Student _____ Date _____ Period _____

Tootsie Roll Half-life Determination Lab

Dr. Katz – Honors Chemistry (30 points)

Introduction: In this lab, you will calculate the half-life, $t_{½}$, of the rare (fictional) radioisotope, Sweetyumium-212 (symbol ^{212}Sw). Sweetyumium is commonly found occurring in the same location as radioactive purple Calorium isotopes, Mm-69; however, the radioisotope Sw-212 is found occurring in Tootsie Rolls. Sweetyumium-212 has 84 protons and is known to spontaneously undergo alpha decay. In addition to calculating the half-life of Sweetyumium, you will also calculate the binding energy and binding energy per nucleon released during the alpha decay of one Sw-212.

Materials: 32 Midgie Tootsie Rolls, 1 piece of paper, 1 calculator, and 1 clock with a second hand (YOU DO NOT NEED TO BRING THESE TO LAB) – you must have AT LEAST 5 group members to complete this lab.

Safety and Waste Disposal:

1. Safety goggles are not required for this lab (unless you are afraid of getting Sweetyumium in your eyes).
2. Do not eat any of the isotopes unless instructed to do so!
3. Dispose of all wastes as directed by your teacher.

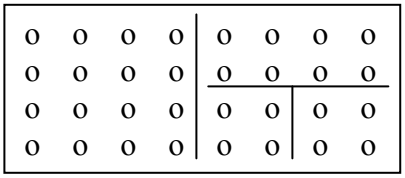
Pre-Lab Questions: (refer to your notes if you have difficulty with these questions)

1. Write the nuclear symbol for the radioisotope Sw-212. Be sure to include the mass number and the atomic number in their proper locations (1 pt).

2. Write the nuclear reaction that is being modeled in this lab, clearly showing what <u>actual isotope</u> (go to the PT) is formed as a result of the **alpha decay of Sw-212** (2 pts).

Procedure:

1. Obtain a piece of paper. Draw 32 circles on the paper in the pattern shown below:



2. Place each isotope on one circle on the paper. Make sure that 32 isotopes are present. If you are missing any, notify your instructor.
3. Select **4 group members** to complete step 4. The fifth group member will watch the clock.
4. When the clock-watcher is ready, the 4 group members should *unwrap* **<u>4 isotopes each</u>**. Once unwrapped, each isotope should be replaced on its circle. In the data table on page 2, record the time it took for 4 group members to *unwrap* a total of 16 isotopes.
5. Select **<u>only 2 group members</u>** to complete step 6. Another person will record the time.
6. When the clock-watcher is ready, the 2 group members should *unwrap* **<u>8 isotopes</u>**. Once unwrapped, each isotope should be replaced on its circle. In the data table, record the time it took for 2 group members to *unwrap* a total of 8 isotopes in the data table on page 2.
7. In this final step, **<u>1 group member</u>** will *unwrap* **<u>4 isotopes</u>** and replace the isotope on its circle, while another group member records the time in the data table on page 2.
8. Inform your instructor that you have completed steps 1 - 7. Your instructor will make sure there are no dangerous radioisotopes left in your sample before you clean up.

Student _____ Date _____ Period _____

Data Table (3 pts) Don't forget units**:**

From Step 4: Time required for half the isotopes to "decay" (be unwrapped): _____
From Step 6: Time required for half the remaining isotopes to "decay" _____
From Step 7: Time required for half the remaining isotopes to "decay" _____

Observations: List 2 observations you made during this experiment (2 pts).
1.

2.

Calculations: Don't forget units! (2 pts) Calculate the average time it took for half of your sample to decay using the information in your data table. (This average will be your half-life). Show work here and then report your average half-life in the Results section below.

Results: Half-life of Sw-212 _____ (1 pt).

Questions: Don't forget units and sig fig rules! SHOW WORK IF YOU WANT PARTIAL CREDIT

1. What is the nuclear symbol for an ***unwrapped*** "Tootsie Roll" (1 pt)? (Hint: see Pre-Lab Question 2)

2. Using your measured half-life (from Results), how long would it take for 31 atoms of Sw-212, in a sample of 32 atoms, to decay? (3 pts)

3. The total mass of your sample was initially 212.013 amu, but after one alpha decay occurred the mass of the sample was only 212.005 amu.
   a. Calculate the mass defect in amu. (2 pts)

   b. Calculate the mass defect in kg. (1.6605×10^{-27} kg = 1 amu) (2 pts)

   c. Calculate the amount of energy released during this reaction in Joules. ($c = 3.0 \times 10^{8}$ m/s) (2 pts)

   d. Calculate the binding energy per nucleon for Sw-212. (2 pts)

4. After 2 half-lives have passed, what percentage of your sample has decayed? _____ (1 pt)

5. After 4 half-lives have passed, what percentage of your sample is left over? _____(1 pt)

6. In a sample of Sw-212, the ratio of product isotope to Sw-212 is 91 to 13. How long has this sample been present? Use your measured half-life. (FYI - This is how scientists actually perform radioactive dating!) (3 pts)

7. **Conclusion**: In two complete scientific sentences (not about candy!), write a conclusion for this experiment. (Hint – Look at the conclusion explanation for the Calorium lab; then look at the introduction to this lab which tells you the lab's purpose. Ask yourself, "What was I trying to calculate, determine, or uncover?" Then, state the facts of the lab in the conclusion in a brief but informative sentence. (2pts)