Introduction to Radioactivity

Introduction

One of the most important discoveries in the history of people was the discovery of radioactivity. This is the ability of some atoms of chemical elements to change into atoms of a different chemical element and, when this happens, emit (give off) energy. Today, people make use of radioactive isotopes in many ways. Some are beneficial (good), such as medical treatment and creating electrical energy. Others are harmful and dangerous, such as atomic bombs.

In this activity, you will first review some of the important ideas about atoms. Then you will begin to learn about two important ways in which radioactivity can occur. This prepares you for conducting an experiment that models what happens during radioactive decay.

Reviewing Some Ideas about Atoms

Use your knowledge and information from the textbook to print the best word(s) in each sentence.

1. Atoms are the “basic” particles of chemical _________________________________.

2. There are __________ “natural elements” and about ______________ additional elements that have been created in laboratories.

3. Almost all of the atom’s mass is in its central __________________. This is made of positively-charged ___________________________ and ________________________ that have no electrical charge.

4. Negatively-charged __________________________ move in “orbits” around the nucleus, but have very little mass.

5. The atomic ______________________________ is the number of protons in the nucleus. The sum of protons and neutrons is the ______________________ mass number.

6. Each element has its own unique ______________________________. But isotopes of different elements can have the same ______________________________.

7. We can represent atomic and mass numbers in various ways. We will use as our example Carbon-14. This means the isotope of Carbon that has 6 protons and 8 neutrons. Its atomic number is 6, and its mass number is 14. Three ways to represent this isotope are:

   C-14   6C^{14}   6 P
   8 N
8. The table lists the names of some other important isotopes we will be using as we learn about radioactivity. **Use your Periodic Table** to complete the chart with the three ways shown above.

<table>
<thead>
<tr>
<th>Isotope</th>
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</thead>
<tbody>
<tr>
<td>Carbon-12</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Nitrogen-14</td>
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<tr>
<td>Uranium-238</td>
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<tr>
<td>Thorium-234</td>
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<tr>
<td>Protactinium-234</td>
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<tr>
<td>Lead-206</td>
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<tr>
<td>Potassium-40</td>
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<td></td>
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<tr>
<td>Argon-40</td>
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</tbody>
</table>
9. One way in which one radioisotope changes into another is called **alpha decay**. When an atom breaks apart by alpha decay, it gives off an **alpha particle**. The symbol for this is the Greek letter \( \alpha \).

An alpha particle has 2 protons and 2 neutrons, so it is like the nucleus of a \( \text{He} \) atom. But unlike a \( \text{He} \) atom, the alpha particle does not have electrons orbiting around it.

When an atom **undergoes** alpha decay, its atomic number will **decrease** by \( \) and its mass number will decrease by \( \).

For example, \( \text{U}^{238} \) undergoes alpha decay to become \( \text{Th}^{234} \):

\[
\text{\( _{92}^{238} \text{U} \rightarrow _{90}^{234} \text{Th} + \alpha + \text{energy} \)}
\]

10. Other radioisotopes undergo **beta decay**. A **beta particle** (symbol: \( \beta \)) is basically the same as an electron. Since the electron has only about \( \frac{1}{2000} \) the mass of a proton or neutron, when beta decay occurs, the mass number \( \) the same. But because the \( \beta \)-particle has a negative charge, the atomic number \( \) by one.

For example, \( \text{C}^{14} \) undergoes beta decay to become \( \text{N}^{14} \):

\[
\text{\( _{6}^{14} \text{C} \rightarrow _{7}^{14} \text{N} + \beta + \text{energy} \)}
\]

Potassium-40 changes into Argon-40 through a beta decay. Show it in the space below, using the example given for Carbon-14:

\[
\_\text{K} \rightarrow \_\text{Ar} + +
\]

11. Some radioactive decay actually involves a series of steps. Each one is either an \( \alpha \) or \( \beta \), but the steps continue until a **stable** isotope is produced. For example, after \( \text{U}^{238} \) changes into \( \text{Th}^{234} \), this atom changes into \( \text{Pa}^{234} \) by **beta decay**. Show this step:

\[
\_\text{Th} \rightarrow \_\text{Pa} + +
\]

The \( \text{Pa}^{234} \) then undergoes an \( \alpha \) decay, and then other steps follow, until finally \( \text{Pb}^{206} \) is created, which is a **stable** isotope. So often chemists only show the original **“parent”** radioisotope and the final stable **“daughter”** radioisotope, like this:

\[
\text{U}^{238} \rightarrow \text{Pb}^{206}.
\]
Introduction to Radioactivity Vocabulary List

Radioactivity

Emit

Isotope

Beneficial

Harmful

Radioactive decay

Chemical elements

Protons

Neutrons

Atomic nucleus (note—not the same as cell nucleus)

Electrons

Atomic number

Mass number

Alpha decay

undergo (undergoes)

decrease

Beta decay

stable isotope

“parent radioisotope”

“daughter radioisotope”