



State Standards for Chemistry

- **Nuclear Processes**
 - **Protons and neutrons in the nucleus are held together by nuclear forces**
 - **Nuclear forces overcome electro-magnetic repulsion between protons.**

State Standards for Chemistry

- Some naturally occurring isotopes of elements are radioactive, as are isotopes formed in nuclear reactions.
- The three most common forms of radioactive decay are α , β and γ .
- α , β and γ radiation produce different amounts and kinds of damage in matter and have different penetrations.
- Calculate the amount of radioactive substances remaining after an integral number of half-lives have passed.

Radioactivity

- An unstable nucleus will emit particles and energy in an attempt to become stable.
- Instability is caused by too many or too few neutrons in the nucleus.

Stability of a nucleus

The ability of an atom to remain stable changes as the mass of the atom increases.

Elements	Neutron/Proton Ratio
# 1 to 20	1.0
#21 to 60	1.35
#61 to 92	1.5

Instability

²³⁸ ₉₂ U	92 protons	146 neutrons
²³² ₉₀ Th	90 protons	142 neutrons
⁶⁷ ₃₀ Zn	30 protons	37 neutrons
²⁰⁷ ₈₂ Pb	82 protons	125 neutrons

Neutrons / Protons Ratios

- U - 1.59
- Th - 1.58
- Zn - 1.23
- Pb - 1.52

Radioactive Decay

So What happens?

- The nucleus decays and emits radiation particles.
- A neutron will break into a proton and an electron.

Emissions from Nuclear Reactions

α	${}^4_2\text{He}^{+2}$	alpha	Helium nucleus
β^-	${}^0_{-1}\text{e}^-$	beta	Electron
γ		gamma	High Energy form of light
β^+	${}^0_{+1}\text{e}^+$	positron	
ν		neutrino	
	${}^1_0\text{n}$	neutron	

Contribution to Nucleus

		Contribution to		
		atomic number	atomic mass	
α	${}^4_2\text{He}^{+2}$	alpha	+2	+4
β^-	${}^0_{-1}\text{e}^-$	beta	-1	0
γ		gamma	0	0
β^+	${}^0_{+1}\text{e}^+$	positron	+1	0
ν		neutrino	0	0
	${}^1_0\text{n}$	neutron	0	1

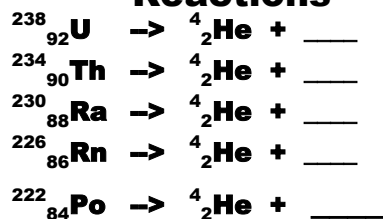
Radiation Shielding

Particle	can be shielded by
α Alpha	Paper, Clothing
β Beta	Metal Foil
γ Gamma	Lead, Concrete

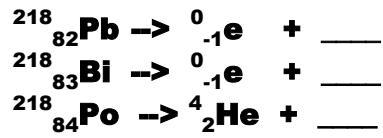
Penetration of Body Tissue

α Alpha	0.05 mm
β Beta	4 mm
γ Gamma	Passes through a human body easily.

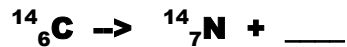
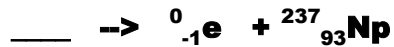
Nuclear Decay Transmutation Reactions



Nuclear Decay Transmutation Reactions



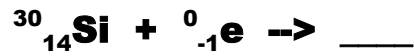
More Transmutations Exercises



Radioactive Decay

- The electron (Beta) is expelled from the nucleus leaving the proton behind, thus changing the atomic number of the atom.

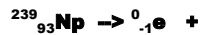
K - Capture



The nucleus captures a beta particle changing a proton into a neutron.

Neutron absorption

The nucleus of an atom can sometimes absorb a neutron, when this happens the atomic mass changes, or a new isotope is formed. Usually done inside a reactor.



Half-Life λ

The time it takes for one-half of a substance to undergo radioactive decay.

Length = λ
