

# 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: Reactions and Stoichiometry**

### SAM Theme Activities, Day 1:

The first day of the SAM materials for chemical reactions explores the factors that permit atoms to react with each other. The effects of temperature and reactant concentration are explored with respect to reaction rate. The activity finishes with the barest introduction to chemical notation. Prior to proceeding with this activity, a student should be familiar with what temperature means at atomic and molecular scales. A review of kinetic energy and conservation of energy, including a discussion of elastic potential energy, could be helpful to developing the understanding that there is a "sweet spot" in the selection of a temperature for a process when both rate of reaction and yield are considerations.

### With Day 1:

[ARISE Chemistry Topic 6: Chemical Names and Formulas, Compounds and Elements](#) (pdf)

#### Articles:

- *ChemMatters*, February 1986, pp. 17–19, "Nitrous Oxide: By No Means a Laughing Matter."
- *ChemMatters*, December 2002, pp. 14–16, "Matches: Striking Chemistry at Your Fingertips."
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[ARISE Chemistry Topic 18: Reaction Rates and Kinetics](#) (pdf)

#### Labs:

- *Flinn ChemTopic Labs*, Vol. 14, "Introduction to Reaction Rates." The blue bottle lab using dextrose and methylene blue is usually done as a demo. Here it is used as an experiment to show how the reaction rate can be measured.
- *Flinn ChemTopic Labs*, Vol. 14, "Temperature and Reaction Rates." In this inquiry-based lab the students design and carry out a procedure to analyze

- the rate of the reaction of magnesium with HCl at different temperatures.
- *Flinn ChemTopic Labs*, Vol. 14, “The Order of Reaction.” This is a microscale starch/iodine clock reaction lab. Students determine the relationship between the rate of a reaction and concentration of reactants to find the order and the rate law.
  - *Chemistry*, Nelson. British Columbia Edition, 1996. p. 194. “The Iodine Clock Reaction (With an Inquiry Twist).” What makes this activity engaging is that it is presented with minimal instructions for the students. It is a classic example of a lab that traditionally was done with 10–20 steps for students to follow, but here it has been changed so that student thinking and involvement are increased dramatically. The book gives the students a simple problem: “Make solution A react with solution B in a time of  $20 \pm 1$  seconds.” Students may manipulate any variable they choose. Temperature, concentration, volume etc. can all be changed and their effects measured. Students design their own experiments, collect their own data, and share their data with the class. Learning is assessed by their performance as well as their written work. This is an outstanding lab that really engages the students in an authentic investigation. This activity provides a striking example of how an open-ended investigation is a much more effective learning experience than is a cookbook lab.

Demonstrations:

- *Flinn ChemTopic Labs*, Vol. 14, “Iodine Clock Reaction.” This demo uses the classic iodine clock reaction to develop the ideas about what affects the rate of a reaction.
- *Flinn ChemTopic Labs*, Vol. 14, “Sudsy Kinetics.” Uses the decomposition reaction of hydrogen peroxide to teach most of kinetics. This one demo could cover most of the major concepts of kinetics.

SAM Theme Activities, Day 2:

Day 2 of the SAM materials Chemical Reactions module introduces the student to chemical equations. The concept of conservation of mass (by accounting for atoms) is introduced. The advantage of “leaning” a fuel—air ratio is discussed as an example of using a limiting reagent. Major types of chemical reactions are introduced. Before tackling these topics, a student should understand conservation of mass with respect to chemical reactions. Of all the SAM materials explored, this set of topics will require the most additional work—primarily following these activities—to achieve the desired mastery of the topics. Some traditional practice in balancing and classifying equations will continue to be essential.

With Day 2:

[ARISE Chemistry Topic 6: Chemical Names and Formulas, Compounds and Elements](#) (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 7, “Micro Mole Rockets.” This microscale lab is used to determine limiting reagents and mole ratios and to shoot rockets!
- *Flinn ChemTopic Labs*, Vol. 7, “Mole Ratios.” This lab is used to determine a

- chemical equation using stoichiometry. Mole ratios are also determined.
- *Flinn ChemTopic Labs*, Vol. 7, “Decomposition of Sodium Chlorate.” This is lab used to determine a chemical equation by using stoichiometry.
  - *Flinn ChemTopic Labs*, Vol. 7, “Magnesium Oxide.” This is the classic lab for empirical formula.
  - ICE Laboratory Leadership, Lab 6, “Formula of a Blue Hydrate.” Students determine the formula of a hydrate. Hydrates have a variety of practical applications. Their ability to gain or lose their waters of hydration makes them versatile. One formula unit of a hydrate contains one formula unit of an anhydride bonded to a fixed number of water molecules. Careful heating removes the water so that the ratio of water molecules to anhydride formula units can be determined, provided the molar mass of the anhydride is known. A hydrate is represented by the formula of the anhydride followed by a raised dot that represents the "weak" bond between the anhydride and the number of water molecules, i.e.,  $\text{MgSO}_4 \cdot 7 \text{H}_2\text{O}$ .

[ARISE Chemistry Topic 8: Chemical Reactions](#) (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 4, “All in the Family.” This microscale lab helps students to see why Mendeleev would have classified these metals as a group in developing the periodic table. It also serves to introduce the activity series and reinforce reaction types.
- *Flinn ChemTopic Labs*, Vol. 4, “Periodic Trends and the Properties of Elements.” This microscale lab helps students to see why Mendeleev would have classified these elements as a group in developing the periodic table. It also serves to introduce the activity series and, by the students carrying out the reactions, reinforces learning of reaction types.
- *ChemMatters*, September 2001, pp. 10–11, “Carbon Dioxide: A Pourable Greenhouse Gas.”
- ICE Laboratory Leadership, Lab 2, “The Nature of a Chemical Reaction.” Changes go on about you all the time. Some changes are chemical changes, such as gasoline burning or a nail rusting. But what is happening when a chemical change occurs? What is the nature of a chemical reaction? The purpose of this lab is to examine the behavior of matter in a chemical reaction, focusing on the behavior of the individual particles of each substance involved.

Demonstrations:

- *Flinn ChemTopic Labs*, Vol. 4, “Periodic Activity of Metals.” This demo helps students to see why Mendeleev would have classified these metals into groups while developing the periodic table. It also serves to introduce the activity series and reinforce reaction types and acid/base reactions.
- *Flinn ChemTopic Labs*, Vol. 4, “Safe Swimming with Sodium.” This demo helps students to see a classic demo of sodium in water in a safe and interesting way.

Articles:

- *ChemMatters*, October 1984, pp. 4–5, “The Interrupted Party.”
- *ChemMatters*, April 1986, pp. 4–7, “Polymers.”

- *ChemMatters*, December 1986, pp. 13–15, “Going Against the Flow: The Isolation of Fluorine.”
- *ChemMatters*, December 1988, pp. 13–15, “Fireside Dreams.”
- *ChemMatters*, October 1989, pp. 4–8, “The New Gold Rush.”
- *ChemMatters*, December 1989, pp. 4–6, “Automatic Sunglasses.”
- *ChemMatters*, April 1990, pp. 4–6, “Real Leather.”
- *ChemMatters*, October 1990, pp. 14–15, “Friedrich Wohler’s Lost Aluminum.”
- *ChemMatters*, December 1990, pp. 4–6, “Nylon.”
- *ChemMatters*, April 1992, pp. 12–15, “Wastewater.”
- *ChemMatters*, October 1993, pp. 8–10, “Insect Arsenals.”
- *ChemMatters*, October 1994, pp. 13–15, “Iron for Breakfast.”
- *ChemMatters*, October 1995, pp. 12–15, “Chemiluminescence, the Cold Light.”
- *ChemMatters*, April 1996, pp. 4–5, “Leavening: How Great Cooks Loaf.”
- *ChemMatters*, October 1996, pp. 7–9, “Skunk Non-scents.”
- *ChemMatters*, December 1996, pp. 4–5, “Silver Lightning.”
- *ChemMatters*, February 1997, pp. 4–5, “Airbags: Chemical Reaction Saves Lives.”
- *ChemMatters*, October 1997, pp. 10–12, “CO Control: On the Street, in the House, where You Live.”
- *ChemMatters*, February 1998, pp. 12–14, “Ozone—Out of Bounds.”
- *ChemMatters*, December 2000, pp. 4–6, “Hydrogen Fuel Cells for Future Cars.”
- *ChemMatters*, April 2001, p. 2, “Is Water the Best Fire Extinguisher in the Kitchen?”
- *ChemMatters*, April 2001, “Rockets: Chemistry Model for Liftoff.”
- *ChemMatters*, September 2001, pp. 7–9, “Ozone: Molecule with a Split Personality.”
- *ChemMatters*, April 2002, pp. 7–9, “Caves: Chemistry Goes Underground.”
- *ChemMatters*, February 2003, pp. 8–10, “The Explosive History of Nitrogen.”
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[ARISE Chemistry Topic 9: Stoichiometry](#) (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 7, “Who’s Counting?” This lab helps students to develop a feel for Avogadro’s number and for counting by weighing.

Demonstrations:

- *Flinn ChemTopic Labs*, Vol. 7, “Stoichiometry Balloon Races.” This demo gives kids a visual feel for limiting reagents using common household chemicals.

[ARISE Chemistry Topic 18: Reaction Rates and Kinetics](#) (pdf)

Articles:

- *ChemMatters*, February 2000, p. 16, “Why Do Eggs Take Longer to Cook in the Mountains?”

