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: Phase Change

SAM Theme Activities, Day 1:
Day 1 of the "Phase Change" module of SAM models the kinetic properties of the particles in each a gas, a liquid and a solid. Before tackling these topics the student should have experience with electrostatic forces. This need not be quantitative (Coulomb's Law) for this module. The charge properties of subatomic particles and how these affect the properties of ions and produce dipoles in molecules is essential background. The student should have at least a rudimentary knowledge of covalent and ionic bonding (perhaps including a discussion of electronegativity) before attempting to understand why some particles "stick together" in a solid at one temperature, while other particles fly about in space unaffected by the behavior of neighboring atoms of the same element.

With Day 1:

ARISE Chemistry Topic 1: Matter and Change (pdf)

Articles:

- *ChemMatters*, December 1987, pp. 10–13, “Polywater.”

ARISE Chemistry Topic 10: Phases: Solids, Liquids, and Gases (pdf)

Articles:

- *ChemMatters*, April 1986, pp. 15–19, “Silly Putty.”
- *ChemMatters*, February 2001, pp. 7–9, “Scuba: The Chemistry of an Adventure.”
- *ChemMatters*, February 2002, pp. 8–9, “Maple Syrup: Sweet Sap Boils Down to This.”

SAM Theme Activities, Day 2:
Day 2 of the SAM project's Phase Change module models the relationships

between energy, temperature and state of matter. A student embarking on this module should firmly grasp the definition of kinetic energy, and that when this definition is extended to atomic-sized particles it (or the average of it as distributed over many) represents what we understand as temperature. The graph produced by plotting the sum of the kinetic and potential energy bars against temperature on page 7 is very meaningful but difficult to grasp with casual inspection—the student should have significant experience interpreting complex graphs and the instructor should expect to provide some guidance and checking for understanding at this stage. Finally, before making sense of the evaporative cooling model on page 8, the student should be able define "boiling" and explain the forces that are being overcome at the instant a molecule "goes over" from liquid to vapor.

With Day 2:

ARISE Chemistry Topic 10: Phases: Solids, Liquids, and Gases (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 10, “Measuring Energy Changes.” This lab is to identify possible physiological and environmental factors that lead to protein denaturation and activity.
- *ChemCom*, Fourth Edition, Unit III, Section A, Lab A.2, p. 178, “Separation by Distillation.” In this lab students are given a mixture of two liquids and asked to separate and identify the liquids based on boiling points and reaction with iodine.
- ICE Laboratory Leadership, Lab 16, “Heat of Vaporization of Liquid Nitrogen.” Students determine the heat energy needed to vaporize (boil) one gram of liquid nitrogen. Nitrogen, the major component of air, is a gas at room temperature with the formula N2 (g). It can be stored in its liquid form in a specially insulated bottle called a Dewar flask. In this laboratory activity, students will determine the energy needed to vaporize (boil) liquid nitrogen by letting a known mass interact with warm water. The energy given up by the warm water will cause the nitrogen to boil until it is completely converted to gaseous nitrogen. This energy is called the heat of vaporization.

Articles:

- *ChemMatters*, February 1987, pp. 17–19, “Cooking with Steam.”
- *ChemMatters*, April 1999, pp. 12–13, “The Case of the Missing Caffeine.”
- *ChemMatters*, April 2000, pp. 14–15, “A Supercritical Clean Machine.”
- *ChemMatters*, December 2000, pp. 10–11, “Artificial Snow: Powder for the Slopes.”
- *ChemMatters*, February 2002, pp. 11–13, “The Fizz–Keeper: Does it Really Keep the Fizz?”
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ARISE Chemistry Topic 16: Covalent Bonds, Molecular Shapes, and Intermolecular Forces (pdf)

Labs:

- *Flinn ChemTopic Labs*, Vol. 12, “Freezing-Point Depression.” Students measure the freezing-point depression for four different solutes dissolved in water and learn how the concentration and number of dissolved solute particles (colligative properties) affect the freezing point of water.

Articles:

- *ChemMatters*, April 1997, pp. 4–7, “Lava Lite: A Chemical Juggling Act.”