

# 28.1

## NUCLEAR RADIATION

### SECTION REVIEW

#### Objectives

- Discuss the processes of radioactivity and radioactive decay
- Characterize alpha, beta, and gamma radiation in terms of composition and penetrating power

#### Key Terms

- radioisotopes
- radioactivity
- radiation
- radioactive decay
- alpha radiation
- alpha particles
- beta radiation
- beta particles
- gamma radiation

#### Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

Isotopes with unstable nuclei are 1 and are called 2. The 3 of radioisotopes decay to 4 nuclei plus 5. The radiation may be alpha, 6, or gamma. 7 radiation consists of alpha particles (positively charged 8 nuclei) that are easily stopped by a sheet of paper. Beta radiation is composed of fast-moving particles, which are 9. Beta radiation is more penetrating than alpha radiation; it is stopped by 10. 11 radiation is electromagnetic radiation similar to 12, but much more energetic. Gamma radiation has no 13 or charge. It is extremely penetrating. 14 bricks and 15 reduce the intensity of gamma radiation but do not completely 16 it.

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## Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- \_\_\_\_\_ 17. Beta radiation is emitted when a radioisotope decays.
- \_\_\_\_\_ 18. Gamma radiation has a negative charge
- \_\_\_\_\_ 19. Gamma radiation and X-radiation are high-energy electromagnetic radiation.
- \_\_\_\_\_ 20.  ${}_{92}^{238}\text{U} + {}_{-1}^0e \rightarrow {}_{92}^{239}\text{U}$
- \_\_\_\_\_ 21. When a beta particle is emitted, the atomic number increases by 1, and the mass number stays the same.

## Part C Matching

Match each description in Column B to the correct term in Column A.

### Column A

- \_\_\_\_\_ 22. radioisotopes
- \_\_\_\_\_ 23. radioactive decay
- \_\_\_\_\_ 24. gamma radiation
- \_\_\_\_\_ 25. alpha particles
- \_\_\_\_\_ 26. beta radiation

### Column B

- a. the process in which an unstable nucleus loses energy by emitting radiation
- b. isotopes that have unstable nuclei and undergo radioactive decay
- c. high-energy radiation with no mass or charge
- d. fast moving electrons emitted from a radioactive source
- e. helium nuclei emitted from a radioactive source

## Part D Questions and Problems

Answer the following in the space provided.

27. Write nuclear equations for these processes.

a. The alpha decay of  ${}_{84}^{218}\text{Po}$

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b. The beta decay of  ${}_{82}^{210}\text{Pb}$

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# 28.2 NUCLEAR TRANSFORMATIONS

## SECTION REVIEW

### Objectives

- Use half-life information to determine the amount of a radioisotope remaining at a given time
- Give examples of equations for the synthesis of transuranium elements by transmutation

### Key Terms

- band of stability
- positron
- half-life
- transmutation
- transuranium elements

### Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

Nuclei that lie outside the 1 undergo spontaneous radioactive decay. Nuclei with too many neutrons undergo 2 decay as neutrons are converted to protons. A 3 is a particle with a positive charge and the mass of an electron.

Every radioisotope decays at a characteristic 4. A 5 is the time required for one-half of the nuclei in a radioisotope to decay. The product nuclei may or may not be 6. Half-lives vary from fractions of a second to 7 of years.

The conversion of atoms of one element to atoms of another is called 8. This process can occur spontaneously, or when 9 particles bombard the nucleus of an atom. All of the elements with 10 above 92 have been 11 in nuclear reactors or accelerators.

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## Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

- \_\_\_\_\_ 12. If you start with one mole of a radioisotope, after 10 half-lives, there will be none of the isotope left.
- \_\_\_\_\_ 13. A radioisotope has a half-life of 12 minutes. After 36 minutes only one-third of the radioactive atoms initially present will remain.
- \_\_\_\_\_ 14. Transuranium elements have atomic numbers greater than 92.
- \_\_\_\_\_ 15. Transmutation reactions occur spontaneously.
- \_\_\_\_\_ 16. Positively charged particles have the mass of an electron.

## Part C Matching

Match each description in Column B to the correct term in Column A.

### Column A

- \_\_\_\_\_ 17. band of stability
- \_\_\_\_\_ 18. positron
- \_\_\_\_\_ 19. half-life
- \_\_\_\_\_ 20. transmutation
- \_\_\_\_\_ 21. transuranium elements

### Column B

- a. conversion of an atom of one element to an atom of another element
- b. time required for one half of the atoms of a radioisotope to decay to products
- c. region containing stable nuclei in a neutron vs. proton plot
- d. elements with atomic numbers higher than 92
- e. particle with the same mass as an electron but with a positive charge

## Part D Questions and Problems

Answer the following in the space provided.

22. Sodium-24 has a half-life of 15 hours. How much sodium-24 will remain in an 18.0 g sample after 60 hours?
23. After 42 days a 2.0 g sample of phosphorus-32 contains only 0.25 g of isotope. What is the half-life of phosphorus-32?