Name ______________________ Per # _____ Due date ______________

McCarter Biology 2

Calculating the Half-Life of Twizzlers and M&Mium

Background: The half-life of a radioactive element is the time it takes for half of its atoms to decay into something else. For example, Uranium-238 (U-238) has a half-life of about 4.468 Billion years; therefore in 4.468 Billion years, 2.0 grams of U-238 will turn into one gram of U-238 and one gram of Pb-206 (the radioactive decay product). After another 4.468 Billion years have elapsed, only .5 gram of the original 2.0 g of U-238 will remain.

Learning Goals:

- Illustrate the concept of half-life and how it relates to radioactive material
- Determine the half-life of Twizzlers and a "radioactive" element called M&Mium
- Create graphs to represent the half-life of an element
- Determine how different factors modify the shape of the half-life graph

Materials and Equipment Per Group of 2:

2 Twizzlers 50 M&Mium "isotopes" plastic cup ruler graph paper

Procedure: Part I: Amount of Twizzler vs. Time

1. Hold one Twizzler vertically against the y axis of your graph paper with one end at the origin. Mark the "length". This represents the beginning amount.
2. Wait for further instructions to "Take a ½ bite!" You must eat HALF (and *only* half) the length of the Twizzler**. Mrs. McCarter will tell you to take a bite every 45 seconds (for 5 half-lives) and record your data.**
3. Repeat step 1, holding the Twizzler a unit from the origin. Mark the new length (this is your y coordinate).
4. Repeat steps 2 and 3 until your teacher tells you to stop.(5 half-lives)
5. Draw a smooth "Best Fit" line on your graph.

Conclusions and Analysis:

1. Did the Twizzler ever completely disappear? Explain.

2. Does a radioactive sample decay completely in real life? Explain.

3. What was the half-life of the Twizzler? ______________________________
4. How long will it take until 1/8 of the sample remains? _____________________________
5. Using your graph as reference, determine between which time intervals there was the greatest decrease in parent element and the greatest increase in daughter element. Explain.

6. If you started with a giant Twizzler (2 times the normal size), how would this have affected the shape of the graph? Explain

7. Describe the effect on the graph if you took a bite every 90 seconds.

Procedure: Part II: Determining the Half-Life of M&Mium

1. Wash your hands and your lab table. Count the number of M&Mium (50) atoms as you place them in the cup. Record the total number of radioactive atoms you start with (50) in Data Table 1.
2. Cover and shake/rattle the cup.
3. Carefully pour your atoms onto your white paper. You will see that several of the previously radioactive atoms in the group have decayed into "Blankiums", and the "m" is no longer visible. This means that they are now considered "safe" and are no longer radioactive. Remove the "Blankiums". Count the remaining candy M&Miums and record the number **next to shake #1** and **under Trial #1** on your data table. Place these M&Miums into the cup and repeat #'s 2 & 3. This data goes **next to shake #2** and continues **under Trial #1.** Continue shaking, and pouring until you have no remaining M&Miums. Be sure to record your data. Start over with 50 candies for Trial #2. Repeat again with 50 candies for Trial #3. **(NOTE: You should not eat any of the decayed M&Miums until you are finished with the 3rd trial.)**
4. Add across all three trials to obtain a total. Divide the total by 3 to calculate the averages.

Results:

Using the graph paper provided, construct a graph of *number of remaining M&Mium* (y axis) as a function of the *number of shakes* (x axis). Use the average of 3 trials to construct this graph. Remember to label both axes and title it.

Conclusions:

1. In your model for radioactive decay, what do the following items represent?

   a. The "m" side of the M&M ________________________________

   b. The blank side of the M&M ________________________________

   c. The contents of the cup ________________________________

   d. Each shake ________________________________

2. Approximately what percentage of M&Ms were removed after each shake? _________

3. What was the average number of shakes required to produce a single M&Mium? __________

4. If each shake is equal to 1 million years, what is the half-life of M&Mium? _______________

5. If the plastic cup represents a rock which originally contained 100 atoms of U-238, calculate the age of the rock when 1 atom of U-238 remains (based on your average results and information given in the Background section). Show your calculations below.

6. The half-life of C-14 is 5,730 years. Explain why C-14 dating is not used to determine the absolute age of fossils more than 75,000 years old.

Data Table 1 – M&Mium decay into Blankium

Shake #	Trial 1 # m&mium remaining	Trial 2 # m&mium remaining	Trial 3 # m&mium remaining	Total	Average