Section 7.1.
Atomic Theory, Isotopes, and Radioactive Decay.

Textbook pages 286 to 301.

Before You Read.

Radiation is used for many purposes. What uses of radiation are you already aware of?

What is radioactivity?

Radioactivity is the release of high-energy particles and rays of energy from a substance as a result of changes in the nuclei of its atoms. **Radiation** refers to high-energy rays and particles emitted by radioactive sources, including radio waves, microwaves, infrared rays, visible light, and ultraviolet rays, that are found on the electromagnetic spectrum. **Light** is a form of radiation that humans can see.

What are isotopes?

Isotopes are different atoms of a particular element that have the same number of protons but different numbers of neutrons. The **mass number** of an atom is an integer (whole number) that represents the sum of the atom's protons and neutrons—so isotopes have different mass numbers. The mass number of an isotope is found by adding the atomic number (number of protons) to the number of neutrons.

Mass number **equals** atomic number **plus** number of neutrons

To find the number of neutrons of an isotope, subtract the atomic number from the mass number.

Number of neutrons **equals** mass number **minus** atomic number

How are isotopes represented?

Chemists represent isotopes using standard atomic notation (also called the **nuclear symbol**), a shortened form involving the chemical symbol, atomic number, and mass number. The mass number is written as a superscript (above) on the left.

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of the symbol. The atomic number is written as a subscript (below), also on the left.

The mass number of this potassium isotope is thirty nine. The atomic number is nineteen. An isotope of potassium with a mass number of thirty nine can also be represented as potassium-39, or K-39.

What is radioactive decay?

By emitting radiation, atoms of one kind of element can change into atoms of another element. Radioactive atoms emit radiation because their nuclei are unstable. Unstable atoms gain stability by losing energy. **Radioactive decay** is the process in which unstable nuclei lose energy by emitting radiation. Unstable radioactive atoms undergo radioactive decay and form stable, non-radioactive atoms, usually of a different element.
Radioisotopes are natural or human-made isotopes that decay into other isotopes, releasing radiation.

What different types of radiation are emitted during radioactive decay?

The three major types of radiation are alpha radiation, beta radiation, and gamma radiation. Their properties are summed up table 7.3 (text page 298).

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How is radioactive decay expressed?

Radioactivity results when the nucleus of an atom decays.
There are three radioactive decay processes:

1. Alpha decay: The emission of an **alpha particle** (the same particles found in the nucleus of a helium atom) from a nucleus is a process called **alpha decay.** When a radioactive nucleus emits an alpha particle, the atomic number of the product nucleus is reduced by two, and its mass number by four. However, the sum of the atomic numbers and the sum of the mass numbers on each side of the arrow remain equal.
2. Beta decay: In **beta decay**, a neutron changes into a proton and a **beta particle**, an electron. The proton remains in the nucleus while the electron leaves the nucleus. Since the proton remains in the nucleus, the atomic number of the element increases by one—it has become an atom of the next higher element on the periodic table. However, its mass number does not change, as a proton of almost equal mass has replaced the neutron.
3. Gamma decay: **Gamma decay** results from a redistribution of energy within the nucleus. **Gamma radiation** consists of rays of high-energy, short wavelength radiation. A gamma ray is given off as the isotope changes from a high-energy state to a lower energy state.