ARISE Curriculum Guide

Chemistry: Topic 5—Radioactivity, Fusion, Fission

ChemMatters

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Articles for Student Use

The Birth of the Elements: Oct. 2000, pp. 4-5.
Bringing Helium Down to Earth: Oct. 1985, pp. 14-15.
Carbon-14 Dating: Feb. 1989, pp. 12-15.
Happy Birthday Helium: Dec. 1995, p. 12.
Hydrogen and Helium: Oct. 1985, pp. 4-7.
Positron Emission Tomography Scan: Feb. 1994, pp. 12-15.
Radioactivity: It's a Natural: April 2000, pp. 6-9.
Should Food be irradiated? April 1999, p. 16.
Volcanoes-Forecasting the Fury: Dec. 1999, pp. 12-13.

Articles for Teacher Use

Number and Topic:	4. Atomic Structure 5. Radioactivity, Fusion, Fission
Source:	*ChemMatters*, Oct. 2000, pp. 4-5, "The Birth of the Elements"
Type of Material:	Student Journal Article
Building on:	Atomic Structure
Leading to:	Fusion, stellar synthesis of elements
Links to Physics:	Matter, energy, gravity, sun, atoms, subatomic particles, nuclear
Links to Biology:	Evolution
Good Stories:	
Activity Description:	The article deals with the origins of the elements, starting with hydrogen and helium and then to the stellar synthesis of heavier elements and on to the formation of even heavier elements in events such as supernovae.

Number and Topic:	**4. Atomic Structure** **5. Radioactivity, Fusion, Fission**
Source:	*ChemMatters*, April 2000, pp. 6-9, "Radioactivity: It's a Natural"
Type of Material:	Student Journal Article containing a personal worksheet for estimating your personal annual radiation dose
Building on:	Atomic Structure
Leading to:	Radioactivity
Links to Physics:	Nuclear, radioisotopes, subatomic particles
Links to Biology:	Cells, growth and reproduction
Good Stories:	Contains a nice worksheet and some good information about the amount of radioactivity in cigarette smoke.
Activity Description:	Article treats radioactivity, what it is, how it is produced, the most common types (alpha, beta, gamma), and their characteristics. It presents some of the history behind the discovery and characterization of radioactivity, the sources of radioactivity in our environment, the possible biological effects of exposure, and ends with the worksheet.

Number and Topic:	**4. Atomic Structure** **5. Radioactivity, Fusion, Fission** **7. Moles**
Source:	*ChemMatters*, Oct. 1985, pp. 14-15, "Bringing Helium Down to Earth"
Type of Material:	Student Journal Article
Building on:	Basic chemical knowledge
Leading to:	Spectroscopy, radioactivity, subatomic particles, properties of noble gases, Rutherford's scattering experiment, transmutation of elements, determination of Avogadro's number
Links to Physics:	The sun, light, electromagnetic spectrum, subatomic particles
Links to Biology:	
Good Stories:	
Activity Description:	This article presents the history behind the discovery of helium, first in the sun and later on earth. It continues to discuss the transmutation of elements and how Ernest Rutherford determined Avogadro's number.

Number and Topic:	**5. Radioactivity, Fusion, Fission** **8. Chemical Reactions** **12. Gases/Gas Laws/Kinetic Theory**
Source:	*ChemMatters*, Dec. 1999, pp. 12-13, "Volcanoes—Forecasting the Fury"
Type of Material:	Student Journal Article
Building on:	Gases, Radioactivity, chemical reactions
Leading to:	Viscosity, pH, acid rain
Links to Physics:	Heat, nuclear, radioisotopes
Links to Biology:	
Good Stories:	Relates the story of Mt. St. Helens explosion of 1980.
Activity Description:	Discusses volcanic eruptions, how and why they occur and their links to topics such as acid rain.

Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	*ChemMatters*, April 1999, p. 16, "Should Food be Irradiated?"
Type of Material:	Student Journal Article
Building on:	Radioactivity
Leading to:	Effect of radiation on molecular structures
Links to Physics:	Atoms, subatomic particles
Links to Biology:	Effect of radiation on molecules contained in meat
Good Stories:	
Activity Description:	Article nicely explains what happens when food is irradiated and tries to dispel irrational fears based on inaccurate science.

Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	*ChemMatters*, Oct. 1998, pp. 13-15, "The Radium Girls. Dialing up Trouble"
Type of Material:	Student Journal Article
Building on:	Atoms
Leading to:	Nuclear reactions, radioactivity
Links to Physics:	Atoms, subatomic particles, radioisotopes
Links to Biology:	Cells, mutations, DNA
Good Stories:	Tells about the "radium girls" who painted the hands of watches with radium salts and the terrible physical consequences they suffered because of their absorption of radioactive alpha emitters into their bodies.
Activity Description:	Article deals with both the human and the science side of this terrible tragedy.

Number and Topic:	**5. Radioactivity, Fusion, Fission** **6. Chemical Names and Formulas/Compounds and Elements** **14. Periodicity/Periodic Law/Metals, Non-metals and Families**
Source:	*ChemMatters*, Dec. 1995, p. 12, "Happy Birthday Helium"
Type of Material:	Student Journal Article
Building on:	Elements
Leading to:	Spectroscopy
Links to Physics:	Electromagnetic spectrum, sun, atoms
Links to Biology:	
Good Stories:	Relates how helium was discovered in the sun before it was actually discovered on earth!
Activity Description:	Article relates the discovery of helium, its source on earth, and some of its very unusual properties.

Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	*ChemMatters*, Feb. 1994, pp. 12-15, "Positron Emission Tomography Scan"
Type of Material:	Student Journal Article
Building on:	Radioactivity, radioisotopes
Leading to:	Biological processes that occur in the human brain
Links to Physics:	Radioisotopes
Links to Biology:	The human brain, nerve synapses, cocaine addiction
Good Stories:	Relates the physiological bases for cocaine addiction.
Activity Description:	Article describes how a PET scan works, how it generates the images that it does, and how these kinds of images can be used to determine what is going on inside a human body at the time it is actually occurring.

Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	*ChemMatters*, Feb. 1989, pp. 12-15, "Carbon-14 Dating"
Type of Material:	Student Journal Article
Building on:	Isotopes
Leading to:	Nuclear reactions, radioactive decay
Links to Physics:	Nuclear, atoms, radioisotopes, subatomic particles
Links to Biology:	The carbon cycle
Good Stories:	
Activity Description:	Article explains what C-14 dating is, how and why it works, its accuracy, and gives several practical examples of its application.

Number and Topic:	**5. Radioactivity, Fusion, Fission** **21. Organic Chemistry**
Source:	*ChemMatters*, Oct. 1985, pp. 4-7, "Hydrogen and Helium"
Type of Material:	Student Journal Article
Building on:	Basic properties of hydrogen and helium, atomic and molecular weights,
Leading to:	Archimedes' Principle
Links to Physics:	Abundance of hydrogen and helium in the universe, gravity, the sun
Links to Biology:	
Good Stories:	The Hindenburg disaster
Activity Description:	This article discusses the properties uses and potential uses of hydrogen and helium.

Flinn ChemTopic Labs

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Computer Lab: Problem-Based Learning with the PAX Nuclear Reactor
Lab: Alpha, Beta and Gamma Radiation

ICE LABS

Online Descriptions and Experiments

No activities for this topic.

Technology-Adapted Labs

Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	Bill Grosser, Glenbard South High School
Type of Material:	Computer Lab: Problem-Based Learning with the PAX Nuclear Reactor
Building on:	Isotopes, atomic structure
Leading to:	Applied science/technology, science literacy, and nuclear chemistry
Links to Physics:	Atomic structure, isotopes, and transfer of energy
Links to Biology:	Nuclear waste, effects of radiation
Good stories:	Links to Chernobyl, Three Mile Island. Great opportunities to discuss the pros and cons of a complicated issue.
Activity Description:	The PAX nuclear reactor simulator is freeware that originated back around 1990. The software was developed by Penn State University to train their nuclear engineering students. The software presents students with a pressurized water reactor control room. Algorithms in the software actually allow the students to simulate running the fission reactor, generating electricity, and also to monitor many of the vital functions of the plant. (Handouts, software, screenshots and sample student projects are attached in the problem based learning section.) The software is old but can't be beat! Students can learn to run the reactor in a half-hour then can experiment on the reactor using open-ended problems indefinitely.
Inquiry Driven**:**	The software can hook students of all levels into wanting to learn exactly how a nuclear power plant works. After their first try students either generate miniscule amounts of power or drive the plant to emergency shutdown mode. After their first experience students are begging to know exactly what the primary and secondary loops are, how boron affects the plant, exactly what role the control rods play, how the core temperature and change in water temperature affect power output, etc.
Interactive Nuclear Labs**:**	The entire topic of nuclear chemistry is tough to incorporate a lot of lab activities. This is a great way to get out of the lecture and worksheet mode and into the experiential mode.
Problem Based Learning**:**	This software provides a great opportunity to incorporate a problem based learning activity into the existing curriculum. A number of partially defined problems, such as "What is the maximum power output of the plant?" can be given to the students to explore. Students must first decide what constitutes "maximum output." A one-time spike, a sustainable output, etc. Students design experiments that can be run on the plant, collect and graph data, use math skills to analyze the data, then present their findings to the class.
Technology**:**	This is a great example of how technology can be used to involve students in a truly interactive activity that otherwise would not be possible.

Moral:	Use technology when it fits and enhances the curriculum. Problem-based learning is one of many great teaching methods and is a perfect fit for this activity. Any new course should strive to blend in different types of learning experiences and different types of teaching styles.
Number and Topic:	**5. Radioactivity, Fusion, Fission**
Source:	*ChemCom*, Fourth Edition, Unit 6: Nuclear Interactions, Section B, Lab Activity B.4, p. 434. Bill Grosser, Glenbard South High School
Type of Material:	Lab: Alpha, Beta and Gamma Radiation
Building on:	Radiation
Leading to:	Transmutations, half-life labs, background radiation
Links to Physics:	Atomic structure
Links to Biology:	Biological effects of radiation exposure
Good stories:	Excellent way to bring in discussion of Yucca Mountain, spent fuel storage, medical uses of radiation, etc.
Activity Description:	This is a three-part lab that explores basic behavior of alpha, beta and gamma radiation by collecting data using a Vernier radiation probe and Excel graphing software. Part 1: Explores the effect of distance on radiation levels. Part 2: Compares the penetrating ability of alpha, beta and gamma radiation sources. Part 3: Explores methods of radiation shielding.
Technology:	Radiation monitors are expensive, but this lab lends itself to being done effectively as a class lab or interactive demonstration. Using a projection device and **one computer** in the classroom, the teacher can project the meter so the entire class can view and record the data. I have found that general to lower level students enjoy doing interactive demos such as this with the entire class. Excel or other simple graphing programs can be used to prepare graphs of the data. This is a great lab/interactive demo. It engages the students and can be enhanced significantly using only one computer in a classroom.