Earth Science 11 Name: Sierra Haziza

M&M Half Lives

Object: To investigate how half lives work for calculating the radiometric age of rocks. **You will be including your Data, Calculations, Graph, Questions and Conclusion on Unit 3 of your ePortfolio.**

Preamble:
When igneous rocks form (cool down from molten material) they have small amounts of radioactive material (the parent) in them. Over time the radioactive material "decays" to become stable material (the daughter.) The time for half the parent to decay and become daughter is called one "half life." For the purposes of this activity, we'll assume that when the rock forms it contains none of the daughter element in it.

Procedure:
1. Do NOT eat any "radioactive" M&M's (until you have collected **ALL** the data.)
2. Lay out all the M&M's with the M's facing down. This represents the parent (radioactive) isotope at time = 0 (magma has just turned into rock.). Count the number of M&M's you have.
3. Put all the M&M's into the cup provided and shake them for 5 seconds (which represents one half life in this activity.)
4. Carefully dump the M&M's onto a paper towel. Count how many land M's down (radioactive parent) and how many land M's up (stable daughter.) Record this information on the chart below and put ONLY the parents (M's down) into the cup. (Set aside the daughters (M's up) for eating later.)
5. Note: the number of stable daughters recorded in the data table is the total of all the daughters (M's up) from previous shakes/dumps as well.
6. Shake for 5 seconds, carefully dump remaining M&M's, count parents and daughters, put only the parents back in the cup.
7. Repeat procedure 5 until there are no M&M's that land M's down – in other words, all the parents have decayed and turned into daughter.
8. Once you have the data table completed, you may eat your "stable" M&M's. Enjoy!

Data:
Length of a half life in this activity: 5 seconds

# of half lives that have passed (# of times you've dumped the cup)	**# of radioactive parents (landed M-side down)**	**"Total" # of stable daughters (that landed M-side up so far)**	**Age of the sample at each point (ignore time for counting the samples each time)**
0	(all) # 24	0	0
1	13	11	5s
2	7	17	10s
3	6	18	15s
4	2	22	20s
5	1	23	25s
6	0	24	30s
7	1	24	35s

Calculations:

Age = (length of a half life) x (# of half lives that have passed)

Show a *sample calculation* here and then fill in the last column of the table above.

Age = (1) x (5s) = 5s

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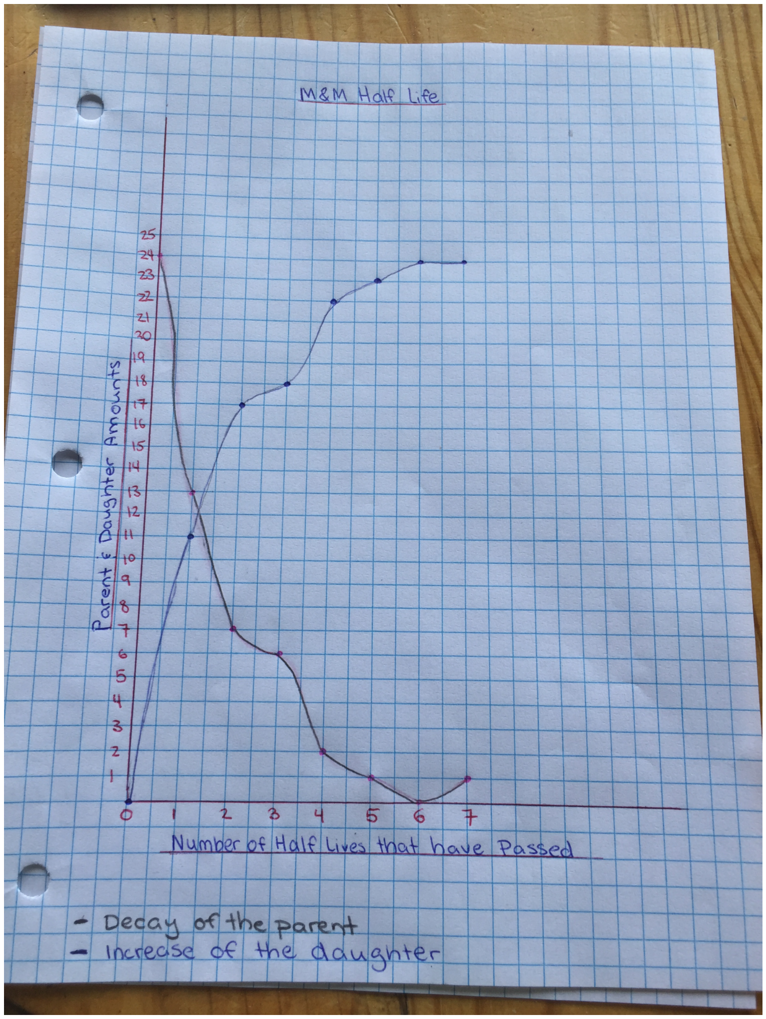
Graph:

Draw a graph with two curves, one for the decay of the parent and one for the increase of the daughter. Put the parent and daughter amounts on the y-axis and the # of half lives on the x-axis. Plot the points then connect them with a smooth curve. *(You may choose to create this graph in Excel, like we have done in the past).*



Questions:

1. If a sample started with 100% parent and now has 25% parent and 75% daughter,
   a. How many half lives have passed?

If a sample contains 25 percent of a parent isotope and 75 percent of its daughter isotope, two half-lives must have passed. If the sample started with 100% of a parent isotope after one half-life, 50 percent of the parent isotope would remain. After a second half-life, half of the remaining parent isotopes would have decayed, leaving 25 percent of the original parent isotope and 75 percent daughter isotope.

   b. If one half life is 7 million years, how old is the sample?

Using the formula Age = (length of half-life) x (# of half-lives that have passed), and substituting 7 million years for the length of the half-life, and two for the number of half-lives that have passed, it can be determined that the sample is 14 million years old.

2. Carbon 14/Nitrogen 14 can only be used for dating things that were alive (not rocks). The half life for this pair is 5730 years. How long has a tree been dead that has half C^{14} and half N^{14}?

If the measured abundance of Carbon 14 and Nitrogen 14 is equal, one half-life has passed, and the tree is 5,730 years old.

3. An igneous rock contains 8 parents and 56 daughter atoms. How many half lives have passed?

If there are eight parents and 56 daughter atoms, three half-lives have passed. If the total number of atoms is 64, after one half-life, 32 parent atoms and 32 daughter atoms would be present. After two half-lives, 16 parent atoms and 48 daughter atoms would be present. After three half-lives, eight parent atoms and 56 daughter atoms would be present.

4. Potassium/Argon is another special isotope pair because the daughter, Argon, is a gas. Over time, in a particular sample, some daughter has escaped. What effect will this have on the apparent age (will the sample appear too old or too young?) Explain.

The sample will appear younger, as fewer daughter atoms will indicate less half-lives have occurred

Conclusions:

Considering what we've done in the lab and questions, describe how to calculate the age of a rock using radiometric methods.

Radiometric dating methods estimate the age of rocks using calculations based on the decay rates of radioactive elements. Some minerals in rocks and organic matter contain radioactive elements that gradually decay into other elements. The original element is referred to as the parent, and the result of the decay process is referred to as the daughter. The amount of time that it takes for half of the parent isotope to decay into daughter isotopes is called the half-life of an isotope. When the quantities of the parent and daughter isotopes are equal, one half-life has occurred. If the half-life of an isotope is known, the ratio of the parent and daughter isotopes can be measured, and the amount of time that has elapsed since the radioactive decay of the parent isotope began can be calculated.