

Nuclear Reactions- Radioactive Decay

1. What are the types of radiation emitted by the nuclei of radioactive elements?

alpha particles, beta particles, and gamma rays

2. What changes occur to the atomic number and mass of a nucleus during each of the following decay scenarios?

- a. an α particle is emitted The atomic number (Z) decreases by 2 units and the mass number (A) decreases by 4 units.
Original nucleus: ${}_Z^AX \rightarrow$ Decay products: ${}_{Z-2}^{A-4}Y + {}_2^4\alpha$
- b. a β^- particle is emitted The atomic number increases by 1 unit and the mass number remains unchanged.
- c. γ radiation is emitted The emission of gamma radiation does not cause any changes in the atomic number (Z) or mass number (A) of the nucleus.
- d. a positron is emitted A decrease in the atomic number while maintaining the same mass number.
- e. an electron is captured A decrease in the atomic number while maintaining the same mass number.
Gamma rays may also be emitted.

3. What is the change in the nucleus that results from the following decay scenarios?

- a. emission of a β^- particle The key change in beta-minus decay is the conversion of a neutron into a proton.
- b. emission of a β^+ particle The key change in beta-plus decay is the conversion of a proton into a neutron.
- c. capture of an electron The key change in electron capture is the conversion of a proton into a neutron.

4. Many nuclides with atomic numbers greater than 83 decay by processes such as electron emission. Explain the observation that the emissions from these unstable nuclides also normally include α particles.

5. Why is electron capture accompanied by the emission of an X-ray?

Original nucleus: ${}_Z^AX + e^- \rightarrow$ Decay products: ${}_{Z-1}^AY + \nu_e$

Here, ${}_Z^AX$ represents the original nucleus, and ${}_{Z-1}^AY$ is the resulting nucleus after electron capture, with ν_e representing the electron neutrino released in the process. The X-ray is emitted to conserve lepton number during the process.

6. Explain how unstable heavy nuclides (atomic number > 83) may decompose to form nuclides of greater stability (a) if they are below the band of stability and (b) if they are above the band of stability

(a) In this case, the nucleus may undergo a process known as beta decay. In beta decay, a neutron is transformed into a proton, and an electron (beta particle) and gamma rays are emitted. This increases the proton-to-neutron ratio, moving the nucleus towards a more stable configuration. For example,



Key Terms Radioactivity And Nuclear Reactions Answer Key

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