Nuclear Equations

Unit: Nuclear Chemistry

MA Curriculum Frameworks (2016): N/A (HS-PS1-8 in physics frameworks)

Mastery Objective(s): (Students will be able to…)

- Write & solve nuclear equations.

Success Criteria:

- Equations include the correct product of decay (α, $\beta-$ *or* $\beta+$ particle)
- Equations include the correct starting material(s) and/or product(s).

Tier 2 Vocabulary: decay

Language Objectives:

- Explain the equations for radioactive decay and how to calculate the products.

Notes:

nuclear equation: a chemical equation describing the process of an isotope undergoing radioactive decay. For example:

$$^{238}_{92}\text{U} \rightarrow {}^{234}_{90}\text{Th} + {}^{4}_{2}\text{He}$$

In a nuclear equation, the number of protons (atomic number) and the total mass (mass number) are conserved on both sides of the arrow. If you look at the bottom (atomic) numbers, and replace the arrow with an = sign, you would have the following:

$$92 = 90 + 2$$

Similarly, if you look at the top (mass) numbers, and replace the arrow with an = sign, you would have:

$$238 = 234 + 4$$

Use this space for summary and/or additional notes:

Sample problems:

Q: What are the products of beta-minus ($\beta-$) decay of $^{131}\mathrm{I}$?

A: A $\beta-$ particle is an electron, which we write as ${}^{0}_{-1}e$ in a nuclear equation. This means $^{131}\mathrm{I}$ decays into some unknown particle plus ${}^{0}_{-1}e$. The equation is:

$$^{131}_{53}\mathrm{I} \rightarrow {}^{m}_{p}X + {}^{0}_{-1}e$$

We can write the following equations for the atomic and mass numbers:

Atomic #s: $53 = p + -1 \rightarrow p = 54$; therefore X is Xe

Mass #s: $131 = m + 0 \rightarrow m = 131$

Therefore, particle X is ${}^{131}_{54}\mathrm{Xe}$ So our final answer is:

The two products of decay in this reaction are ${}^{131}_{54}\mathrm{Xe}$ and ${}^{0}_{-1}e$.

Q: Which particle was produced in the following radioactive decay reaction:

$$^{212}_{86}\mathrm{Rn} \rightarrow {}^{208}_{84}\mathrm{Po} + {}^{m}_{p}X$$

A: The two equations are:

Atomic #s: $86 = 84 + p \rightarrow p = 2$; therefore X is He

Mass #s: $212 = 208 + m \rightarrow m = 4$

Therefore, particle X is ${}^{4}_{2}\mathrm{He}$, which means it is an α particle.

Use this space for summary and/or additional notes:

Homework Problems

For these problems, you will need to use a periodic table and radioactive decay information from "Table U. Selected Radioisotopes" on page 514 of your Chemistry Reference Tables.

Give the nuclear equation(s) for radioactive decay of the following:

1. ^{222}Rn

2. ^{85}Kr

3. ^{220}Fr

4. ^{37}K

5. ^{3}H

Give the starting material for the following materials produced by radioactive decay:

6. Alpha (α) decay resulting in $^{267}_{108}$Hs

7. Beta-minus ($\beta-$) decay resulting in $^{185}_{75}$Re

Use this space for summary and/or additional notes: