What is Nuclear Decay and Half-Life?

Worksheet

Nuclear decay follows exponential decay: N(t) = N (1/2)^(t/t/), where N is initial nuclei, t is elapsed time, and t/ is the half-life.

N(t) = N (1/2)^(t/t)

Questions

1. After 2 half-lives, what percentage of nuclei remain?
A) 50%
B) 25%
C) 12.5%
D) 6.25%

2. The half-life of Strontium-90 is 29 years. True or false: after 58 years, all nuclei are gone?
A) True
B) False

3. Which type of radiation is least penetrating?
A) Alpha
B) Beta
C) Gamma
D) All equal

4. N(t) = 1000 (1/2)^(t/10), where t is in hours. After 30 hours, N(t) = ?
A) 875
B) 500
C) 250
D) 125

5. Carbon-14 has a half-life of 5,730 years. If a fossil has 25,000 C-14 atoms initially, how many remain after 11,460 years?

6. Iodine-131 has a half-life of 8 days. Start with 1 million atoms. How many remain after 24 days?

7. Uranium-238 has a half-life of 4.5 billion years. Start with 80 kg. How much remains after 13.5 billion years?

8. Define: What is nuclear decay?

9. Define: Define half-life.

10. Define: Is nuclear decay random?

Answer Key

1. B) 25% - (1/2) (1/2) = 1/4 = 25%.
2. B) False - After 58 years (2 half-lives), 25% remain. Decay never reaches zero.
3. A) Alpha - Alpha particles (helium nuclei) are blocked by paper and skin.
4. D) 125 - 30/10 = 3 half-lives; 1000 (1/2) = 1000 0.125 = 125.
5. t = 11,460 years = 2 half-lives (11,460 5,730) N(t) = 25,000 (1/2) = 25,000 0.25 = 6,250 atoms
6. 24 days = 3 half-lives (24 8) N(t) = 1,000,000 (1/2) = 1,000,000 0.125 = 125,000 atoms
7. 13.5 billion = 3 half-lives (13.5 4.5) Remaining = 80 (1/2) = 80 0.125 = 10 kg
8. The spontaneous breakdown of unstable atomic nuclei, releasing energy and particles (alpha, beta, or gamma).
9. The time required for half of the original radioactive nuclei to decay.
10. Yes, individual decay events are random, but the rate is predictable statistically.