**Objective**: This activity will define half-life and develop a half-life curve for radioactivity.

**Procedures**

1. Obtain 80 pennies or 80 one inch squares of paper (Write an “X” on one side). You can also use a large bag of m & m’s (~320 count). When done, you will have a total of 320 “atoms”. RECORD this in the title of the chart below.

2. Each penny (or paper square) represents a radioactive atom.

3. Place all the pennies into a large plastic cup or container. Shake the pennies in the container, and GENTLY release them onto your desk. (If you use paper squares, place them in a small container and shake/mix thoroughly. Then, pour them onto a table and spread them out).

4. REMOVE all the pennies that are “HEADS” facing UP (they have decayed). The pennies that are “TAILS” facing up have “NOT” decayed and will be REUSED.

5. COUNT the number of pennies remaining (reused / “tails”) after one “half-life”. Record this number in the data table under “1” for both Half Life and # of pennies.

6. Repeat steps 3-5 FOUR more times with ONLY THE PENNIES REMAINING each time to complete the **“Trial 1” column** only.

7. After filling out the “Trial 1” column. Start over with your 80 pennies for Trial 2 to fill in the “Trial 2 Column”. Repeat this until you have completed Trials 3 & 4 as well.

**Data Table** Original Number of Pennies TOTAL: \_\_\_\_\_\_\_\_\_\_

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| --- | --- | --- | --- | --- | --- |
| Half-Life  ↓ | Number of Pennies Remaining After Each Half-life | | | | |
| Trial 1 | Trial 2 | Trial 3 | Trial 4 | Total  (add each row) |
| 1 |  |  |  |  |  |
| 2 |  |  |  |  |  |
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**Graph Instructions**

* Construct a graph of your data, showing the relationship between the number of half-lives and the number of atoms remaining after each half-life.
* The number of half-lives is the independent variable (x axis), while the number of atoms remaining {total} is the dependent variable (y axis).

1. Title your graph – “*Radioactive Half Life: # Half Lives versus Atoms remaining*.”

2. Label axes with proper variable placement; leave space to label each axis; include units.

3. Choose an appropriate scale – make sure that each box on each axis is given the same interval value, and that the data will fit on the graph according to your scale.

4. Draw a curved slope line that best represents the points (do not just “connect the dots”).

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**Conclusion Questions** (*Write in complete sentences conveying a scientific thought*.)

1. What is a half-life?

2. Describe the shape of your graph and state the relationship between the abundance of a radioactive element and time.

3. Extrapolate the slope line on your graph (*extend it beyond the last half-life*). What would you estimate the number of atoms being left after the 6th half-life? How long would it take to completely eliminate all atoms?

4. What is the half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 g of nitrogen-16 in 21.6 s?

5. The half-life of Carbon-14 is 5,730 years. If a fossil is dug up by a scientist who calculates its Carbon-14 abundance to be approximately 1/16th of what a living organism would have, what is the age of the fossil?

ANSWERS (*for guidance NOT for copying & pasting*)

**Data Table** Original Number of Pennies TOTAL: *320*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Half-Life | Number of Pennies Remaining After Each Half-life | | | | |
| Trial 1 | Trial 2 | Trial 3 | Trial 4 | Total  (add each row) |
| 1 | *40* | *40* | *40* | *40* | ***160*** |
| 2 | *20* | *20* | *20* | *20* | ***80*** |
| 3 | *10* | *10* | *10* | *10* | ***40*** |
| 4 | *5* | *5* | *5* | *5* | ***20*** |
| 5 | *2* | *3* | *2* | *3* | ***10*** |

*These values are based on theoretical estimates, not the actual lab.*

*Radioactive Half Life: # Half Lives versus Atoms remaining.*

of

Atoms

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Half-Lives

**Conclusion Questions** (*Write in complete sentences conveying a scientific thought*.)

1. What is a half-life?

* *Half-life measures the rate of decay of a radioactive isotope.*
* *Specifically, half-life is the time it takes for ½ of an original quantity of a radioactive element to decay into another element.*

2. Describe the shape of your graph and state the relationship between the abundance of a radioactive element and time.

* *The shape of the graph is a negative exponential curve, meaning that the slope curves downward from left to right.*
* *The relationship between the abundance of a radioactive element and time is inverse, meaning that as time increases (more half-lives), the amount of radioactive element decreases.*

3. Extrapolate the slope line on your graph (*extend it beyond the last half-life*). What would you estimate the number of atoms being left after the 6th half-life? How long would it take to completely eliminate all atoms?

*When one extrapolates the slope line of the graph, one could estimate that the number of atoms left after the sixth half-life would be approximately 5. Because half-life yields a negative exponential curve, theoretically the atoms would never be completely eliminated. Based on this experiment, the number of atoms would decrease to 2 after the 7th half-life, and 1 after the 8th half-life.*

4. What is the half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 g of nitrogen-16 in 21.6 s?

*100.0 g 🡪 50.0 g 🡪 25.0 g 🡪 12.5 g … 3 half-lives*

*21.6 s / 3 half-lives = 7.2 seconds/half-life*

*The half-life of a 100.0 g sample of nitrogen-16 that decays to 12.5 g of nitrogen-16 in 21.6 s is 7.2 seconds.*

5. The half-life of Carbon-14 is 5,730 years. If a fossil is dug up by a scientist who calculates its Carbon-14 abundance to be approximately 1/16th of what a living organism would have, what is the age of the fossil?

*1/1 🡪 ½ 🡪 ¼ 🡪 1/8 🡪 1/16 … 4 half-lives*

*4 half-lives x 5,730 years/half-life = 22,920 years old*

*If a fossil is dug up by a scientist who calculates its Carbon-14 abundance to be approximately 1/16th of what a living organism would have, the age of the fossil would be estimated at 22,920 years old.*