



Nuclear Decay Investigation

Model alpha, beta-minus, and gamma decay; balance nuclear equations; compare shielding; and investigate why half-life describes populations rather than predicting one atom.

NGSS: HS-PS1-8 - Develop models to illustrate changes in the composition of the nucleus and the energy released during fission, fusion, and radioactive decay.

Name: _____ Class / Period: _____ Date: _____

Part A - What Changes in the Nucleus?

Use the isotope selector and decay animation. Complete the table after observing at least one example of each decay mode.

Decay mode	Example parent	Change in mass # (A)	Change in atomic # (Z)	Emitted radiation
Alpha				
Beta-minus				
Gamma				

1. Which decay mode changes the element without changing mass number? Explain what happens inside the nucleus.

2. Which decay mode changes neither A nor Z? What does the nucleus lose?

Part B - Balance Nuclear Equations

Use the equation challenge in the model. For each parent isotope, predict the daughter before checking your answer.

Parent	Mode	Predicted daughter (symbol-A)	Daughter Z	Check / correction
U-238	alpha			
C-14	beta-minus			
Sr-90	beta-minus			
Ba-137m	gamma			

3. State the conservation rule you used to balance mass number and atomic number in a nuclear equation.

Part C - Shielding Investigation

Select one alpha, one beta-minus, and one gamma source. Compare detector signal with different shielding materials. The model is qualitative; real attenuation depends on radiation energy, material, and thickness.

Radiation	No shield	Paper	Plastic	Aluminum	Lead	Concrete
Alpha						
Beta-minus						
Gamma						

4. Which radiation is easiest to stop? Which is most penetrating in the model? Use detector-signal evidence.

5. Why should a shielding model not be interpreted as saying that one exact thickness of a material always blocks the same percentage of radiation?

Part D - Half-Life: Random vs. Theoretical

Choose a sample size (64, 128, or 256). Compare **random** atom-by-atom decay to the **theoretical** curve. Record the fraction remaining at each time.

Time (half-lives)	Theoretical fraction remaining	Random fraction remaining
0	1.000	
1	0.500	
2	0.250	
3	0.125	
4	0.0625	
5	0.03125	

6. Why does the random sample not match the theoretical curve perfectly?

7. Repeat with a larger sample. Does the random curve tend to look more or less like the theoretical pattern? Explain.

Final Model / Explanation

8. Compare alpha, beta-minus, and gamma decay. Your explanation must include what changes in the nucleus, what is emitted, and whether the element identity changes.

9. A sample starts with 800 radioactive nuclei. Predict the theoretical number remaining after 3 half-lives. Show your reasoning.

10. Why can half-life predict the behavior of a large population but not the exact moment when one particular nucleus will decay?

CER: Radioactive Decay Changes Nuclear Composition

Claim: Write a claim describing how radioactive decay can change the composition of an atomic nucleus.

Evidence: Use at least two specific isotope examples from the model.

Reasoning: Connect conservation of A and Z, emitted radiation, and daughter nuclei to your claim.
