Name: _____ Period: ___ Date: _____ Assign# ___

Simulating Radioactive Decay with m&m Candies

Using m&m Candies to Simulate Radioactive Decay And Radiometric Dating

Background: How old is Earth and the Rockies? And how old are dinosaur or hominid fossils? It was not until the end of the 1800's that scientists found a method for answering these questions. They found that rocks and fossils can contain small amounts of radioactive isotopes. Over time, these **unstable** radioactive isotopes decay (= change) to other **stable** elements, by giving off alpha and/or beta particles and energy (gamma rays) at a constant and measurable rate. Decay time is very precise: it is like a clock keeping track of time that has passed since the rock had formed.

It takes a certain period of time for one half of the parent radioactive isotope to decay to the stable daughter elements. This is referred to as a half-life. **By measuring the ratio of parent isotopes to daughter products and by knowing the half-life of the parent isotope, you can calculate the absolute age of the rock or fossil.**

For instance, the age of a Neanderthal skull needs to be determined. At the death of this organism, the skull contained 100% of C-14, a radioactive isotope. How much 100% represents can be determined by measuring newly-dead organisms. We know that C-14 has a half-life of 5,730 years. Therefore, 5,730 years after its death only 50% of the parent isotopes were present in the skull – the other 50% had turned into stable N-14 daughter isotopes. Another 5,730 years later, half of the **remaining** C-14 decayed into N-14. So, after two half-lives, only 25% of the original C-14 remained. By measuring the % of remaining C-14 in the skull and applying it to the amount of half lives and fractions thereof, we can determine the absolute age of the Neanderthal. Keep in mind: After many half-lives, such tiny amounts of the parent isotope remain that they may no longer be measurable. For instance, dating with C-14 is only"good" for a maximum of 75,000 years.

Purpose: To use m&m's to simulate how the radioactive element Carbon-14 decays over several half-lives, and to determine the corresponding ages at each of the half-lives.

Materials/ Roles Played:

1. m&m with the "m" side up = a single atom of carbon-14, a naturally radioactive element found in living things.
2. m&m with the "blank" side up = a single atom of nitrogen-14, the decay element formed when C-14 decays.
3. Shaking and dumping the m&m's = a half-life, in this case, 5730 years.

Procedure:

1. Count your m&m's to get the starting number and record that number in your data table.
2. To start, place all the m&m's with the "m" side up on the table. What % of the sample is "m"-side up? How old is the sample? Write these into your data table.
3. Make your prediction if perfect decay for your m&m took place. Fill # and % into your data table.
4. Also, fill in the column for their age, using the time past in years for each of C-14's half lives.
5. **Now only**, place all the m&m's into the cup, cover the cup, shake it, and dump the pieces onto the paper towel or plate.

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6. Separate the pieces with the "blank" side up from the pieces with the "m" side up. Count and record these numbers in "1 H.L." row.

7. Set the "blank" pieces aside. They represent the decay element N-14 and they will not be used again.

8. Place ONLY the "m" side up pieces back into your cup and cover the cup, shake it, and dump the pieces onto the paper towel or plate.

9. Again, separate the pieces that are blank from the pieces with the "m" side up. Record the number of "m" side pieces that remain on the next row of the data table

10. Subtract the number of "m" side pieces remaining from the starting number to calculate the TOTAL number of "blank" pieces created thus far. Record this difference in the data table.

11. Repeat Steps 8-10 until you only have one piece left at the end of a shake.

12. Complete the data table, graph, and analysis questions.

Data Table:

Half-Life #	Total Time passed since death (yrs) [1/2 life of C-14 = 5730 yrs]	Prediction of perfect decay (#)	Prediction of perfect decay (%)	# of "m" side up pieces	# of "blank" side up pieces	% of starting # left : $\frac{\#\text{ "m" side}}{\text{starting \#}} \times 100 = \%$
0	0	Starting #: 80	100%	Starting #: 80	0	Starting %: 100
1	5730	40	50%/40	50	30	62.5%
2	11,460	20	25%	25	25	
3	17190	10	12.5			
4						
5						
6						

Data Analysis: Graphing

On a separate piece of graph paper graph the radioactive decay of carbon-14 by plotting the # of pieces remaining vs. # of half-lives. Draw a curve to connect the points.

Analysis Questions: Write answers NEATLY on a separate sheet of paper.

1. What does the tossing of the m&m's and the pieces removed represent?
2. Refer to your data table, how many years did it take for there to be only 12.5% of the Carbon-14 left? How many half-lives is this?
3. Think backwards. You find a fossil that has 25% Carbon-14 and 75% Nitrogen-14. How old is it?
4. Uranium-235 is another radioactive element which has a half-life of 713 million years. It decays to Lead-207. Make a table of Uranium-235 decay through 5 half-lives.
5. Approximately what percentage of Uranium-235 will be left after 2139 million years (2.139 billion years)?
6. If you find a rock with 6.25% Uranium-235 and the rest Lead –207, how much time has passed?