RADIOACTIVITY

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	N_{eutron}/P_{roton} Ratio
# 1 to 20	1.0
#21 to 60	1.35
#61 to 92	1.5

Instabilty

$^{238}_{92}U$	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

$N_{eutrons}$ / P_{rotons} 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	$^{4}_{2}He^{+2}$	**alpha**	**Helium nucleus**
β^-	$^{0}_{-1}e^{-}$	**beta**	**Electron**
γ		**gamma**	**High Energy form of light**
β^+	$^{0}_{+1}e^{+}$	**positron**	
ν		**neutrino**	
	$^{1}_{0}n$	**neutron**	

Contribution to Nucleus

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

$^{238}_{92}U \rightarrow {}^{4}_{2}He + \_\_\_\_$

$^{234}_{90}Th \rightarrow {}^{4}_{2}He + \_\_\_\_$

$^{230}_{88}Ra \rightarrow {}^{4}_{2}He + \_\_\_\_$

$^{226}_{86}Rn \rightarrow {}^{4}_{2}He + \_\_\_\_$

$^{222}_{84}Po \rightarrow {}^{4}_{2}He + \_\_\_\_\_$

Nuclear Decay Transmutation Reactions

$^{218}_{82}Pb \rightarrow {}^{0}_{-1}e + \_\_\_\_$

$^{218}_{83}Bi \rightarrow {}^{0}_{-1}e + \_\_\_\_$

$^{218}_{84}Po \rightarrow {}^{4}_{2}He + \_\_\_\_$

More Transmutations Exercises

$\_\_\_\_ \rightarrow {}^{0}_{-1}e + {}^{237}_{93}Np$

$^{14}_{6}C \rightarrow {}^{14}_{7}N + \_\_\_\_$

$^{243}_{95}Am \rightarrow \_\_\_\_\_ + {}^{239}_{93}Np$

Radioactive Decay

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

K - Capture

$^{30}_{14}Si + {}^{0}_{-1}e \rightarrow \_\_\_\_$

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.

$^{238}_{92}U + {}^{1}_{0}n \rightarrow$

$^{239}_{92}U \rightarrow {}^{0}_{-1}e +$

$^{239}_{93}Np \rightarrow {}^{0}_{-1}e +$

Half-Life λ

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

Length = λ