Decay by Chance

Use simulation data to estimate half-life

PHY.6.4 "Simulate the process of nuclear decay using online simulations and/or laboratory experiences and using mathematical computations determine the half-life of radioactive isotopes."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle two pairs of counts in the table that show roughly half the nuclei remaining, then underline their matching times to track the length of each half-life.

A Radioactive Sample on Screen

1. Imagine tracking a sample of a fictional radioactive isotope called Trace-7. Each nucleus can decay, changing into a different nucleus, but no one can predict which one will decay next. A computer can model this uncertainty: in each round, it gives every undecayed nucleus a chance of decaying, then counts what remains.

2. For a classroom simulation, the computer starts with 200 nuclei. Each round represents three minutes. It assigns each surviving nucleus a random outcome: decay or remain, with an equal chance of either outcome. Only those that remain enter the next round. The recorded results below come from one run, not a guarantee of what a second run will show.

ONE SIMULATION RUN

Time (minutes)	Nuclei remaining
0	200
3	102
6	49
9	25
12	12

3. Half-life is the time it takes for about half of a large group of radioactive nuclei to decay. To estimate it, compare counts at different times and look for a drop near one half. A single nucleus has no scheduled decay time. Repeated runs can differ, even when their overall patterns are similar.

2 ANSWER WITH EVIDENCE

Use the passage

1. Use the counts at minutes 0 and 3 to estimate the isotope's half-life. Explain your estimate.

2. About how many half-lives pass between minutes 6 and 12? Show how the counts support your answer.

3. Using the last count in the table and your estimated half-life, predict how many nuclei might remain at minute 15.

4. A second run has 94 of 200 nuclei remaining at minute 3. Calculate the percent that decayed and explain whether this fits the simulation's decay rule.

3 YOUR TURN

Your own words

Design a coin-flip simulation that starts with 96 undecayed nuclei and uses one round to represent two minutes. Explain what happens to a coin when its nucleus decays, predict the expected number of nuclei remaining after each of four rounds, and calculate the half-life.

Decay by Chance

PART 1 · READ AND MARK

Circle two pairs of counts in the table that show roughly half the nuclei remaining, then underline their matching times to track the length of each half-life. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Use the counts at minutes 0 and 3 to estimate the isotope's half-life. Explain your estimate.	**About 3 minutes. After 3 minutes, 102 of 200 nuclei remain, which is close to half.**
2	About how many half-lives pass between minutes 6 and 12? Show how the counts support your answer.	**About two half-lives. The count falls from 49 to 25, then from 25 to 12, roughly halving twice.**
3	Using the last count in the table and your estimated half-life, predict how many nuclei might remain at minute 15.	**About 6 nuclei, half of the 12 remaining at minute 12.**
4	A second run has 94 of 200 nuclei remaining at minute 3. Calculate the percent that decayed and explain whether this fits the simulation's decay rule.	**106 of 200 decayed, or 53%. This fits: each nucleus has a 50% chance of decaying in a round, but the total need not be exactly half.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I would start with 96 coins, each representing one undecayed nucleus. Every two minutes, I would flip all remaining coins and remove those that land heads because heads means decay. The expected counts after four rounds are 48, 24, 12, and 6. The half-life is about two minutes because about half of the nuclei remain after each round.

Accept estimates that recognize the table shows approximate, not exact, halving. For Your Turn, accept either coin face as decay if the rule is consistent; the predicted counts should use halves, not claim that every run must produce them.