<u>Half-Life of an Element</u>

PRE-LAB DISCUSSION:
Half-life is the time required for half of the atoms of a radioactive isotope to undergo decay. Some isotopes are very stable, undergo decay very slowly, and have extremely long half-lives. Uranium-238 has a half-life of 4.46 **billion** years! Other isotopes are extremely unstable, and have short half-lives. The isotope francium-233 has a half-life of 22 minutes. That means that if you possessed 10 grams of francium-233, after only 22 minutes you would have 5 grams of francium-233, while the remainder of the atoms would have been converted by some decay processes to other elements.

While it <u>is</u> possible to predict the percentage of atoms of an isotope that will undergo decay in a certain time span, it <u>is not</u> possible to predict which individual atoms within a sample will be the ones to undergo decay. The inability to solve this perplexing problem prompted a frustrated Albert Einstein to say, “God does not play dice with the Universe!”

PURPOSE: To gain an understanding of the statistical probabilities underlying the half-life of elements.

PROCEDURE:
1. Place **64** atoms (pennies) into the paper cup provided.
2. Cover the top of the cup and shake for **10** seconds.
3. After 10 seconds, dump the pennies on the lab table. Count all of the pennies that landed “heads up.” Record the number of “heads up” pennies in your data table.
4. Return only the “heads up” pennies to the cup. (We assume that the “tails” pennies have undergone decay.)
5. Shake the cup, and pour the pennies on the table. Once again, count the pennies that landed “heads up.” Record the number of “heads up” pennies from this trial in your data table. Return these remaining “heads up” pennies to the cup, shake, and dump them on the counter. Each time, you are eliminating the tails pennies as if they had undergone radioactive decay.
6. Repeat this procedure, stacking and recording data after each trial, until there are no “heads up” pennies to return to the cup.
7. Go back to the beginning, and repeat the entire procedure, recording your data in an entirely new table.
8. Repeat the entire process a THIRD time, again recording your data in an entirely new table.

RESULTS:
<u>Data and Observations</u>

Table 1	
Toss #	# Atoms (pennies) remaining
0	64
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	XXXXX
Add as many rows as necessary to finish the required task.	

Table 2	
Toss #	# Atoms (pennies) remaining
0	64
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	XXXXX
Add as many rows as necessary to finish the required task.	

Table 3	
Toss #	# Atoms (pennies) remaining
0	64
1	XXXXX
2	XXXXX
3	XXXXX
4	XXXXX
5	XXXXX
Add as many rows as necessary to finish the required task.	

Each of these data tables should appear in your lab write-up, and may include as many rows for trials as necessary.

Calculations and Graphs

1. Mark a piece of **graph paper** into quarters in preparation for making four graphs.
2. Create three bar graphs, representing the stacks of "heads up" pennies. The number of "Atoms Remaining" should be the y-axis, and the number of the toss should be the x axis. Label each graph according to which Data Table it represents. Be certain to label each axis on each graph, including a unit scale (# of atoms) for the y-axis.
3. Calculate an AVERAGE number of pennies for each of the trials by adding the number of pennies remaining for each toss and dividing by three. Record your work in a table in this section, like the one below.
4. Create a fourth graph that represents the data in the table of averages, with the Toss # on the x-axis and the Average on the y-axis.

Summary Table		
Toss #	TOTAL Atoms Remaining (Tables 1 + 2 + 3)	AVERAGE Atoms Remaining (TOTAL ÷ 3)
0	64 + 64 + 64 = 192	64
1	XXXXX	XXXXX
2	XXXXX	XXXXX
3	XXXXX	XXXXX
4	XXXXX	XXXXX
5	XXXXX	XXXXX
Add as many rows as necessary to finish the required task.		