TEACHER'S NOTES 5

HOW IS NATURAL RADIOACTIVE DECAY RELATED TO RADIATION MEASUREMENT?

BACKGROUND

This is one of the more technical lesson plans included in this teacher's guide. Students need to comprehend the relationship between the half-life of one or more nuclides and the pattern of radioactivity emitted by those nuclides. Students should understand that the half-life of one isotope can limit the decay rates of subsequent isotopes in a decay series. It is important that the students have a good grasp of the basic principles of radioactivity and half-life before attempting this activity. Lesson Plans # 1 and # 4 would be appropriate prerequisites.

Explain to the students that an isotope like polonium-218 might have a very short half-life (3 minutes), but still not decay very often because it has to be formed *before* it can decay. The formation of the polonium-218 is slower than its decay because it is formed by the decay of radon, which has a longer half-life (3.8 days).

MINIMUM RECOMMENDED TIME ALLOCATION

One class period

STUDENT RESPONSES

Question 3: Radioactivity will begin to be detected as soon as the first gamma-emitting isotope in the series (lead-214) is formed and itself begins to decay. The half-lives of polonium-218 and lead-214 are much shorter than the half-life of radon-222. Therefore, a maximum level of radioactivity will soon be reached, based on how soon the shorter-lived nuclides decay away after they are formed. The total amount of radioactivity will steadily decrease as more and more of the initial radon disintegrates. After many radon half-lives, the radioactivity will decrease to very low levels.

Question 4: Equilibrium represents the point at which the rates of isotope formation and isotope decay (destruction) reach a balance. At equilibrium, the rate of decay is equal to the rate of production for the isotopes being measured. If there was a continuous source of radon injected into the chamber, this equilibrium would be reflected by fairly constant ratios among the various radionuclides. Because radon is not replenished in this experiment, however, the activity of the gamma emitters will steadily decrease after having reached equilibrium.

Questions 5, 6: The half-life of the cumulative radiation sources can be calculated by choosing any two points on the y-axis (radioactivity) that differ by a factor of about 2 (e.g., 40 and 20 or 20 and 10). The points on the x-axis (time) that correspond with these points will be about 3.8 days apart. This is the half- life of radon. Even though radon is not being measured at all *directly* in this experiment, it governs the half-life of the overall process. This is because the decay products further down the chain (polonium-218 and lead-214) have much shorter half-lives than radon. Radon *limits* the amount of the alpha emitters that are available to decay.

Question 8: You would need to know the half-lives of all of the subsequent radioactive isotopes in the series.

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The New Jersey Department of Environmental Protection is happy to provide these lesson plans for use by teachers. In order to evaluate the use of the lesson plans, we would greatly appreciate your response to the following questions. All teachers who return these forms will receive a FREE RADON POSTER depicting information about radon in a colorful format and a STORYBOOK about a Native American child and his experience with radon in his home.

1. Which Radon Alert lesson plan(s) did you use?

_____

2. How useful did you find it/them (check one) ?

___ Not useful
___ Slightly useful
___ Moderately useful
___ Very useful
___ Extremely useful

3. Do you plan to use them again in the future? ___Yes ___ No

4. In your view, what would make the lesson plans MORE useful:

Your name:_____ Phone Number: _____

Subject area: _____Grade:_____

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