



## Nuclear Science Week

### Radioactive Decay Chains

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**OBJECTIVE:****Grade:** 8-12

*Students will understand that the radioactive decay chains define the number and type of particles emitted by the differing isotopes of atoms. Students will be able to demonstrate the changes that occur in the nucleus of the atom as they decay into more stable atoms.*

**Intended Learning Outcomes:**

- Make predictions
- Use a model to demonstrate understanding
- Understand science concepts and principles

**Subject:** Math, Physics, Science**Materials:**

- Journal or other method for recording results
- Decay chain chart (attached)

**Teaching Time:**

15-20 minutes for the demonstration

10-15 minutes for the discussion and analysis

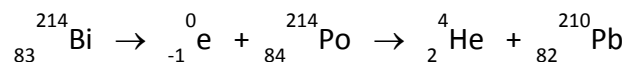
**Number of Players/Students:** 4-30 students, split into groups of 4-5

**Teacher Information:** Most nuclei decay by the emission of electrons (betas) or alphas. Each of these decays changes the number of neutrons and protons in the nucleus, thus creating a new element. The nucleus resulting from the decay of a 'parent' is often called the 'daughter'. Using simple mathematics (addition and subtraction) the identity of the daughter nucleus can easily be determined.

Alphas            (2 neutrons, 2 protons)             ${}^4_2\text{He}$

Betas             (1 electron)                                     ${}^0_{-1}\text{e}$

So if Bismuth-214 beta decays and then alpha decays, the equations would look like:



So the daughter of Bi-214 by beta decay has an atomic number of 84 which is Polonium, Po, and the daughter of Po-214 by alpha decay has an atomic number of 82, which is Lead, Pb. Thus, we can write an equation that identifies the daughters in a long decay chain.

**Procedure:**

- 1) Divide the class into working groups of 4 or 5.
- 2) Have each group write the equation for the first 6 daughters in the Uranium-238 decay chain.
- 3) Atomic numbers are:
  - Radon – 86
  - Radium – 88
  - Thorium – 90
  - Protactinium – 91
  - Uranium – 92
 U-238 decays by emission of an alpha, followed by two betas, followed by three alphas.

**Analysis and Results:**

- 1) Have the students identify the 6 daughters.
- 2) Have each member of the group write one of the equations and identify the daughter in that decay.

**Assessment:** Have the students describe how a decay chain can transform an element into a stable element.

**Lesson Extension:** Have the students choose other elements such as U-235, Th-232, and Np-237; then write the decay chain for these elements.

Ele	Tl	Pb	Bi	Po	At	Rn	Fr	Ra	Ac	Th	Pa	U
Z →	81	82	83	84	85	86	87	88	89	90	91	92
	IIIb	IVb	Vb	Vib	VII	O	I	Ia	IIIa	Iva	Va	VIa
N												U-238
↓										Th-234		
138										↓	Pa-234	
↓											↓	U-234
↓										Th-230		
↓										↓		
132												
↓												
↓												
128												
↓												
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124												

Decay Chain for Uranium-238