

Nuclear Chemistry— Experiment Summaries and Concepts



Up in the Clouds—Detecting Nuclear Radiation

Just as “seeding” a cloud with crystals produces rain or snow, passing ionizing radiation through a chamber saturated with vapor leaves a trail of liquid droplets in its wake. Students compare the general properties of alpha and beta radiation by studying the “cloud tracks” (condensation trails) produced by these particles in a cloud chamber. Lantern mantles, which are sold for consumer use with portable gas camping lanterns, provide a safe source of low-level nuclear radiation for this experiment.

Natural Radiation—Activity and Half-life of Potassium-40

Most people think of nuclear radiation as an artificial or man-made danger. There are, however, numerous natural sources of low-level nuclear radiation in our lives. Natural sources of “background” radiation include cosmic rays from the sun and radon in the atmosphere. Potassium, one of the most abundant minerals on the Earth, is present in most foods and is an essential element in the human body. It is also a major source of natural radiation! The purpose of this experiment is to measure the activity (counts per minute) of nuclear radiation from potassium chloride and to determine the half-life of the radioactive potassium-40 isotope.



Properties of Nuclear Radiation—Penetrating Power of α , β , and γ Radiation

Although potentially very harmful to living organisms, nuclear radiation has been adapted for many beneficial purposes, including the diagnosis and treatment of disease. How do workers in nuclear medicine facilities protect themselves from the harmful effects of nuclear radiation? Students measure the amount of radiation emanating from low-level, sealed sources of alpha, beta, and gamma radiation, compare their ability to “penetrate” matter, and investigate the radiation protection provided by distance and shielding.



Half-life Simulation—The Probability of Random Events

Roll the dice! Radioactive decay is a spontaneous and completely random process. There is no way to predict how long it will take a specific unstable nucleus to disintegrate and produce a new atom. The probability, however, that a specific atom will decay after a certain period of time can be simulated by studying other random processes. The purpose of this activity is to model the process of radioactive decay by studying the “decay curve” for dice. (Dice “decay” when they land on a predetermined “decay number.”) The “half-life” is then determined by graphing the number of dice remaining after each roll of the dice.

Carbon Dating Activity—It’s a Puzzle

Archeologists have been able to reconstruct a great deal of ancient cultural history by “dating” a variety of artifacts—everything from nutshells to parchment maps—by radiocarbon dating. Use this great puzzle activity to help students learn the basic principles of carbon-14 dating. Students “piece together” the process of carbon-14 dating by arranging a set of story and picture tiles in a logical sequence to form a narrated story board.

Concepts

- Nuclear radiation
- Alpha, beta, and gamma radiation
- Ionizing radiation
- Cloud chamber

- Radioactivity
- Nuclear decay equations
- Geiger-Müller radiation detector
- Half-life

- Alpha, beta, and gamma radiation
- Ionizing radiation
- Penetrating power
- Shielding

- Radioactive decay
- Half-life
- First-order rate
- Probability

- Cosmic rays
- Radioactive decay
- Half-life
- Isotope ratios