Radioactive Dating

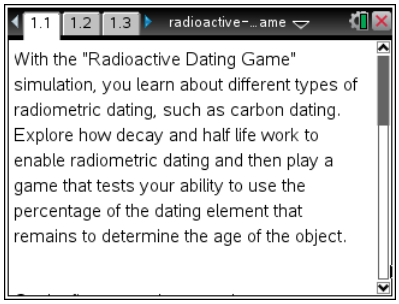
Middle Grades Student Activity

Name _____

Class _____

Open the TI-Nspire document *Radioactive_Dating.tns.*

In this simulation, you will discover how isotopes of different atoms change chemically (in a decomposition reaction) and give off radioactivity in the process. You will learn how the known rate at which certain isotopes decompose is used to estimate the age of a fossil. Then you will play a game to learn more about radioactive dating of fossils in an archeological site.



How can the number of particles in the nucleus (center) of an atom vary and yet still be the same element? Atoms of the same element can have different numbers of neutrons. They still have the same number of electrons and protons. These different possible versions of each element are called isotopes.

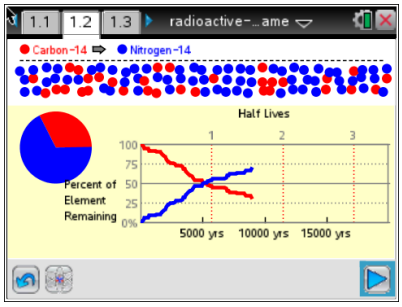
Carbon-14 is a radioactive isotope. It decomposes into another element and releases radioactivity in the process. This decomposition occurs at a known rate, so scientists can use the amount of the element/isotope remaining to determine how old something is. This known rate is called half-life, and here is how it works.

During the first 50% of its life, or during half-life 1, 50% of its atoms of an isotope will decompose. At 75% of its life, half-life 2, another 50% of the atoms that are left over from half-life 1 will decompose. Finally up to 100% of its life, half-life 3, another 50% of remaining atoms remaining from half-life 2 will decompose. Then a few will decompose slowly until all change into a different isotope.

Read the directions on page 1.1.

Move to page 1.2.

1. Run the simulation for Carbon-14 by selecting the play button. Observe how long it takes for Cabon-14 to decompose into Nitrogen-14. Then analyze the patterns you see. Select  to change from Carbon-14 to Uranium-238. Observe how long it takes for Uranium-238 to decompose into Lead-236.



Q1. How are the divisions of half-life along the top of the horizontal axis on the graph determined? What is the pattern in the placement of the vertical lines named Half Lives?

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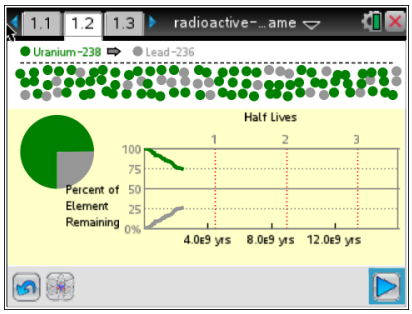
Q2. What do you notice about the rate at which the substances decompose at the beginning of the process? What do you notice about this rate as time progresses?

2. Select to change from Carbon-14 to Uranium-238. Run the simulation again.



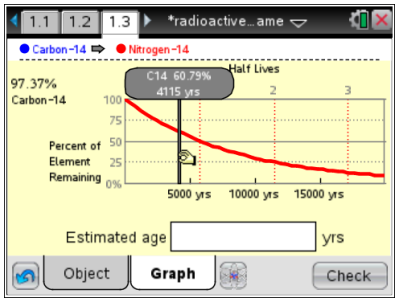
Q3. Why do you think the intersecting line for the decomposition of Uranium-238 into Lead-236 is not exactly at the 1st half-life line?

Q4. What do you notice about the difference in decomposition rates between Carbon-14 and Uranium-238?

Q5. For what objects might Carbon-14 be more useful than Uranium–238 in determining the age of substances? In other objects, why might Uranium-238 be more useful than Carbon-14?

Move to page 1.3 and select Graph.

3. Now look at graph that shows the percent of Carbon-14 and Uranium-238 remaining after a certain number of years. The percent is shown in the gray oval at the top of the vertical bar.
4. Grab () the gray bar and drag it. Observe how the percent remaining changes as the age increases from left to right.
   Note: Select to change from Carbon-14 to Uranium-238.



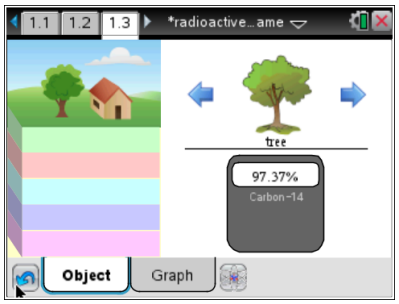
Tech Tip: To move the gray bar, tap to drag it to the left or right across the screen. It is best to grab the bar at its base so you do not obstruct the data above it.

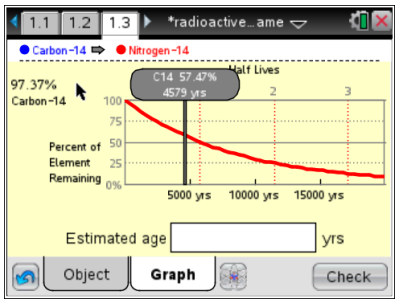
Q6. How does the age of Carbon-14 differ from the age of Uranium-238 after they have both decomposed about 50% (the first half-life)? 50% of the first 50% (the second half-life) and 50% of the previous 50% (the third half-life)?

Q7. What is similar about the decomposition of both elements? What is different?

On page 1.3, select Object.

5. Play the Radioactive Dating game. Select each of the different layers on and below Earth's surface. View objects and where they can be found. Or use the arrows and to move up and down the layers. (Note: Two objects are found at each level.) Then use the following directions to predict the age of each object using radioactive dating.
6. First, decide whether it is more useful to use Carbon-14 or Uranium-238. Then select to change from one of these isotopes to another. (Hint: If an object does not have an isotope remaining, showing 0%, you must use the other isotope to obtain a range.)
7. Record the percentage of the isotope remaining for the object. Then select Graph.
8. Move the gray slider in both directions until the number in the oval is as close as possible the percentage you recorded in step 6 above. Write down the corresponding age of the object.
9. Enter the estimated age in the box provided. (Note: When entering ages in billions, you must write the number in numerals without commas, for example 240000000 for 240 billion years.)
10. Select Check and the appearance of the green face means your answer is correct. The red face means your answer is incorrect.





Tech Tip: To enter the estimated age, tap inside the box next to Estimated age. The keyboard will appear. Select the button **".?123"** to the left or right of the space bar to enter a numerical quantity. After you have entered the value, select "return." Then, select Check to check your answer.

Analysis Questions.

Q8. Where do you suppose the younger layers of Earth's surface are located? Where are the older layers?

Q9. In which layers would the younger fossils be found? The older fossils be found?

Q10. Which isotope was more useful in analyzing younger fossils? Analyzing older fossils?

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Q11. Did the percent remaining seem to make a difference when choosing Carbon-14 or Uranium-238? If so, when was this the case?