Nuclear Chemistry—Preface

Locked within the nucleus of the atom is a source of tremendous energy. The 20th century showed us that the power of nuclear chemistry could be devastating. It also demonstrated, however, that the principles of radioactive decay and nuclear chemistry could be applied to benefit mankind—to generate energy, diagnose disease, and determine the structure of the human genome. The purpose of *Nuclear Chemistry,* Volume 18 in the Flinn ChemTopic™ Labs series, is to provide high school chemistry teachers with laboratory activities that will help students understand the basic principles of radioactivity and become more informed citizens. Five experiments and four demonstrations allow students to determine the properties of nuclear radiation, investigate sources and levels of natural background radiation, study the process of radioactive decay, and understand how distance and shielding can be used to reduce the level of radiation exposure.

Introduction to Nuclear Chemistry

For many students, high school chemistry class may be the only "exposure" they will ever have to nuclear chemistry! Our democracy requires that all citizens participate in the decision-making with respect to the important issues that face our society. Is it safe to live near a nuclear power plant? What are the dangers associated with transporting or storing nuclear waste? When does the radiation risk from nuclear medicine outweigh the potential benefit? There are several obstacles to overcome for both students and teachers in learning about nuclear chemistry. Many people think of nuclear radiation as an artificial or man-made danger. The myriad of measurements and units that are used to characterize nuclear radiation are unfamiliar and confusing. The *Introduction to Nuclear Chemistry* section in this book has three short lesson plans, including worksheets, which allow teachers to address these issues. "Sources of Natural Radiation" provides basic information about sources and levels of background radiation. The symbolic language in "Writing Nuclear Decay Equations" helps students develop the conceptual framework to understand nuclear processes. The examples in the accompanying worksheet reinforce awareness of consumer applications of nuclear chemistry. Nuclear radiation measurements are summarized in "Units of Radioactivity and Radiation." The worksheet calculations provide important safety information regarding the use of sealed, low-level sources of nuclear radiation in this book. (See "Properties of Nuclear Radiation" and "Quantitative Shielding.") The average radiation "dose" from working with these sources is less than 1 mrem per hour, which is comparable to watching TV for a year.

Properties of Nuclear Radiation

In "Up in the Clouds," students compare the general properties of alpha and beta radiation by studying the condensation trails produced by these particles in a cloud chamber. This is a very affordable experiment, and using a consumer item (a lantern mantle) as the radiation source avoids any controversy that might arise from working with "artificial" radiation. "Properties of Nuclear Radiation" provides a more in-depth experimental study. Students measure the amount of radiation emanating from alpha, beta, and gamma radiation sources with a radiation detector and compare the "penetrating" ability of different forms of nuclear radiation. Looking at the effect of distance and shielding on radiation intensity helps students understand the basic principles of radiation safety.

Radioactive Decay and Half-life

Potassium, one of the most abundant minerals on Earth, is present in most foods and is an essential element in the human body. It is also a major source of background radiation. In "Natural Radiation," students measure the rate of radioactive decay of potassium chloride and determine the half-life of the radioactive potassium-40 isotope. Radioactive decay is a spontaneous and completely random process. The probability that a specific unstable nucleus will decay within a certain period of time can be simulated by studying another random process—rolling dice! Rolling dice in the "Half-life Simulation" provides a fun, alternative way for students to learn how half-lives are determined. There is also a great "Carbon Dating Activity" puzzle that will help students "piece together" the process by which radioactivity is used to date historical and cultural artifacts.

Safety and Creativity

Nuclear Chemistry offers the high school chemistry teacher a wide selection of classic experiments, safe adaptations, and creative simulations to investigate the principles and applications of this important subject. The hands-on and "minds-on" activities in this book—combined with complete sample data and teachers notes—give you the opportunity to engage your students and increase their knowledge and understanding of the role of nuclear chemistry in their lives. All of the experiments and demonstrations in Nuclear Chemistry have been thoroughly tested and retested. You know they will work! Use the experiment summaries and concepts on the following pages to locate the concepts you want to teach and to choose experiments and demonstrations that will help you meet your goals.

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