

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: Heat and Temperature

Prior to Day 1:

[ARISE Physics Topic 6: Momentum](#) (pdf) (N.B.: A treatment of elastic collisions is best to complement the Concord materials here. The *ARISE Instructional Materials Guide, Part 1 - Physics* does not treat elastic collisions in Physics Topic 5: Work and Energy but rather in the Momentum topic.)

Labs:

- Hewitt Lab 19, "Go Cart." Use a reversible "bouncing dart" and a dynamics cart to compare an elastic collision to an inelastic collision. The instructor in this case should emphasize that the thermodynamics principles under study are consistent with particles undergoing elastic rather than inelastic collisions.
- Hsu Lab 3A, "Momentum and the Third Law." Dynamics carts (one initially at rest) are collided approximately elastically. The instructions in the Hsu lab focus on the momentum aspects, but data collected (mass and velocity of each cart, before and after collision) also supports an exploration of conservation of mechanical energy. The instructor should plan to guide students to this. If this activity has already been completed (say during the Newton's Laws section), the data can be recalled and the analysis extended in this unit.
- "Collisions on an Air Track," *ARISE Instructional Materials Guide, Part 1 - Physics*. Emphasis should be placed on the elastic collisions explored.
- "Collisions in 2-D." Not described in the ARISE materials. Presumably one of many activities conducted on an air table with one or another method of recording and followed by a vector analysis of motion before and after. The algebra here can be messy, so, for ninth graders, it's

probably important that one puck start the interaction at rest.

SAM Theme Activities, Day 1:

Day 1 of the SAM materials thoroughly defines temperature and relates it closely to the SAM energy materials. A clear distinction is made between the average kinetic energy of a group of atoms and their speed and how they relate to the temperature of a material. The differences between different phases of a substance at different temperatures are also discovered.

Prior to Day 2 (N.B. The ARISE physics materials don't treat thermodynamics in any direct way during the physics curriculum. Perhaps the Concord materials need to be used by physics-first students as their principal bridge from physics to chemistry in this discipline.):

[ARISE Physics Topic 5: Work and Energy](#) (pdf)

Work and Energy Worksheet, Part (B): Gravitational Potential Energy and Kinetic Energy, *ARISE Instructional Materials Guide, Part 1 – Physics*

[ARISE Chemistry Topic 11: Thermochemistry](#) (pdf)

Demonstrations:

- *Flinn ChemTopic Labs*, Vol. 10, “Colorful Heat.” Uses food coloring and water to show the relationship between heat and temperature.

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[ARISE Chemistry Topic 12: Gases, Gas Laws, and Kinetic Theory](#) (pdf)

Articles:

- *ChemMatters*, December 2001, p. 2, “Do Ducks Get Cold Feet?” Given the large surface area of a duck's feet, it would seem that they would lose an excessive, perhaps unrecoverable amount of heat when swimming in icy water. But through an ingenious arrangement of veins and arteries, they manage to keep heat loss to a minimum.

SAM Theme Activities, Day 2:

Day 2 of the SAM materials shows the difference between heat and temperature. They also discuss how heat is transferred from one object to another and how this occurs at the atomic level. This treatment of the subject makes the traditional explanations very clear.