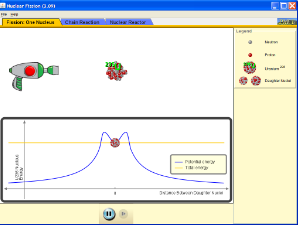
Open the “Nuclear Fission” simulation by clicking on:



<http://phet.colorado.edu/simulations/sims.php?sim=Nuclear_Fission> and click on “Run Now.”

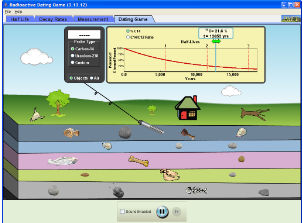
Use <http://somup.com/cYfFYHilbC> if you cannot open the simulations on your computer.

1. Click on the red button of the neutron gun. Describe what happens:

2. Click on the “Chain Reaction” window shade. On the right side of the screen, move the toggle slider of the U-235 to 50 atoms. Click on the red button of the neutron gun. Describe what happens. You can aim the gun.

3. Compare the first simulation of nuclear fission with the chain reaction simulation:

4. Open the “Nuclear Fission” simulation by clicking on:



<http://phet.colorado.edu/simulations/sims.php?sim=Radioactive_Dating_Game> and click on “Run Now.”

5. On the first screen, “Half Life,” click below the “bucket of atoms” to add 10 atoms.

a. What happened to the ten C-14 atoms?

b. Based on this simulation, what is the result of radioactive decay?

6. Click on the window shade “Decay Rates.” On the bucket, move the slider about half way across and release it. Describe what happens to the RED C-14 atoms. Observe the graph also.

7. Click the “Reset All” button. Now, move the slider all the way to the right of the bucket and release it. On the graph (red & blue lines), where does the intersection compare with step 6?

8. Click on the window shade “Measurement.” Make sure the probe type is Carbon 14. Then, click on the “Plant Tree,” observing the graph as well. How many years does it take for the tree to have 50% of the carbon 14 remaining?

9. Click on the “Reset” button. Change the probe type to Uranium 238. Then, click on the “Plant Tree,” observing the graph as well. What happens? Notice the % of Uranium 238:

10. Click on the “Reset” button. With the probe type on Uranium 238, click on the “Rock” button. Then, click on “Erupt Volcano.” Observe what happens, including the graph. How many years does it take for the tree to have 50% of the Uranium 238 remaining?

11. Why didn’t the Uranium 238 have any effect on the tree, but on the rock?

12. Click on the window shade “Dating Game.” Move the age indicator over the items listed in the chart below and fill in the percent shown above the probe type. Ignore age.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | % Remaining |  | Item | % Remaining |
| Bone |  |  | Fish Fossil 1 |  |
| Wooden Cup |  |  | Rock 1 |  |
| Human Skull |  |  | Dinosaur Skull |  |
| Human Skull 2 |  |  | Rock 2 |  |
| Fish Bones |  |  | Trilobite |  |

a. Why did the items in the second column above have 0 % Carbon remaining?

b. According to the graph, what is carbon’s half-life? \_\_\_\_\_\_\_\_\_\_

|  |  |
| --- | --- |
| Item | % Remaining |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

13. Change the probe type to “Uranium 238.” Move the age indicator over ALL of the items on the simulation screen. Write the items that had higher than 0 % remaining in the table.

a. Based on the simulation, what can you deduce about the type of radioactive isotope used when dating objects?

b. How could one determine the age of the fish fossil, dinosaur skull and the trilobite? Try it on the simulation.

Answer Key

1. Click on the red button of the neutron gun. Describe what happens:

**When the neutron hits the U 238 nucleus, the U 238 nucleus becomes unstable, eventually splitting apart.**

2. Click on the “Chain Reaction” window shade. On the right side of the screen, move the toggle slider of the U-235 to 50 atoms. Click on the red button of the neutron gun. Describe what happens. You can aim the gun.

**The first neutron (from the gun) started a chain reaction. When the first U 235 nucleus split, neutrons were released which hit other U 235 nuclei.**

3. Compare the first simulation of nuclear fission with the chain reaction simulation:

**The first reaction splits on atom, while the chain reaction continues to split many atoms.**

5. On the first screen, “Half Life,” click below the “bucket of atoms” to add 10 atoms.

a. What happened to the ten C-14 atoms?

**The RED C-14 atoms changed into BLUE N-14 atoms (new element)**

b. Based on this simulation, what is the result of radioactive decay?

**Radioactive decay produces NEW elements**

6. Click on the window shade “Decay Rates.” On the bucket, move the slider about half way across and release it. Describe what happens to the RED C-14 atoms. Observe the graph also.

**Almost all the RED C-14 atoms change to form BLUE N-14 atoms (new element)**

7. Click the “Reset All” button. Now, move the slider all the way to the right of the bucket and release it. On the graph (red & blue lines), where does the intersection compare with step 6?

**The intersection of the red and blue lines represents the half-life of C-14. The two graphs are similar. Usually, the more atoms used, the closer the intersection of the two lines is to the “ideal” half-life (indicated by the dotted vertical lines)**

8. Click on the window shade “Measurement.” Make sure the probe type is Carbon 14. Then, click on the “Plant Tree,” observing the graph as well. How many years does it take for the tree to have 50% of the carbon 14 remaining?

**About 5700 years**

9. Click on the “Reset” button. Change the probe type to Uranium 238. Then, click on the “Plant Tree,” observing the graph as well. What happens? Notice the % of Uranium 238:

**Trees do not contain Uranium 238 … so there is 0 %**

10. Click on the “Reset” button. With the probe type on Uranium 238, click on the “Rock” button. Then, click on “Erupt Volcano.” Observe what happens, including the graph. How many years does it take for the tree to have 50% of the Uranium 238 remaining?

**About 4.4 billion years**

11. Why didn’t the Uranium 238 have any effect on the tree, but on the rock?

**Uranium 238 is used to date rocks, not organic material (C based life forms)**

12. Click on the window shade “Dating Game.” Move the age indicator over the items listed in the chart below and fill in the percent shown above the probe type. Ignore age.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | % Remaining |  | Item | % Remaining |
| Bone | **83.9** |  | Fish Fossil 1 | **0** |
| Wooden Cup | **88.2** |  | Rock 1 | **0** |
| Human Skull | **76.6** |  | Dinosaur Skull | **0** |
| Human Skull 2 | **0.8** |  | Rock 2 | **0** |
| Fish Bones | **14.4** |  | Trilobite | **0** |

a. Why did the items in the second column above have 0 % Carbon remaining?

**They were too old. The C-14 dating is not reliable.**

b. According to the graph, what is carbon’s half-life: **6137 years**

|  |  |
| --- | --- |
| Item | % Remaining |
| **Rock 1** | **97.9** |
| **Rock 2** | **96** |
| **Rock 3** | **93.3** |
| **Rock 4** | **89.4** |
| **Rock 5** | **82.3** |

13. Change the probe type to “Uranium 238.” Move the age indicator over ALL of the items on the simulation screen. Write the items that had higher than 0 % remaining in the table.

a. Based on the simulation, what can you deduce about the type of radioactive isotope used when dating objects?

**One must use different radioactive isotopes for different objects.**

b. How could one determine the age of the fish fossil, dinosaur skull and the trilobite? Try it on the simulation.

**One would need to use a different radioactive isotope, having a different half-life. Change the Probe type to “Custom” and use 10 my and 100 my (“my” = million years).**