Concept Development

Chemistry
Nuclear Checkers

Problem:

What does an actual decay series look like?
How can knowledge of the series be used?

Materials:

Decay Checkerboard, 1 penny, 1 washer, colored discs, periodic chart

Procedure:

Most elements with smaller nuclei have some stable isotopes. Elements with larger nuclei, however, have no stable isotopes. These unstable nuclei transmutate spontaneously and randomly while emitting radioactivity (as we saw in *Dial 'M' For Radioactivity*). The resulting nuclei are often still unstable so the process continues until lighter, stable nuclei are formed (as we saw in *Serious Decay*). An unknown element, $^{238}_{92}P$, is one such heavy isotope. A nucleus of this isotope decays into a number of lighter nuclei (daughter products) until a final (stable) daughter product is formed: $^{206}_{82}W$. In this activity you'll play Nuclear Checkers to establish the decay series of the $^{238}_{92}P$ nucleus into the stable $^{206}_{82}W$ nucleus.

1. Use the Decay Checkerboard that is a graph of mass number vs. atomic number.

2. The $^{238}_{92}P$ is represented by a penny; place your penny on the appropriate location on the board. A washer represents the final daughter product: $^{206}_{82}W$; place your washer on the appropriate location on the board. Save yourselves some time – **double check the placement of your penny and washer before proceeding!**

3. For your team to win at Nuclear Checkers, you must create the decay process from $^{238}_{92}P$ to $^{206}_{82}W$. You will trace your path with colored discs to show all resulting daughter products. You are restricted to two types of moves:

   •*A-moves that allows you to move down two squares and then move to the left two squares.*
   •*B-moves that allows you to move to the right one square.*

   Your first move must be an A-move and your next move must be a B-move. All remaining moves are at your discretion. You must end at the the washer ($^{206}_{82}W$) and you can only make A and B moves.

4. Leave your sequence on the board for the Analysis questions.

5. Compare your results with those of other groups. (How many A and B moves did you/they make? How many total moves did you/they make?)

Analysis:

1. Use a copy of the periodic chart to determine the decay series. Use extended atomic symbols to help you record your sequence.

2. An A-move results in the production of a new daughter nucleus and the emission of a particle. What is the "A" particle that is produced? How do you know? Explain.

3. A B-move always results in the production of a new daughter nucleus and the emission of a particle. What is the "B" particle that is produced during a B-move? How do you know? Explain.

4. How can the atomic number **increase** during a B-move?

;-) 5. Why is Klaus Hergesheimer the graphic?

Extend:

1. Zircon ($ZrSiO_4$), during its formation, will incorporate uranium atoms into its crystalline structure. The uranium atoms substitute for zirconium atoms. Lead, on the other hand, is strongly rejected from crystal formation. How can we use this fact, and the decay sequence you just found to date the age of zircon rocks?

2. Were pennies and washers appropriate choices for our simulation? Justify your answer.

3. How does your decay series compare to the actual decay series for uranium -238? How are the similar? How are they different?

4. Why is radon perhaps the most feared of all of uranium's products?

*Further Research:

1. Find the other naturally occurring isotopes of uranium. Do they decay in a similar fashion to uranium-238? Do the other isotopes affect your Extend answer #1?

2. What happens to the nucleus when gamma rays are emitted?