

Nuclear Reactions

- 1 What evidence indicates that the nuclei of strontium-90 atoms are unstable?
 - (1) Strontium-90 electrons are in the excited state.
 - (2) Strontium-90 electrons are in the ground state.
 - (3) Strontium-90 atoms spontaneously absorb beta particles.
 - (4) Strontium-90 atoms spontaneously emit beta particles.

- 2 The stability of an isotope is related to its ratio of
 - (1) neutrons to positrons (3) electrons to positrons
 - (2) neutrons to protons (4) electrons to protons

- 3 The stability of isotopes is related to the ratio of which particles in the atoms?
 - (1) electrons and protons
 - (2) electrons and positrons
 - (3) neutrons and protons
 - (4) neutrons and positrons

- 4 Which statement describes the stability of the nuclei of potassium atoms?
 - (1) All potassium atoms have stable nuclei that spontaneously decay.
 - (2) All potassium atoms have unstable nuclei that do not spontaneously decay.
 - (3) Some potassium atoms have unstable nuclei that spontaneously decay.
 - (4) Some potassium atoms have unstable nuclei that do not spontaneously decay.

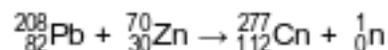
- 5 Radiation is spontaneously emitted from hydrogen-3 nuclei, but radiation is not spontaneously emitted from hydrogen-1 nuclei or hydrogen-2 nuclei. Which hydrogen nuclei are stable?
 - (1) nuclei of H-1 and H-2, only
 - (2) nuclei of H-1 and H-3, only
 - (3) nuclei of H-2 and H-3, only
 - (4) nuclei of H-1, H-2, and H-3

- 6 Nuclei of U-238 atoms are
 - (1) stable and spontaneously absorb alpha particles
 - (2) stable and spontaneously emit alpha particles
 - (3) unstable and spontaneously absorb alpha particles
 - (4) unstable and spontaneously emit alpha particles

- 7 A change in the nucleus of an atom that converts the atom from one element to another element is called
 - (1) oxidation-reduction (3) substitution
 - (2) single replacement (4) transmutation

- 8 In which reaction is an atom of one element converted into an atom of another element?
 - (1) combustion (3) oxidation-reduction
 - (2) fermentation (4) transmutation

- 9 Given the equation representing a reaction:

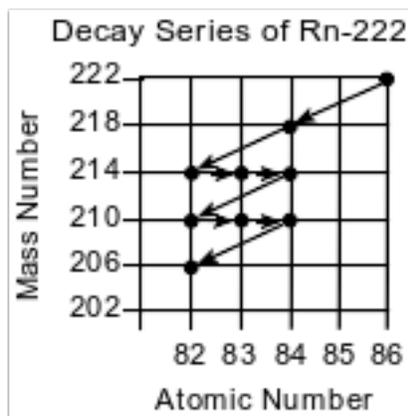


Which type of reaction is represented by this equation?

- (1) neutralization (3) substitution
- (2) polymerization (4) transmutation

Base your answers to questions 10 on the information below and on your knowledge of chemistry.

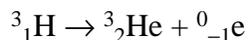
The isotope Rn-222 is produced by the decay of uranium in Earth's crust. Some of this isotope leaks into basements of homes in areas where the ground is more porous. An atom of Rn-222 decays to an atom of Pb-206 through a series of steps as shown on the graph below.



10 Explain, in terms of elements, why the decay of Bi-210 is considered a transmutation.

Base your answers to questions 11 on the information below and on your knowledge of chemistry.

A nuclear reaction is represented by the equation below.



11 Explain why the equation represents a transmutation.

Base your answers to questions 12 on the information below and on your knowledge of chemistry.

When uranium-235 nuclei are bombarded with neutrons, many different combinations of smaller nuclei can be produced. The production of neodymium-150 and germanium-81 in one of these reactions is represented by the equation below.



Germanium-81 and uranium-235 have different decay modes. Ge-81 emits beta particles and has a half-life of 7.6 seconds.

12 Explain, in terms of nuclides, why the reaction represented by the nuclear equation is a fission reaction.

Base your answers to questions 13 on the information below and on your knowledge of chemistry.

One fission reaction for U-235 is represented by the balanced nuclear equation below.



Both radioisotopes produced by this fission reaction undergo beta decay. The half-life of Xe-140 is 13.6 seconds and the half-life of Sr-94 is 1.25 minutes.

- 13 Explain, in terms of both reactants and products, why the reaction represented by the nuclear equation is a fission reaction.

Base your answers to questions 14 on the information below.

Nuclear fission has been used to produce electricity. However, nuclear fusion for electricity production is still under development. The notations of some nuclides used in nuclear reactions are shown in the table below.

Some Nuclides Used in Nuclear Reactions

Reaction	Nuclides
nuclear fission	${}_{92}^{233}\text{U}$, ${}_{92}^{235}\text{U}$
nuclear fusion	${}_{1}^1\text{H}$, ${}_{1}^3\text{H}$

- 14 Compare the atomic masses of nuclides used in fusion to the atomic masses of nuclides used in fission.

Base your answers to questions 15 on the information below and on your knowledge of chemistry.

Phosphorus-30 and phosphorus-32 are radioisotopes. Phosphorus-30 decays by positron emission.

- 15 Complete the equation in your answer booklet for the decay of phosphorus-30 by writing a notation for the missing product.

Answer Keys

1 4

2 2

3 3

4 3

5 1

6 4

7 4

8 4

9 4

10 Allow 1 credit. Acceptable responses include, but are not limited to:

- Bi-210 has an atomic number of 83 and becomes Po-210 with an atomic number of 84.
- The number of protons in the nucleus changes when the bismuth isotope decays.
- A different element forms.

11 Allow 1 credit. Acceptable responses include, but are not limited to:

- Hydrogen-3 is converted to helium-3.
- One element is changed into a different element.
- Atomic number changes.
- The number of protons in the nucleus changed.

12 Allow 1 credit. Acceptable responses include, but are not limited to:

- The $^{235}_{92}\text{U}$ nuclide splits into two different smaller nuclides.
- the splitting of a large atom into two smaller ones

13 Allow 1 credit. Acceptable responses include, but are not limited to:

- The $^{235}_{92}\text{U}$ nucleus splits into two smaller nuclei.
- One large atom is broken down into smaller atoms.

14 Allow 1 credit. Acceptable responses include, but are not limited to:

- The nuclides used for fusion have smaller atomic masses than nuclides used for fission.
- The nuclides used in fission are many times more massive.
- Fusion particles are lighter.

15 Allow 1 credit. Acceptable responses include, but are not limited to:

- $^{30}_{14}\text{Si}$
- ^{30}Si
- silicon-30
- Si-30