ARISE Curriculum Guide

Chemistry: Topic 4—Atomic Structure

ChemMatters

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Articles for Student Use

An Atomic Tour: Oct. 1983, pp. 4-7.
The Birth of the Elements: Oct. 2000, pp. 4-5.
Bringing Helium Down to Earth: Oct. 1985, pp. 14-15.
Chemiluminescence: Oct. 1995, pp. 12-15.
CO Control: On the Street, In the House, Where You Live: Oct. 1997, pp. 10-12.
The Color of Gems: Dec. 1988, pp. 7-9.
Colors Bursting in Air: Oct. 1998, pp. 7-9.
Lasers: April 2003, pp. 2-3.
A Light of a Different Color: April 1999, pp. 4-7.
Light Your Candy: Oct. 1990, pp. 10-12.
Luminol. Casting a Revealing Light on Crime: Dec. 2001, pp. 12-13.
Memory Metal: Oct. 1993, pp. 4-7.
Nanotechnology, The world of the super small: Dec. 2002, pp. 9-13.
Radioactivity: It's a Natural: April 2000, pp. 6-9.
The Radium Girls. Dialing up Trouble: Oct. 1998, pp. 13-15.
Spectroscopy: Sensing the Unseen: Sep. 2001, pp. 4-6.
Superconductivity: Oct. 1987, pp. 18-21.

Articles for Teacher Use

Number and Topic:	2. Measurement 4. Atomic Structure
Source:	*ChemMatters*, Dec. 2002, pp. 9-13, "Nanotechnology, The world of the super small"
Type of Material:	Student Journal Article
Building on:	Matter and change, measurement, atomic structure
Leading to:	Electrons in atoms, bonding
Links to Physics:	Matter, quantum theory, subatomic particles
Links to Biology:	Proteins
Good Stories:	Entire article is a "good story."
Activity Description:	A very good introduction to the general area of nanotechnology for the general student. Describes, in fairly simple and clear terms, both the theoretical foundation and practical applications.

Number and Topic:	**4. Atomic Structure** **13. Electrons in Atoms**
Source:	*ChemMatters*, April 2003, pp. 2-3, "Lasers"
Type of Material:	Student Journal Article
Building on:	Atomic structure
Leading to:	Electron transitions in atoms—emission of photons
Links to Physics:	Light, Atoms, Electromagnetic spectrum
Links to Biology:	
Good Stories:	
Activity Description:	Article discusses lasers, both the scientific principles behind their operation and their technological design.

Number and Topic:	**4. Atomic Structure** **8. Chemical Reactions** **21. Organic Chemistry**
Source:	*ChemMatters*, Dec. 2001, pp. 12-13, "Luminol. Casting a Revealing Light on Crime"
Type of Material:	Student Journal Article
Building on:	Atomic structure, chemical reactions
Leading to:	Organic chemistry
Links to Physics:	Electromagnetic spectrum
Links to Biology:	Living matter, composition of blood
Good Stories:	Luminol can be used to detect the possible presence of blood at a crime scene.
Activity Description:	Article describes how luminol reacts with blood (and other substances) and how the reaction produces a product whose electrons are in a high energy state but then fall to a lower state with the emission of visible light.

Number and Topic:	**4. Atomic Structure** **13. Electrons in Atoms** **16. Covalent Bonds, Molecular Shapes and Intermolecular Forces**
Source:	*ChemMatters*, Sep. 2001, pp. 4-6, "Spectroscopy: Sensing the Unseen"
Type of Material:	Student Journal Article
Building on:	Atomic Structure
Leading to:	Discussion of how electromagnetic radiation allows us to detect the presence of different molecules in the atmosphere
Links to Physics:	Electromagnetic spectrum, atoms, light, motion and forces
Links to Biology:	Except that the atmosphere is a very important part of our ecosystem, and any change in the atmosphere can have significant effects upon life on earth.
Good Stories:	
Activity Description:	The article discusses the electromagnetic spectrum and how the interaction of light with matter can be used to detect and measure gases present in earth's atmosphere. This is then connected to the NASA EOS-Aura project, a project that will launch a satellite that will carry four state-of-the-art instruments designed to make sophisticated measurements of earth's atmosphere.

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**
Source:	*ChemMatters*, April 1999, pp. 4-7, "A Light of a Different Color"
Type of Material:	Student Journal Article
Building on:	Atomic Structure
Leading to:	Electrons in atoms, emission of light, fluorescence, phosphorescence, triboluminescence
Links to Physics:	Electromagnetic spectrum, atoms, kinetic and potential energy, light
Links to Biology:	
Good Stories:	Shows how Wint-O-Green Lifesavers exhibit the property of triboluminescence.
Activity Description:	Discusses the difference between fluorescence, phosphorescence, and triboluminescence. Explains what they are and how they arise as well as some practical applications of these phenomena.

Number and Topic:	**4. Atomic Structure** **8. Chemical Reactions** **11. Thermochemistry** **22. Redox/Electrochemistry**
Source:	*ChemMatters*, Oct. 1998, pp. 7-9, "Colors Bursting in Air"
Type of Material:	Student Journal Article
Building on:	Atomic structure, electron transitions in atoms
Leading to:	Redox
Links to Physics:	Electromagnetic spectrum, light, electrons
Links to Biology:	
Good Stories:	
Activity Description:	Article discusses the chemistry and electron transitions that produce the colors seen in fireworks.

Number and Topic:	**4. Atomic structure** **8. Chemical Reactions** **13. Electrons in Atoms**
Source:	*ChemMatters*, Oct. 1995, pp. 12-15, "Chemiluminescence, the Cold Light"
Type of Material:	Student Journal Article
Building on:	Electromagnetic spectrum, chemical reactions, electrons in atoms
Leading to:	Organic chemistry
Links to Physics:	Atoms, electromagnetic spectrum, light
Links to Biology:	Bacteria, bioluminescence
Good Stories:	Several interesting stories of how specific organisms utilize bioluminescence in their daily quests for survival.
Activity Description:	Article deals with the entire subject of chemiluminescence. It details the kinds of chemical reactions typically involved, presenting specific examples and several practical applications of the phenomenon both in nature and in medicine.

Number and Topic:	**4. Atomic Structure** **13. Electrons in Atoms**
Source:	*ChemMatters*, Oct. 1990, pp. 10-12, "Light Your Candy"
Type of Material:	Student Journal Article
Building on:	Atomic structure
Leading to:	Energy levels and changes in atoms and molecules
Links to Physics:	Electromagnetic spectrum, quantum theory, energy, light, electrons
Links to Biology:	
Good Stories:	
Activity Description:	Article describes the phenomenon of triboluminescence and how and why the common Wint-O-Green Lifesaver exhibits this phenomenon.

Number and Topic:	**4. Atomic Structure** **13. Electrons in Atoms**
Source:	*ChemMatters*, Dec. 1988, pp. 7-9, "The Color of Gems"
Type of Material:	Student Journal Article
Building on:	Atomic structure
Leading to:	Electron configurations, electron transitions within atoms, crystal structures
Links to Physics:	Quantum theory, atoms, electrons, light, electromagnetic spectrum
Links to Biology:	
Good Stories:	
Activity Description:	Article discusses why certain gems exhibit the colors that they do and gets into the electron configurations of atoms and electron transitions between orbitals.

Number and Topic:	**4. Atomic Structure** **13. Electrons in Atoms**
Source:	*ChemMatters*, Oct. 1987, pp. 18-21, "Superconductivity"
Type of Material:	Student Journal Article
Building on:	Atomic structure and normal electrical conductivity
Leading to:	Mechanism of superconductivity
Links to Physics:	Electrons, electricity, electrical conductivity
Links to Biology:	
Good Stories:	
Activity Description:	Article describes the history of superconductivity and then attempts to present an explanation of this most unusual and counterintuitive phenomenon.

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:	**4. Atomic Structure** **6. Chemical Names and Formulas/Compounds and Elements** **10. Phases, Solids, Liquids and Gases (States of Matter)** **12. Gases/Gas Laws/Kinetic Theory** **16. Covalent Bonds, Molecular Shapes and Intermolecular Forces** **17. Water, Aqueous Solutions**
Source:	*ChemMatters*, Oct. 1983, pp. 4-7, "An Atomic Tour"
Type of Material:	Student Journal Article
Building on:	Basic knowledge of atomic and molecular structures
Leading to:	Modeling, molecular motions, Bolzmann's distribution, composition of air, structure of water, polarity, hydrogen bonds, structure of ice
Links to Physics:	
Links to Biology:	
Good Stories:	
Activity Description:	This article, written by the late Isaac Asimov, takes the reader on an imaginary journey where he/she becomes smaller and smaller until he/she can see individual atoms and molecules. The article goes on to describe several molecular structures and motions.

Number and Topic:	**4. Atomic Structure** **10. Phases, Solids, Liquids and Gases (States of Matter)** **15. Ionic and Metallic Bonds**
Source:	*ChemMatters*, Oct. 1993, pp. 4-7, "Memory Metal"
Type of Material:	Student Journal Article
Building on:	Atomic structure, phases
Leading to:	Crystal structures
Links to Physics:	Matter
Links to Biology:	Medical applications of nitinol metal
Good Stories:	How nitinol metal was used to repair shoulder problems in Los Angeles Dodgers pitcher Orel Hershiser.
Activity Description:	Article deals with Nitinol metal, the "memory" metal that returns to any shape that it was initially set in upon heating—even if it has been twisted or bent into a completely different shape. Article explains why this amazing phenomenon occurs and also shows several practical uses of this unusual property.

Flinn ChemTopic Labs

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Activity: Quantum Numbers (with an inquiry twist)
Demo: The Think Tube—A Black-Box Demonstration
Demo: Energy in Photons—Light Energy Demonstration
Demo: The Photoelectric Effect—Light Energy Demonstration
Demo: Measuring the Size of a Molecule
Demo: Mapping Atomic Structure—Building a Scale Model
Demo: Excited States—A Musical Demonstration
Lab/ Activity: Bean Bag Isotopes—Relative Abundance and Atomic Mass
Lab/Activity: Atomic Target Practice—Rutherford Scattering and the Nuclear Atom
Lab/Activity: Quantum Leap Lab—Probability and Electron Structure
Lab: Flame Tests—Atomic Emission and Electron Energy Levels
Lab: Atomic Spectra—Light, Energy, and Electron Structure
Lab: Atomic Coatings—The Size of an Atom

ICE LABS

Online Descriptions and Experiments

No activities for this topic.

Technology-Adapted Labs

Number and Topic: **4. Atomic Structure**
Source: Bill Grosser, Glenbard South High School
Type of Material: Activity: Quantum Numbers (with an inquiry twist)
Building on: Basic structure of atom
Leading to: Electron orbitals, molecular shapes, valence electrons etc.
Links to Physics: Builds on basic atomic structure
Activity Description: Concrete sequential thinking. Students and lecture-based instructors love teaching and learning about quantum numbers. Present the rules, memorize the rules, and repeat the rules. This is remembering, not thinking! Many students are simply bored off their chairs. The solution . . . turn the introduction to quantum numbers to an inquiry-based/pattern recognition activity where the kids construct in their own minds the rules for placing electrons into energy levels.

The Set up/Materials Required: Place a giant laminated blank periodic table that contains only symbols and atomic numbers across the front board. Students receive a copy of a similar blank table to work with.

The Rule: Students must be called on to share all ideas. Shouting out answers is not allowed during the activity. This allows the teacher to let the lesson progress at a rate that allows thinking to continue by the majority of students, even after a few pick up the patterns.

A Typical Lesson/Dialog:

Teacher: Today we are going to continue our investigation of how atoms are constructed. So far we know that protons and neutrons make up the nucleus and electrons orbit the nucleus. The question today is "where exactly do all those electrons reside?" To describe the location or "address" of electrons, electron configurations are used. For example, let's start with hydrogen. How many electrons does a neutral atom of hydrogen have?

Students: *1*

Teacher: Excellent, and this is the address where that electron resides. (Teacher writes a large 1s1 on the hydrogen square.) Everyone get it . . . good. (At this point the complaining starts as they all are completely lost.) Let's move on to helium . . . (Usually under much protest.) Helium has how many electrons?

Students: *2*

Teacher: Great, and who thinks they can tell me the electron configuration of helium?

Students*: Answers are usually submitted like 2, 2s, 2s2, and finally 1s (as nothing more than a lucky guess).*

Teacher: Perfect, see Sue gets it! (This usually drives the other students nuts.) Now lets move on to lithium. Lithium has three electrons. Their electron configuration of course would be . . . .

Students*: Always answer 1s3*.

Teacher: Oh! So close but no, I am sorry it is not 1s3. (By now all the

students are always totally engaged in trying to crack the "code." With some coaxing sometimes the answer comes; otherwise the teacher can provide the correct configuration of 1s2, 2s1.) How about beryllium? How many electrons, and where do they live?
Students: *1s2 2s2 (Usually comes pretty quick.)*
Teacher: Perfect, who thinks they get it? (Many hands go up by now.) Can anyone tell me what some of the numbers mean? (At this point most students can relate the superscript to the number of electrons. Note taking starts with all the students engaged trying to get information that will help crack the rest of the code.) Who would like to try boron? (Many hands go up at this point, as they are full of false confidence!)
Students*: 1s2, 2s3*
Teacher: Ooooh, so close but no! (Chaos usually erupts at this point. The teacher then provides the correct answer of 1s2, 2s2, 2p1. At this point some definitions can be offered to the students. Define principal energy levels and sub-levels.) Can anyone give me a rule for how many electrons can reside in an "s" sub-level? (This kind of questioning continues as students construct their own rules for each principle energy level and each sub-level.) The same type of questioning can lead students to write rules for the number of electrons allowed in a p-sub-level, how the d-sub level drops down or overlaps, where the "blocks" are located, valence electrons etc.
Moral**:** A new course should stress inquiry lessons whenever possible. Part of the teacher-training program should be to take experienced and new teachers though this type of lesson modification and indoctrinate them in the methodology so that students can be actively engaged in the content, even when the topic is something like electron configurations.
Multi-Media: This is the time to follow up with Mike Offutt's excellent chemistry song about electron configurations. (Chemistry Song-Bag I from Flinn Scientific.) Adding the musical component helps many students move the information to long-term memory.