block gamma rays.



In an electric or magnetic field, alpha particles are deflected _____ because they are more massive.

NUCLEAR STABILITY and DECAY

Radioactive nuclei undergo decay in order to gain _____. All elements with atomic numbers greater than _____ are radioactive. Nuclear equations are used to show nuclear transformations. Balanced nuclear equations require that both the _____ number and the mass number must be balanced.

PARTICLE	SYMBOL	PARTICLE	SYMBOL
neutron		alpha	
proton		beta	
electron		positron	

1. When beryllium-9 is bombarded with alpha particles (helium nuclei), a neutron is produced. The balanced nuclear reaction is given as: _____

The atomic number (the number on the bottom) determines the identity of the element.

2. When nitrogen-14 is bombarded with a neutron, a proton is produced. The balanced nuclear equation can be written as: _____

3. Polonium-230 undergoes alpha decay: _____

4. Uranium-234 undergoes alpha decay: _____

5. Cobalt-50 undergoes beta decay: _____

6. What element is formed when iron-60 undergoes beta decay? Give the atomic number and mass number of the element. _____

7. Write a balanced nuclear equation for the alpha decay of the following radioisotope, uranium-235.

_____

8. Nitrogen-12 decays into a positron and another element. Write the balanced nuclear equation.

_____

9. Uranium-238 is bombarded with a neutron. One product forms along with gamma radiation. Write the balanced nuclear equation.

_____

10. Nitrogen-14 is bombarded with deuterium (hydrogen-2). One product forms along with an alpha particle. Write the balanced nuclear equation.

_____

RADIOACTIVE DECAY RATES

Radioactive decay rates are measured in half-lives. A half-life is the time required for one-half of a radioisotope's nuclei to _____ into its products. Every radioactive isotope has its own characteristic half-life. _____ reaction rates are greatly affected by changes in temperature, pressure, and concentration, and by the presence of a catalyst. In contrast, nuclear reaction rates remain _____ regardless of such changes. In fact, the half-life of any particular radioisotope is _____.

11. Iron-59 is used in medicine to diagnose blood circulation disorders. The half-life of iron-59 is 44.5 days. How much of a 2.000-mg sample will remain after 133.5 days?

12. Cobalt-60 has a half-life of 5.27 years. How much of a 10.0 g sample will remain after 21.08 years?

13. If 100.0 g of carbon-14 decays until only 25.0 g of carbon is left after 11,460 yr, what is the half-life of carbon-14?

14. What is the half-life in days of an isotope if 125 grams of a 1000 gram sample remain after 15 days?

15. What is the half-life in years of an isotope if 1 gram of a 16 gram sample remains after 16 years?

16. The half-life of hafnium-156 is 0.025 s. How long will it take a 560 g sample to decay to one-fourth its original mass?

17. Chromium-48 has a short half-life of 21.6 h. How long will it take 360.00 g of chromium-48 to decay to 11.25 g?

18. If the half-life of uranium-235 is 7.04×10^8 yr and 12.5 g of uranium-235 remain after 2.82×10^9 yr, how much of the radioactive isotope was in the original sample?

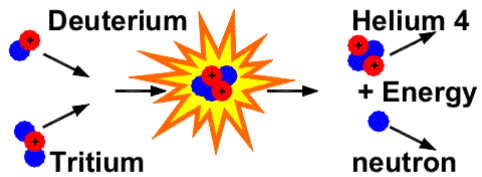
19. Carbon-14 has a half-life of 5730 years. How much of a 250. g sample will remain after 5730 years?

FISSION

Fission is another type of nuclear reaction. The basic difference in radioactive decay and fission is that in radioactive decay, an unstable isotope _____ undergoes a nuclear change. In nuclear fission, a fissionable isotope absorbs a _____, becomes unstable, and then fissions by breaking into a couple of pieces and releasing one or more neutrons plus a large amount of _____. Nuclear fission is usually thought of as intentionally caused. Heavy atoms (mass number > 60) tend to break into smaller atoms, thereby increasing their _____. Nuclear power plants use the process of nuclear fission to produce heat in nuclear reactors.

FUSION

Another type of nuclear reaction is fusion, which is the _____ of atomic nuclei. Fusion reactions can release very large amounts of energy but require extremely high temperatures. For example, nuclear fusion occurs within the Sun, where hydrogen atoms fuse to form _____ atoms.



20. What is the main difference between nuclear fusion and nuclear fission? _____