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**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.**

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**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  $\alpha$ ,  $\beta$  and  $\gamma$ .
- $\alpha$ ,  $\beta$  and  $\gamma$  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.

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# 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.

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# 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

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# Instability

<sup>238</sup> <sub>92</sub> U	92 protons	146 neutrons
<sup>232</sup> <sub>90</sub> Th	90 protons	142 neutrons
<sup>67</sup> <sub>30</sub> Zn	30 protons	37 neutrons
<sup>207</sup> <sub>82</sub> Pb	82 protons	125 neutrons

## Neutrons / Protons Ratios

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

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## Radioactive Decay

### So What happens?

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

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## Emissions from Nuclear Reactions

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

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## Contribution to Nucleus

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

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## Radiation Shielding

Particle	can be shielded by
$\alpha$ <b>Alpha</b>	<b>Paper, Clothing</b>
$\beta$ <b>Beta</b>	<b>Metal Foil</b>
$\gamma$ <b>Gamma</b>	<b>Lead, Concrete</b>

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## Penetration of Body Tissue

$\alpha$ <b>Alpha</b>	<b>0.05 mm</b>
$\beta$ <b>Beta</b>	<b>4 mm</b>
$\gamma$ <b>Gamma</b>	<b>Passes through a human body easily.</b>

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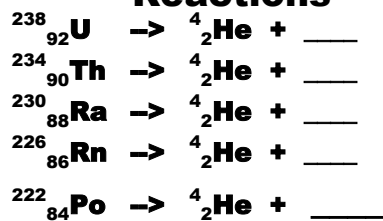
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## Nuclear Decay Transmutation Reactions



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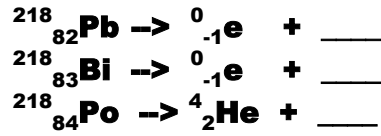
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## Nuclear Decay Transmutation Reactions



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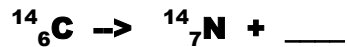
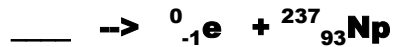
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## More Transmutations Exercises



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## Radioactive Decay

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

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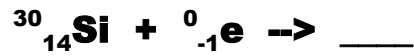
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## K - Capture



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

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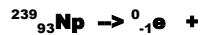
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## Neutron absorption

**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.**



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## Half-Life $\lambda$

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

**Length =  $\lambda$**

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