Nuclear Number Trail

Balance decay equations and track a changing sample

PHY.6 "Students will demonstrate an understanding of the basic principles of nuclear energy. Analyze and explain the concepts of nuclear physics. Explore the mass number and atomic number of the nucleus of an isotope of a given chemical element..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the rules that help you balance a nuclear equation. Circle the table values that show the sample being cut in half, and number each halving in time order.

What Remains After Decay?

1. A smoke detector and a hospital tracer use nuclear processes for different purposes. To describe any nucleus, write its mass number A, the total protons and neutrons, and its atomic number Z, the number of protons. A sealed radium-226 source has Z = 88. In nuclear decay, the sums of A and Z must match on both sides of an equation.

2. An alpha particle is a helium nucleus with A = 4 and Z = 2. Radium-226 can emit one. In beta-minus decay, a neutron becomes a proton and releases an electron, e^{-}. Iodine-131 undergoes beta-minus decay and has Z = 53. For balancing nuclear equations, the emitted electron counts as A = 0 and Z = −1.

3. A classroom simulation starts with 800 iodine-131 nuclei. Each nucleus decays unpredictably, but a large group follows a pattern: after one half-life, about half remain. For iodine-131, one half-life is about eight days. The table shows an idealized run, not an exact prediction for every group of nuclei.

IDEALIZED IODINE-131 SIMULATION

Day	Nuclei remaining
0	800
8	400
16	200
24	100

2 ANSWER WITH EVIDENCE

Use the passage

1. How many neutrons are in a radium-226 nucleus? Show how you found the number.

2. Write a balanced alpha decay equation for radium-226. Use Ra for radium and Rn for the daughter nucleus.

3. Write a balanced beta-minus decay equation for iodine-131. Use I for iodine and Xe for the daughter nucleus.

4. If the table's pattern continues, how many nuclei remain on day 32? How many of the original 800 have decayed by then?

3 YOUR TURN

Your own words

Suppose a new sample has 320 parent nuclei at day 0, a half-life of six days, and a parent nucleus with A = 40 and Z = 19. Write its balanced beta-minus decay equation using P for the parent and D for the daughter, then predict how many parent nuclei remain on day 18 and explain your checks.

ANSWER KEY

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PART 1 · READ AND MARK

Underline the rules that help you balance a nuclear equation. Circle the table values that show the sample being cut in half, and number each halving in time order. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How many neutrons are in a radium-226 nucleus? Show how you found the number.	**138 neutrons, because 226 − 88 = 138.**
2	Write a balanced alpha decay equation for radium-226. Use Ra for radium and Rn for the daughter nucleus.	**$^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He}$.**
3	Write a balanced beta-minus decay equation for iodine-131. Use I for iodine and Xe for the daughter nucleus.	**$^{131}_{53}\mathrm{I} \rightarrow {}^{131}_{54}\mathrm{Xe} + {}^{0}_{-1}\mathrm{e}^{-}$.**
4	If the table's pattern continues, how many nuclei remain on day 32? How many of the original 800 have decayed by then?	**50 remain after another halving; 800 − 50 = 750 have decayed.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

$^{40}_{19}\mathrm{P} \rightarrow {}^{40}_{20}\mathrm{D} + {}^{0}_{-1}\mathrm{e}^{-}$. The mass numbers balance because 40 = 40 + 0, and the atomic numbers balance because 19 = 20 + (−1). Day 18 is three half-lives after day 0, so the sample goes from 320 to 160 to 80 to 40 parent nuclei remaining.

Accept equivalent nuclear notation if both mass number and atomic number balance. Half-life counts are expected values for a large or idealized sample, not guaranteed results for every simulation.