**Radioactive Dating Game Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**
**Instructions**: Open a new browser and search for “PhET Radioactive Dating Game”. Click on the download button and then open the simulation.
1) Click the “Pause” button at the bottom of the window. Drag one atom out of the bucket and release. What is the starting isotope?

2) Click the “Play” button at the bottom and wait until it decays. What element does it decay into?

3) Based on the change in mass number and atomic number, what type of nuclear decay is this an example of?

4) Click the “Pause” button again and then reset all the nuclei. Click the “Add 10” button until there are no more atoms left in the bucket. There are now 100 carbon-14 atoms on the screen. The half-life of carbon-14 is about 5700 years. If you left those 100 carbon-14 atoms to sit around for 5700 years, how many would you expect to decay during that time?

5) Click the “Play” button at the bottom of the window. Click the “Pause” button occasionally to make observations as the atoms undergo decay. Try to press pause when the red atoms are directly over the “Half Life” line in the graphic. Reset all nuclei to do multiple trials.

When you press pause over the “Half Life” line in the graphic, look at the pie graph. Approximately what percentage of elements have decayed at the half life?

6) It is possible to determine the time for any individual atom to decay? Explain your answer.

7) Is it possible to determine approximately when a certain number of atoms will decay? Explain your answer.

**\*Make sure Mr. K approves of your above answers before going on to the next section\*x**8) Switch the tab at the top to “Decay Rates” Drag the slider in the bucket all the way to the right. This will add 1000 atoms to your screen. What are the X and Y axis in the graph at the bottom of the page?

9) Notice the red and blue lines. Specifically describe what each color line represents, and what happens to those lines as time increases.

10) Click the “Reset All Nuclei” button, but try to pause the reaction when you reach the 1st, 2nd, and 3rd half-lives lines. Record the approximate percentages in the table below:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Isotope | Initial % at 0th half-life | Approx. % at 1st half-life | Approx. % at 2nd half-life | Approx. % at 3rd half -life |
| 14C |  |  |  |  |
| 14N |  |  |  |  |

On the right side of the screen, click the button next to Uraniam-238. This time we will watch the decay of this atom. Uranium-238 has a half-life of about 4.5 billion years.

On the bucket of atoms, there is a slider. Drag the slider all the way to the right and watch the graph at the bottom of the screen.

Fill in the answers in this table:

|  |  |
| --- | --- |
| *After one half-life (4.5 billion years), what percent of the original uranium remains?* |  |
| *After two half-lives (9 billion years), what percent of the original uranium remains?* |  |
| *After three half-lives (13.5 billion years), what percent of the original uranium remains?* |  |
| *After four half-lives (18 billion years), what percent of the original uranium would remain?* |  |

Describe any similarities and differences you observe when comparing the data from Uranium-238 to Carbon-14.

Suppose you found a rock, and through testing found out that it had just as much lead-206 as uranium-238 in it. How old would you conclude the rock to be? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C. Measurement

Click the “Measurement” tab at the top of the screen.

Click “Plant Tree” at the bottom of the screen. The tree will grow and live for about 1200 years, then die and begin to decay. Let the time run and watch the graph at the top of the screen.

According to the graph, what is the percent of C-14 in the tree while it is alive? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Why?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

According to the graph, approximately how many years has the tree been dead when its C-14 percent is down to 50%?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

According to the graph, approximately how many years has the tree been dead when its C-14 percent is down to about 12.5%?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Click “Rock” on the right side of the screen. Click “Uranium-238” underneath “Probe Type” in the upper left of the screen. To measure longer times, we need to use an element that decays more slowly than C-14.

Before you click anything, make some predictions. How much uranium will be remaining when the rock is 4.5 billion years old? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ How much will be remaining when the rock is 9 billion years old? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ How much will be remaining when the rock is 13.5 billion years old?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Click “Erupt Volcano” to begin the process of creating an igneous rock. Watch the graph at the top of the screen. Check your predictions from #7. Were they correct?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

D. Dating Game

Now that we understand radioactive decay and half-lives, we can use them to determine how old rocks or fossils are.

Click the “Dating Game” tab at the top of the screen.

You can drag the probe to different items on or below the surface of the earth. The probe tells you how much of the original element is still in the rock or fossil. You can measure C-14 or U-238, whichever works better for the item you are measuring.

You can use the graph to match the percent of element remaining, and then use the time shown to estimate the age of the rock or fossil.

Let’s do an example:

Drag the probe to the dead tree to the right of the house.

Look at the probe reading: it tells you that there is 97.4% of the original C-14 remaining in the dead tree.

Now find the green arrows on the graph at the top of the screen. Drag those arrows right or left until the top line tells you that the C-14 percentage is 97.4%, the reading from the probe.

When you get the graph to read 97.4%, it tells you that the time has been 229 years.

Type this number into the box for “Estimate age of dead tree” and click “Check Estimate”.

You should get a green smiley face, indicating that you have correctly figured out the age of the dead tree.

Repeat the above process for all the other items. Fill in the table below.

|  |  |  |
| --- | --- | --- |
| **Item** | **Age** | **Element Used** |
| Animal Skull |  |  |
| House |  |  |
| Living Tree |  |  |
| Distant Living Tree |  |  |
| Bone |  |  |
| Wooden Cup |  |  |
| Human Skull |  |  |
| Fish Bones |  |  |
| Rock 1 |  |  |
| Rock 2 |  |  |
| Rock 3 |  | *Hint: For the last four items on the list, neither C-14 or U-238 will work well. Select “Custom”, and pick a half-life that gives you something other than 0.0% on the probe.* |
| Rock 4 |  |  |
| Rock 5 |  |  |
| Fish Fossil |  |  |
| Dinosaur Skull |  |  |
| Trilobite |  |  |
| Small Human Skull |  |  |

*Kevin Fairchild, La Costa Canyon High School, 2011*