Name _____ Class _____ Date _____

Chapter 10 Nuclear Chemistry

Summary

10.1 Radioactivity

- **Radioactivity** is the process in which an unstable atomic nucleus emits charged particles and energy.
- Any atom containing an unstable nucleus is called a radioactive isotope, or **radioisotope** for short.

During nuclear decay, atoms of one element can change into atoms of a different element altogether.

- When the composition of a radioisotope changes, the radioisotope is said to undergo nuclear decay.

Common types of nuclear radiation include alpha particles, beta particles, and gamma rays.

- **Nuclear radiation** is charged particles and energy that are emitted from the nuclei of radioisotopes.
- An **alpha particle** is a positively charged particle made up of two protons and two neutrons.
- A **beta particle** is an electron emitted by an unstable nucleus.
- A **gamma ray** is a penetrating ray of energy emitted by an unstable nucleus.
- Nuclear radiation that occurs naturally in the environment is called **background radiation.**

Nuclear radiation can ionize atoms.

- Alpha particles, beta particles, and gamma rays are all forms of ionizing radiation.

Devices that are used to detect nuclear radiation include Geiger counters and film badges.

10.2 Rates of Nuclear Decay

Unlike chemical reaction rates, which vary with the conditions of a reaction, nuclear decay rates are constant.

- A **half-life** is the time required for one half of a sample of a radioisotope to decay. Half-lifes can vary from fractions of a second to billions of years.
- Most materials contain at least trace amounts of radioisotopes. By looking at the rate of nuclear decay for these isotopes, scientists can estimate how old the materials are.

In radiocarbon dating, the age of an object is determined by comparing the object's carbon-14 levels with carbon-14 levels in the atmosphere.

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10.3 Artificial Transmutation

Scientists can perform artificial transmutations by bombarding atomic nuclei with high-energy particles such as protons, neutrons, or alpha particles.

- **Transmutation** is the conversion of atoms of one element to atoms of another. It involves a nuclear change, not a chemical one.

Scientists can synthesize a transuranium element by the artificial transmutation of a lighter element.

- Elements with atomic numbers greater than 92 (uranium) are called **transuranium elements.**
- A **quark** is a subatomic particle theorized to be among the basic units of matter.

10.4 Fission and Fusion

Over very short distances, the strong nuclear force is much greater than the electric forces among protons.

- The **strong nuclear force** is the attractive force that binds protons and neutrons together in the nucleus. This force does not depend on charge.
- **Fission** is the splitting of an atomic nucleus into two smaller parts.

In nuclear fission, tremendous amounts of energy can be produced from very small amounts of mass.

- In a **chain reaction,** neutrons released during the splitting of an initial nucleus trigger a series of nuclear fissions.
- A **critical mass** is the smallest possible mass of a fissionable material that can sustain a chain reaction.
- **Fusion** is a process in which the nuclei of two atoms combine to form a larger nucleus. During fusion, a small fraction of the reactant mass is converted into energy.
- **Plasma** is a state of matter in which atoms have been stripped of their electrons. Plasmas occur only at very high temperatures.

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