ARISE Curriculum Coordination to
Science of Atoms and Molecules (SAM) Project

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This document is laid out by SAM activity. For each activity, there is a list of labs, demonstrations, articles, and/or worksheets that will help support it. Usually, it is assumed that these supplementary materials will help students prepare for the SAM activity, so as to get the most from it. It is not expected that teachers will use all of the materials cited; rather, the compilers have tried to convey the wealth of material available in the *ARISE Instructional Materials Guide, Part 1: Physics* and *Part 2: Chemistry* that supports the SAM activities.

SAM Activity: Excited States and Photons

Prior to Day 1:

ARISE Physics Topic 20: The Atom (pdf)

Labs:

- Hewitt Lab 97, "Nuclear Marbles." The Rutherford Gold Foil Experiment is explored by shooting marbles blindly at one another and estimating the diameter of the target marbles using probability equations and the frequency of collisions.
- Hewitt Lab 98, "Half–Life." Half–Life is modeled with a collection of 200 pennies. The results of ten trials (after which pennies turned to heads are removed) are graphed.
- Hewitt Lab 99, "Chain Reaction." A nuclear chain reaction is simulated using dominoes.
- "Hydrogen's Lowest Energy Level," *ARISE Instructional Materials Guide, Part 1 - Physics*

SAM Theme Activities, Day 1:

Day 1 of the SAM materials introduces the idea that light can come from atoms in excited energy states. A careful connection to conservation of energy is made when discussing what happens when two atoms collide and one becomes excited or un–excited. The SAM materials also discuss how energy levels and energy states compare for different atoms.

Prior to Day 2:

ARISE Physics Topic 14: Electromagnetic Waves (pdf)

Labs:

- Hewitt Lab 81, "Lensless Lens." A quick exploration of the "lensing" of a pinhole in a paper card.

- Hsu Lab 24A, "The Frequency and Wavelength of Light." Spectroscopes are used to observe spectra from red, blue, green and white LEDs.

[ARISE Physics Topic 18: Photons](#) (pdf)

Energy Levels in a Fake Atom Worksheet, *ARISE Instructional Materials Guide, Part 1 - Physics*

Labs:

- Hewitt Lab 96, "Particular Waves." A zinc plate, an electroscope and an ultraviolet lamp are used to explore the photoelectric effect.
- Hsu Lab 9B, "Energy and Quantum Theory." Atoms are "built" by adding marbles to concentric rings surrounding a "nucleus" on a game board. Photons are simulated with "pump cards" allowing an exploration of excited states. "Laser cards" are drawn to produce photon emissions.

[ARISE Chemistry Topic 4: Atomic Structure](#) (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 3, "Flame Tests." In this experiment, students observe or do the classic flame test and look at the colors of light emitted by different metal compounds to identify unknown metal ions.
- *Flinn ChemTopic Labs*, Vol. 3, "Atomic Spectra." The emission spectrum lines from an element provide evidence for the existence of electron energy levels in atoms. This experiment looks at the emission spectra of different light sources, fluorescent lights, gas discharge tubes, neon signs, and novelty lamps to determine the electron transition energies.

Demonstrations:

- *Flinn ChemTopic Labs*, Vol. 3, "Energy in Photons." When white light is shone through different color filters onto a "glow–in–the–dark" phosphorescent strip, only certain spots will glow. The relationship between wavelength, energy, and color is looked at in this demo.
- *Flinn ChemTopic Labs*, Vol. 3, "The Photoelectric Effect." The photoelectric effect is observed when light is shone on certain metal surfaces. The metal may lose electrons if the light has a great enough energy. An electroscope and different types of light sources are used to show the effect.
- *Flinn ChemTopic Labs*, Vol. 3, "Excited States." A simulation of electrons losing energy in the form of light (different-colored objects) in the transition from a higher energy excited state to a lower-energy state set to the musical tune of "I'm So Excited" by the Pointer Sisters!

Articles:

- *ChemMatters*, December 1988, pp. 7–9, "The Color of Gems." Article discusses why certain gems exhibit the colors that they do and gets into the electron configurations of atoms and electron transitions between orbitals.
- *ChemMatters*, October 1990, pp. 10–12, "Light Your Candy." Article

describes the phenomenon of triboluminescence and how and why the common Wint–O–Green Lifesaver exhibits this phenomenon.

- *ChemMatters*, October 1995, pp. 12–15, "Chemiluminescence, the Cold Light." 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.
- *ChemMatters*, October 1998, pp. 7–9, "Colors Bursting in Air." Article discusses the chemistry and electron transitions that produce the colors seen in fireworks.
- *ChemMatters*, April 1999, pp. 4–7, "A Light of a Different Color." 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.
- *ChemMatters*, April 2003, pp. 2–3, "Lasers." Article discusses lasers, both the scientific principles behind their operation and their technological design.
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ARISE Chemistry Topic 5: Radioactivity, Fusion, & Fission (pdf)

Articles:

- *ChemMatters*, December 1995, p. 12, "Happy Birthday, Helium." Article relates the discovery of helium, its source on earth, and some of its very unusual properties.

ARISE Chemistry Topic 8: Chemical Reactions (pdf)

Articles:

- *ChemMatters*, December 1989, pp. 4–6, "Automatic Sunglasses." Article describes the reactions and mechanisms involved in photochromic sunglasses that darken when exposed to sunlight but turn clear when you come back indoors.

SAM Theme Activities, Day 2:

Day 2 of the SAM materials explores how light plays a role in the excitement or decay of an atom. Students here will find that only certain photons stimulate atoms and that each atom has a unique energy level arrangement. Students find what energy level "jumps" correspond to frequencies of light. They learn about the collisions between atoms, the photons given off and absorbed, and the relationships between these things as they build fictitious atoms with a simulator.