1. Atomic Theory Describes Isotopes and Radioactive Decay
   - Radiation refers to high-energy rays and particles emitted by radioactive sources.
   - Isotopes are atoms of the same element that differ in the number of neutrons that they possess; isotopes of an element have the same atomic number but different mass number.
   - Radioisotopes are natural or human-made isotopes that decay into other isotopes, releasing radiation.
   - The three major types of radiation are alpha (helium nucleus), beta (fast-moving electron), and gamma (high-energy electromagnetic radiation).
2. A Half-Life Can Be Used to Describe the Rate of Radioactive Decay of an Isotope
   - All radioactive decay rates follow a similar pattern called a decay curve.
   - A half-life measures the time needed for half the radioisotopes in a sample to decay. The half-life is a constant that does not change regardless of the amount of a given radioisotope that is present.
   - Carbon dating is a method of absolute dating of the remains of organisms based on carbon-12 to carbon-14 ratios, to a maximum of 50 000 years in the past.
   - The Common Isotope Pairs Chart relates parent and daughter isotopes, half-life of parent and the effective dating range that a given isotope pair is useful for.
3. Nuclear Reactions Can Be Described as Fission or Fusion
   - Fission reactions cause changes to the nucleus involving the splitting of a more massive nucleus, releasing two lower mass nuclei as well as other particles and energy.
   - Fission reactions can be induced by colliding some large nuclei such as uranium-238 with neutrons or other small particles.
   - Fission reactions are used in nuclear powered generating stations (and were used in the first atomic weapons).
   - Fusion reactions are the result of two lower mass nuclei fusing to form a new, more massive one. Fusion reactions can release large amounts of energy.
   - The Sun's energy is produced through nuclear fusion reactions at its core, mostly involving isotopes of hydrogen.
   - Modern nuclear weapons use fission reactions involving uranium or plutonium to ignite fusion reactions involving hydrogen. The fusion reaction releases most of the energy.

## CHAPTER REVIEW ANSWERS

### Checking Concepts

1. Radiation refers to high-energy rays and particles emitted by radioactive sources.
2. Radioisotopes are natural or human-made isotopes that decay into other isotopes, releasing radiation.
3. (a) Alpha, beta, gamma
   (b) Alpha particles are helium nuclei, beta particles are fast-moving electrons, and gamma rays are high-energy electromagnetic radiation.
   (c) Alpha particles have a 2+ charge, beta particles have a 1– charge, and gamma rays have no charge.
4. $^{4}_{2}\alpha$ or $^{4}_{2}\mathrm{He}$
5. (a) They have the same number of protons (12 each).
   (b) They have differing numbers of neutrons (12 and 14).
6. Proton
7. Protons and neutrons
8. A beta particle is an electron, which has a negative charge.
9. With the loss of an alpha particle, a nucleus loses two protons and two neutrons. With a different number of protons, the new nucleus is a different element.
10. (a) 

    (b) 

    (c) 

    (d) 

    (e)