

TEARING THROUGH HALF-LIFE

Teacher's Notes

Objective:

Kinesthetic activity will help develop math, science and technology skills on a conceptual level that includes mathematical reasoning and science processing.

Grade: 9 – 12

Intended Learning Outcomes:

- Represent mathematical situations
- Collect and record data
- Understand science concepts and principles
- Construct models
- Analyze data

Subjects: Physics, Math, Geology, Astronomy, Integrated Earth Systems, Physical Science

Materials: Data Analysis sheet for each student (included)
Paper
Pencil or pen
Calculator

Teaching Time: One class period

Number of Players: Entire Class

Teacher Information: Students seem to struggle learning and applying the concept of “half-life,” as it relates to the natural transmutation of elements. This activity allows students to explore “half-life”. This can be followed up with activities that apply the concept of “half-life.” Some follow-up “application” activities for example could be measuring geologic time based on the “half-life” of known nuclides or isotopes or measuring the age of carbon-based items (tools, manuscripts and other items) useful in archeology or paleontology. *Tearing Through Half-Life* is meant to be an activity that is inexpensive and efficient.

Simply stated, we believe that mass is converted into energy through two main processes. One of these “mass-to-energy” converting processes is fusion. Stars are huge fusion reactors, converting hydrogen into helium (and later in their waning lives, into all of the heavier elements). During the fusion process a very small amount of mass is “lost” or better stated, is not accounted for. We

now believe that this mass is not “lost” at all but converted into energy. Paraphrasing the first law of thermodynamics, “energy is neither created nor destroyed, but always exists in one form or another. Simply stated, energy and mass exists in either form, mass or energy.

Fission is another naturally occurring process that converts mass into energy. On Earth and other planets, a phenomenon known as the natural transmutation of elements converts mass into energy. Fission reactions convert mass that is “left-over” when massive “unstable” or radioactive elements decay. This decay is either an alpha decay up or a beta decay down the Periodic Table of Elements. The ultimate destination of this decay in most cases, is the generation of two less massive “daughter” elements that are usually more stable (less radioactive) than the original element. The amount of time it takes for these alpha and beta decay events to occur is known as “half life.” Through the use of modern technologies like super computers and particle accelerators, scientists and engineers reasonably believe they know the “half life” of most of the nuclides or isotopes of each element. Nuclide is the physicist’s term for what chemists call isotopes. These are naturally occurring forms of an element that has more or less nucleons (neutrons in this case) than the average amount of neutrons an element has statistically. It is believed that all elements will eventually alpha or beta decay, even the nuclides or isotopes that we term “stable.” These events related to fission reactions appear to be ever present and ongoing processes that generate the thermal energy that, for example, keep Earth’s mantle fluid and generates the heat that leads to the beauty of Yellowstone’s geysers and relaxing hot springs.

AUTHOR BIO:

Curtis Craig teaches biology for Utah Electronic High School. He received his zoology & botany degree from Brigham Young University (BYU) and earned his Master’s of Education in particle astrophysics from Westminster College and the University of California/Berkeley. He is a co-founder of Hands On Universe. He is the recipient of numerous teaching awards including the United States Department of Energy’s Top Ten Science Educators, the BYU Physical Science & Mathematics Teacher of the Year; the Tandy Technology Teacher of the Year; and the Presidential Awardee for Excellence in Math and Science Teaching. He is also past President of the Utah Science Teachers Association, and was awarded the Technology and Engineering Teacher of the Year award by the Utah Association of Career and Technical Education in 2008.

Data Analysis: Teacher Answer Sheet

(You will attach this half of the 1st half-life with all of your recorded data and answers into your logbook.)

List something that stayed the same during the activity:

ANSWER: The total sum of paper (mass) remained the same.

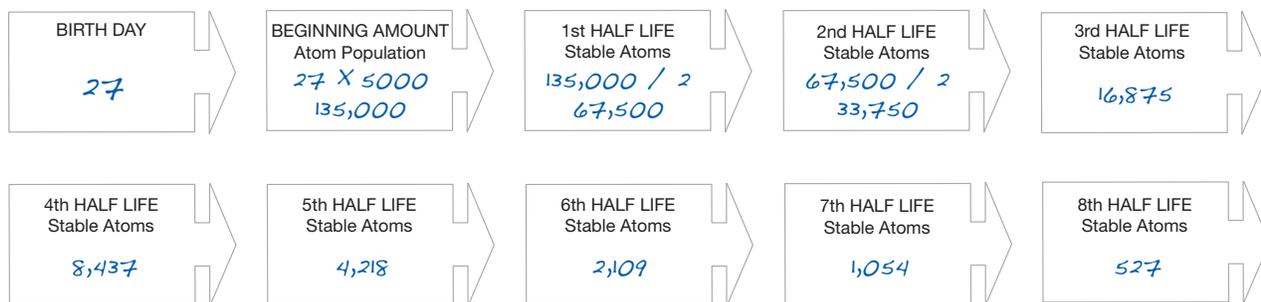
List something that changed during the activity:

ANSWER: The number of stable and unstable atoms changed with each half life.

Was there anything you did that made it easier?

ANSWER: Used some kind of visual indicator of stable atoms (marker, writing number on paper, etc.)

MARCH 27, 1996



TEAR THIS HALF

TEARING THROUGH HALF-LIFE

Student Activity

Activity Instructions:

1. Write down the day of month you were born in the box below (labeled Birth Day). This is just a random number for the purpose of starting this activity.
2. Multiply your Birth Day number by 5000. Write this number in the box labeled: Beginning Amount. This number will represent the initial population of unstable or radioactive atoms of your nuclide or isotope.
3. When the instructor calls “half-life”, divide that number by two (2). Round to the nearest whole number. Write your new answer in the next box. This will divide your original population of atoms in half.
4. Now tear this whole sheet of paper in half along the dotted line. Place the piece of paper, with the boxes and questions, on the desk in front of you. This represents the first “half-life” and half the population of nuclide atoms that are now “stable” and are no longer radioactive.
5. Keep the torn off bottom sheet, that represents the “unstable” nuclide atoms, ready to repeat the process over and over; Divide by 2, Record, Tear in half. Make sure to record your stable atoms “half-life” data on the piece you tear off and set in front of you. Go through seven (7) more half-lives, for a total of eight (8) half-lives. Don’t forget to answer the two questions.

Data Collection Examples:

- 1 If your birthday is March 27, 1996. You will record 27 in the Birth Day box.
- 2 $27 \times 5000 = 135,000$; Record 135,000 in the Beginning Amount box.
- 3 $135,000 / 2 = 67,500$; Record 67,500 in the 1st half life Box box.
- 4 Keep dividing the remaining number of nuclides in half and record the data on the sheet you set in front of you. After you have reached your 8th half-life, record the number of those final stable nuclide atoms in the box labeled 8th half-life.

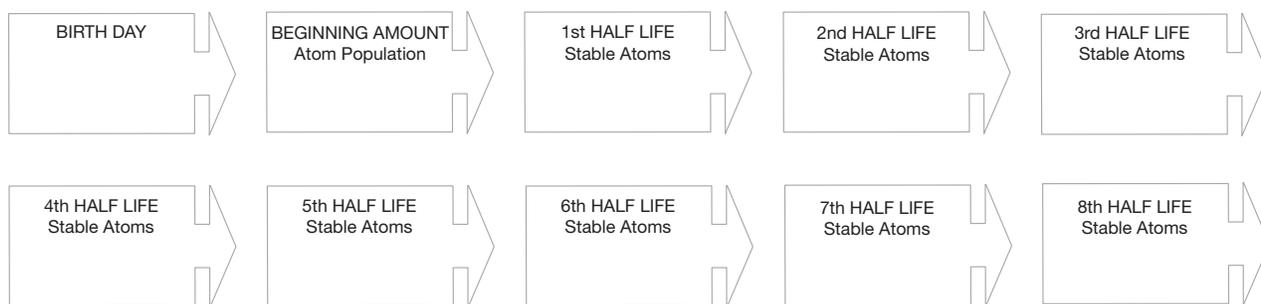
Data Analysis: *Student Activity*

(You will attach this half of the 1st half-life with all of your recorded data and answers into your logbook.)

List something that stayed the same during the activity:

List something that changed during the activity:

Was there anything you did that made it easier?



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