The scientist pictured below is working with radioactive chemicals called isotopes. Not all isotopes are radioactive, but many of them are. To understand why, you first need to know what isotopes are.

What Are Isotopes?

All atoms of the same element have the same number of protons, but some may have different numbers of neutrons. For example, all carbon atoms have six protons, and most have six neutrons as well. But some carbon atoms have seven or eight neutrons instead of the usual six. Atoms of the same element that differ in their numbers of neutrons are called isotopes. Many isotopes occur naturally. Usually one or two isotopes of an element are the most stable and common. Different isotopes of an element generally have the same physical and chemical properties. That's because they have the same numbers of protons and electrons.

An Example: Hydrogen Isotopes

Hydrogen is an example of an element that has isotopes. Three isotopes of hydrogen are modeled in the figure below. Most hydrogen atoms have just one proton and one electron and lack a neutron. These atoms are just called hydrogen. Some hydrogen atoms have one neutron as well. These atoms are the isotope named deuterium. Other hydrogen atoms have two neutrons. These atoms are the isotope named tritium.
Naming Isotopes

For most elements other than hydrogen, isotopes are named for their mass number. For example, carbon atoms with the usual 6 neutrons have a mass number of 12 (6 protons + 6 neutrons = 12), so they are called carbon-12. Carbon atoms with 7 neutrons have atomic mass of 13 (6 protons + 7 neutrons = 13). These atoms are the isotope called carbon-13.

Stability of Isotopes

Atoms need a certain ratio of neutrons to protons to have a stable nucleus. Having too many or too few neutrons relative to protons results in an unstable, or radioactive, nucleus that will sooner or later break down to a more stable form. This process is called radioactive decay. Many isotopes have radioactive nuclei, and these isotopes are referred to as radioisotopes. When they decay, they release particles that may be harmful. This is why radioactive isotopes are dangerous and why working with them requires special suits for protection. The isotope of carbon known as carbon-14 is an example of a radioisotope. In contrast, the carbon isotopes called carbon-12 and carbon-13 are stable.

Summary

- Atoms of the same element that differ in their numbers of neutrons are called isotopes. Different isotopes of an element generally have the same physical and chemical properties because they have the same numbers of protons and electrons.
- Most hydrogen atoms lack a neutron and are just called hydrogen. Hydrogen atoms with one neutron are the isotope known as deuterium, and those with two neutrons are the isotope named tritium.
- For most elements other than hydrogen, isotopes are named for their mass number, which is the number of protons plus neutrons. For example, carbon with a mass number of 14 is called carbon-14.
- Atoms need a certain ratio of neutrons to protons to have a stable nucleus. If they have too many or too few neutrons relative to protons, they are radioactive and will decay to more stable forms. Isotopes with radioactive nuclei are called radioisotopes.

Explore More

At the following URL, watch the video about isotopes of carbon. Then answer the questions below.

- [https://www.youtube.com/watch?v=fx3BqQ44zDE](https://www.youtube.com/watch?v=fx3BqQ44zDE)

1. How does carbon-14 form?

2. Carbon-14 slowly decays over time because it is radioactive. Why does the percent of carbon-14 remain the same in living organisms?

3. How can the percent of carbon-14 in a dead organism be used to estimate the amount of time that has passed since the organism died?
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