Writing Nuclear Equations

When elements undergo radioactive decay, they change from one element to another. This happens by losing high energy alpha or beta particles, or by emitting positrons. The process is called transmutation. Nuclear equations are written to track the changes that occur during transmutation. When writing nuclear equations, it is important to make sure that mass and charge are conserved.

Rules for writing nuclear equations

1. the masses on each side of the equation must be equal
2. the charges on each side of the equation must be equal
3. the nuclear charge is the atomic number, and can be used to identify any new elements that form

General Format

$$ {}^{A}_{Z}X \rightarrow {}^{a}_{z}x + {}^{A-a}_{Z-z}Y $$

A *or* a = mass number

Z *or* z = charge; atomic number

X = original element

x = radioactive emission

Y = new element

Following are general equations for alpha decay, beta decay, and positron emission. An example is also given of each.

Nuclear equations for alpha decay:

- ★ General format: ${}^{A}_{Z}X \rightarrow {}^{4}_{2}He + {}^{A-4}_{Z-2}Y$
- ★ Example: ${}^{235}_{92}U \rightarrow {}^{4}_{2}He + {}^{231}_{90}Th$

Nuclear equations for beta decay:

- ★ General format: ${}^{A}_{Z}X \rightarrow {}^{A}_{Z+1}Y + {}^{0}_{-1}e$
- ★ Example: ${}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa + {}^{0}_{-1}e$

Nuclear equations for positron emission:

- ★ General format: ${}^{A}_{Z}X \rightarrow {}^{A}_{Z-1}Y + {}^{0}_{+1}e$
- ★ Example ${}^{37}_{19}K \rightarrow {}^{37}_{18}Ar + {}^{0}_{+1}e$

The type of emission given off by a radioactive element is listed on *Table N* of the Reference Tables. Once the type of emission an element gives off is known, it is possible to determine what the final product is, or if the new element is known, it is possible to figure out what type of emission was responsible for the transmutation.

Sample Problem

Write a nuclear equation showing what forms when radon 222 decays?

Step 1: Determine the type of emission by looking on *Table N*
the emission is an α–particle

Step 2: Look up the atomic number of the known element and write an equation showing the known information

$${}^{222}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{222-4}_{86-2}Y$$

Step 3: Subtract the weight and charge of the emission from the weight and charge of the original element to determine the weight and charge of the new element

$${}^{222}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{218}_{84}Y$$

Step 4: Identify the new element based on the nuclear charge or atomic number

$${}^{222}_{86}Rn \rightarrow {}^{4}_{2}He + {}^{218}_{84}Po$$

Continue ☞

Answer the questions below based on your reading above and on your knowledge of chemistry. Write a complete nuclear equation showing the transmutation that occurs. Use *Table N* for reference.

1. What forms when carbon–14 decays?

2. What forms when radium–226 decays?

3. What forms when iron–53 decays?

4. What kind of decay causes neptunium–238 to form from uranium–238?

5. From what radioactive element does fluorine–19 form by positron emission?

6. What forms from the decay of francium–220?

7. What forms from the decay of potassium–42?

8. What forms from the decay of potassium–37?

9. What forms from the decay of iodine–131?

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