2. What Is Ionizing Radiation?

Many kinds of radiation are found in our environment. They include visible radiation (light), radio waves, ultraviolet radiation, and cosmic rays. These are examples of electromagnetic radiation found in the electromagnetic spectrum shown in Figure 1. Other kinds of radiation are particles, emitted by radioactive atoms. One property of radiation, which is important in determining how it affects us, is energy.

Some types of radiation are detectable by our senses. We see visible light, feel ultraviolet radiation when we get sunburned, and feel the warmth of infrared radiation. Radiation that has energy above a certain amount is called "ionizing radiation". Ionizing radiation is not detected by any of our senses, but can be easily detected by electronic equipment. Ionizing radiation is emitted by radioactive atoms. Its energy is high enough to damage our bodies. This Fact Sheet describes ionizing radiation and how it behaves.

➤ Atoms and Ions

To understand ionizing radiation, it is helpful to understand the structure of an atom. An atom is composed of a positively charged nucleus surrounded by negatively charged electrons (see Figure 2). Normally, the number of positive charges (protons) in the nucleus is equal to the number of negative electrons in orbit around the nucleus, and the atom is electrically neutral.

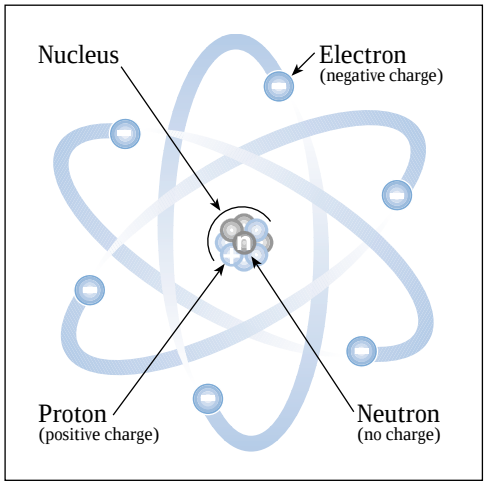

Figure 2. **Structure of an Atom**

If an electron is "knocked" out of its orbit it leaves a positively charged ion. When ionizing radiation passes through anything, it can knock electrons out of their orbits, forming ions; hence its name. Some energy from the ionizing radiation is used up each time an electron is knocked from its orbit.

The formation of ions is important for two reasons. First, if ions are formed in living tissue, such as the human body, they can cause damage. Second, because ions have an electrical charge, they are easy to detect. This makes it possible to measure the amount of radiation present even at extremely low levels, by measuring the ions that are produced.

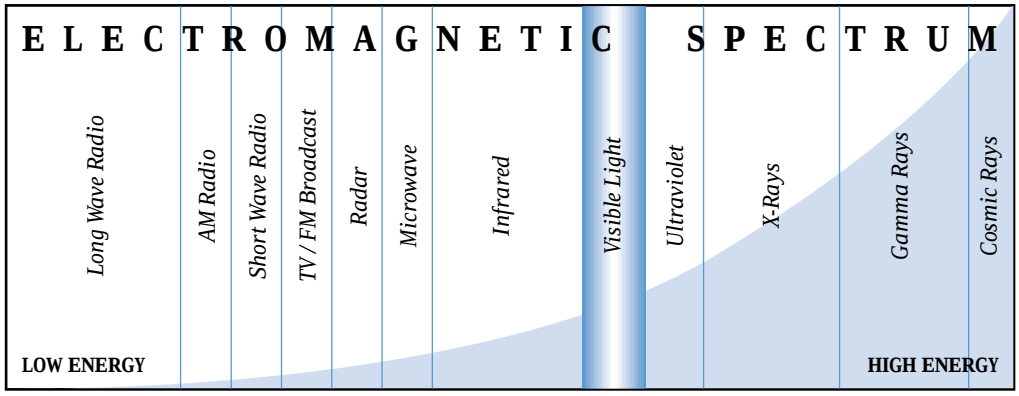

Figure 1. **The Electromagnetic Spectrum**

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Some atoms are unstable. By emitting radiation they change to more stable forms. Three important types of ionizing radiation emitted by radioactive atoms are alpha particles, beta particles, and gamma rays.

➤ Alpha Radiation

Alpha particles are composed of two neutrons with no charge and two positively charged protons, traveling at very high speed. When alpha particles penetrate solid material, they interact with many atoms within a very short distance. They create ions and use up all their energy in that short distance. Most alpha particles will use up their energy while traveling through a single sheet of ordinary notebook paper. The primary health concern associated with alpha particles is that when alpha-emitting materials are ingested or inhaled, energy from the alpha particles is deposited in internal tissues such as the lungs.

➤ Beta Radiation

Beta particles are high-speed electrons that are not attached to atoms. They are small - over 7,000 times lighter than alpha particles. The beta particles travel farther through solid material than alpha particles. For example, a very high-energy beta particle will travel about half an inch through plastic before it uses up all its energy. Like alpha particles, beta particles lose energy with every interaction and no longer produce ions once all their energy is spent. Health concerns associated with beta particles arise primarily when beta-emitting materials are ingested or inhaled.

➤ Gamma Radiation

Gamma rays are electromagnetic, much like X-rays, and can pass completely through the human body. Thus gamma rays emitted from outside of the body may cause ionization, and possible health effects, in any organ in the body. But once a gamma ray loses all its energy, it can no longer cause damage. High energy gamma rays will lose most of their energy in a few feet of soil, three feet of concrete, or six inches of lead.

➤ For More Information

If you would like to read more about ionizing radiation, some of the references and other Fact Sheets listed below may be helpful.

- American Chemical Society, *Chemistry in the Community*, 2nd edition, Kendall/Hunt Publishing Company, 1988. (Fifth section of the book, *Nuclear Chemistry in Our World*, discusses radiation)
- Raymond L. Murray, *Understanding Radioactive Waste*, Battelle Press, 4th Edition 1994 .
- James E. Turner, *Atoms, Radiation and Radiation Protection*, 2nd edition, John Wiley & Sons, Inc., 1995
- Other Fact Sheets:

  #1. What Is Radioactive Material?

  #3. What Are the Sources of Ionizing Radiation?

  #6. How Are People and the Environment Protected from Ionizing Radiation?

  #7. What are the Health Effects of Ionizing Radiation?

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