

Nuclear Chemistry & Half-Life

INSTRUCTOR / SELF-STUDY ANSWER KEY

Answers and reasoning appear in red. Use these to discuss why incorrect choices are incorrect.

Part A — Concept checks

1. After two half-lives, the remaining fraction is...

Answer: B. $1/4$ — $(1/2)^2 = 1/4$.

2. An alpha particle is essentially a...

Answer: B. helium-4 nucleus — An alpha particle has two protons and two neutrons.

3. Beta-minus decay increases atomic number by...

Answer: C. +1 — A neutron converts to a proton plus an emitted electron and antineutrino.

4. Gamma emission changes mass number by...

Answer: C. 0 — Photon emission changes energy but not A or Z.

5. After one half-life, 24.0 g of a sample becomes...

Answer: B. 12.0 g — Half remains.

6. Does ordinary heating greatly alter a nuclide's half-life?

Answer: C. no, generally not — Typical nuclear decay constants are insensitive to ordinary chemical conditions.

Part B — Application and explanation

7. A radioactive sample starts at 80.0 mg. How much remains after three half-lives?

Model solution: $80.0 \text{ mg} \times (1/2)^3 = 80.0/8 = 10.0 \text{ mg}$. This assumes a single nuclide with a constant half-life. Final answer: 10.0 mg

8. Explain why this guideline matters, with an example of what could go wrong if you ignore it: Half-life is the time to lose half of what remains, not the same fixed number of grams in every interval.

Model explanation: Half-life is the time to lose half of what remains, not the same fixed number of grams in every interval. Example/check: Alpha decay emits a helium-4 nucleus; beta-minus decay converts a neutron to a proton; gamma emission changes energy but not atomic number.

REFERENCE RELATIONSHIP

$$N = N_0(1/2)^{(t/t_{1/2})}$$