***Radioactive Dating Game Lab***

[*http://phet.colorado.edu/simulations/sims.php?sim=Radioactive\_Dating\_Game*](http://phet.colorado.edu/simulations/sims.php?sim=Radioactive_Dating_Game)

**Purpose:** You will use the radioactive decay rate and original-daughter element ratios of carbon-14 and uranium-238 to determine the ages of different objects.

**Procedure:**

*Decay Rate*

1. Play around with the simulation for a few minutes.
2. Click on the tab for Decay Rates. Check Carbon-14
3. Click on the bucket and add some nuclei to the simulation, observe what happens
4. What do the red dots represent? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. What do the blue dots represent?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
6. Use the stop and play buttons to control how fast the decay occurs.
7. Explain what the pie graph looks like at one half life.
8. Explain what the pie graph looks like at 2 half lives, then 3 half lives.



1. What happens to the Carbon-14 by the end of the simulation?
2. Load PhET *Radioactive Dating Game*

*Bucket Slider*

1. Click on tab for *Decay Rates*
2. Select *Carbon-14*. Using the graph, the estimated half-life for C-14 is \_\_\_\_\_\_\_\_\_ years.
3. Move the bucket slider all the way to the right. This will place 1000 C-14 atoms onto the screen.

*Step*

button

*Start/Stop*

button

* 1. Click on the *Start/Stop* to stop the C-14 decay. Click on *Reset All Nuclei*
	2. Click on the *Start/Stop* to start the C-14 decay. Stop the decay as you get close to one half-life.
	3. Use the *Step* button to stop decay at one half-life.
		+ After 1 half-life, how many C-14 atoms of the 1000 original remain? \_\_\_\_\_\_\_
	4. Use the *Start/Stop* and *Step* buttons to reach two half-lives. After two half-lives, how many C-14 atoms remain? \_\_\_\_\_\_\_\_
		+ What fraction of C-14 atoms present at 1 half-life remain after 2 half-lives? \_\_\_\_\_\_\_
	5. Use the *Start/Stop* and *Step* buttons to reach three half-lives. After three half-lives, how many C-14 atoms remain? \_\_\_\_\_\_\_\_
		+ What fraction of C-14 atoms present at 2 half-life remain after 3 half-lives? \_\_\_\_\_\_\_
	6. Repeat Steps (a) to (e) with uranium-238.
		+ Estimated half-life for U-238 is \_\_\_\_\_\_\_\_\_ years.
		+ After 1 half-life, how many U-238 atoms of the 1000 original remain? \_\_\_\_\_\_\_
		+ What fraction of U-238 atoms present at 1 half-life remain after 2 half-lives? \_\_\_\_\_\_\_
		+ What fraction of U-238 atoms present at 2 half-life remain after 3 half-lives? \_\_\_\_\_\_\_
	7. Based on the results of *4a* to *4f*, explain the meaning of the word “*half-life*” in one sentence.
1.  Click on the *Measurement* tab.
2. Under *Probe Type*, select *Uranium-238* and *Objects*. Under *Choose an Object*, select *Rock*.
3. Click on *Erupt Volcano*. Let the simulation run until you reach 1 half-life. What % of the original uranium remains? \_\_\_\_\_\_\_\_\_. How many years did this take? \_\_\_\_\_\_\_\_\_\_\_\_
4. Under *Probe Type*, select *Carbon-14* and *Objects*. Under *Choose an Object*, select *Tree*.
5. Click on *Plant Tree*. Let the simulation run until you reach 1 half-life. What % of the original carbon remains? \_\_\_\_\_\_\_\_\_. How many years did this take? \_\_\_\_\_\_\_\_\_\_\_\_
6. Explain why uranium-238 is used to measure the age of rocks while carbon-14 is used to measure the age of the tree trunk? 
7. Click on *Dating Game* tab. There are objects on the surface and in the five layers beneath the surface. There are both rocks and fossils in each layer.
8. Select the *Carbon-14* detector. Move the Geiger counter to each fossil and record the % of original in the table below
9. On the ½ life graph, move the green arrow right or left until the % of original matches the reading on the detector. Record your estimated age for each fossil in the table
10. Repeat Steps 12 and 13 using the Uranium2-38 detector to estimate the rock ages. For fossils with no remaining C-14 signal, use the rock ages to estimate fossil ages in the same layer.
11. Summarize how C-14 and U-238 dating together can be used to determine fossil ages.

***Table: Radiometric Ages for Various Objects***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Object** | **Measured using C-14 or U-238?** | **% of Original** | **Guessed Age** | **Measured Age** |
| Animal Skull |  |  |  |  |
| Living Tree |  |  |  |  |
| Distant Living Tree |  |  |  |  |
| House |  |  |  |  |
| Dead Tree |  |  |  |  |
| Bone |  |  |  |  |
| Wooden Cup |  |  |  |  |
| 1st human skull |  |  |  |  |
| 2nd human skull |  |  |  |  |
| Fish Bones |  |  |  |  |
| Fish Fossil 1 |  |  |  |  |
| Rock 1 |  |  |  |  |
| Dinosaur Skull |  |  |  |  |
| Rock 2 |  |  |  |  |
| Trilobite |  |  |  |  |
| Rock 3 |  |  |  |  |
| Rock 4 |  |  |  |  |
| Rock 5 |  |  |  |  |