POPPY SCHOLARS · PHYSICS OF THE UNIVERSE

Home lab 11 · Unit 11 · about 40 minutes

If every atom decays at random, why is the half-life of a large sample so predictable?

Name _____ Date _____

MATERIALS

You supply everything. Tick each item as you gather it.

- ☐ 100 coins of the same kind (pennies are fine), or 100 beans with one side marked
- ☐ A cup or box to shake them in, and a flat table
- ☐ Paper, pencil and a calculator
- ☐ Graph paper or a spreadsheet, preferably with a log scale or a natural logarithm function

SAFETY

No special safety concerns. Keep coins and beans off the floor, and away from small children and pets.

PROCEDURE

1. Start with 100 coins, each one a radioactive atom. Round 0: record 100 remaining.
2. Shake all the remaining coins in the cup and pour them on the table. Every coin that lands heads up has 'decayed'. Remove it. Count the coins that remain (tails up), and record the number for that round.
3. Repeat with the remaining coins, round after round, until none are left or only 1 is left.
4. Graph the number of coins remaining (vertical) against the round number (horizontal). Draw a smooth curve through the points.
5. Compute the natural logarithm of the number remaining, ln N, for each round with at least 1 coin. Graph ln N against the round. The slope is $-\lambda$, the decay constant.
6. Compute the half-life with $t_{1/2} = \ln 2 \div \lambda = 0.693 \div \lambda$, in rounds, and compare it with the theoretical value of 1 round for a probability of ½ per round.

RECORD YOUR DATA

Round	Coins remaining N	ln N
0		
1		
2		
3		
4		
5		
6		
7		

Also write the slope of ln N against round, the decay constant λ, and your half-life.

LAB REPORT

Write a report that gives your table and both graphs, shows how you found λ and the half-life, and compares it with the theoretical value. Explain why one coin's fate cannot be predicted but the group's can. Then apply the half-life of carbon-14, 5,730 years, to estimate the age of a bone that has 12 percent of its original carbon-14.

Report the numbers you actually got, even when they disagree with the lesson. Write on the lines, or type your report on the website and send it to a teacher there.

Question and hypothesis *State the question in your own words, what you expect to happen, and why you expect it.*

Method *What you changed, what you measured, what you kept the same, and how many trials you ran.*

Observations *Describe what you saw, including anything unexpected. Your data tables are added to the report automatically.*

Calculations *Show each calculation step by step, with units.*

Claim and reasoning *Answer the question using your numbers, then explain why, using the science from the unit.*

Limits and next step *What could have affected your results, and one change you would make next time.*