

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

Prepared by Keith Kuykendall, Tinley Park High School, Tinley Park, IL and
Jason English, William Fremd High School, Palatine, IL
Edited by Spencer Pasero and LaMargo Gill

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: Newton's Laws at Atomic Scale

Prior to Day 1:

[ARISE Physics Topic 1: Vectors](#) (pdf)

C-1: Pre-Vector Discussion Worksheet, *ARISE Instructional Materials Guide, Part 1 - Physics*

D-1: Force Practice Worksheet, *ARISE Instructional Materials Guide, Part 1 - Physics*

Labs:

- Hsu Lab 5A, "Equilibrium and Forces." Uses three spring scales acting in different directions to illustrate that a net force of zero can result by summing many forces.
- "Force Vectors," *ARISE Instructional Materials Guide, Part 1 - Physics*. Uses a tree or other immovable object and three segments of rope each attached to the same ring, one to the tree and one each to groups of students pulling at right angles to each other, to demonstrate the equilibrant concept.

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[ARISE Physics Topic 4: Dynamics](#) (pdf)

Newton's First Law Worksheet, *ARISE Instructional Materials Guide, Part 1 - Physics*

Labs:

- Hewitt Lab 8, "Going Nuts." Inertia is demonstrated by supporting a stack of hex nuts on a hoop, which is in turn supported on a bottle. When the hoop is swept away, the hex nuts fall into the bottle.
- Hewitt Lab 9, "Buckle Up." A doll is placed on a dynamics car with or without a "seatbelt," then crashed.
- Hsu Lab 1A, "Constant Speed." Produces a graph of position vs. time for a cart moving at constant speed.

- Hsu Lab 2A, “The Law of Inertia.” Examines the different speeds that result in a minimal friction system when the same force acts on several different masses.
- Hsu Lab 2B, “Newton’s Second Law.” Compares acceleration of a dynamics cart over a level segment of track to that of the same cart over a pitched segment of track.
- “Constant Force Lab,” *ARISE Instructional Materials Guide, Part 1 - Physics*. Uses a rubber band to apply a constant force to a cart that pulls a tape through a “ticker timer.” Velocity is determined at several intervals and from that a graph of velocity vs. time.

Demonstrations:

- Hewitt Lab 11, “Getting Pushy.” A car’s (real car or other very massive object) bumper is connected to a tree (or other sturdy fixed object) by a chain. Efforts are made to move the car by exerting force on the chain at different points and in different directions. Free body (vector) diagrams are developed to explain the observed results.

• [ARISE Physics Topic 9: Electric Forces](#) (pdf)

Electric Forces Worksheet, *ARISE Instructional Materials Guide, Part 1 - Physics*

Labs:

- Hewitt Lab 86, “Static Cling.” The student uses an electroscope to explore various aspects of positive and negative charge.
- Hsu Lab 15A, “Observing Electric Charge.” The student builds a simple electroscope and observes its behavior in the vicinity of various charged objects.
- “Conceptual Coulomb’s Law,” *ARISE Instructional Materials Guide, Part 1 - Physics*. The force between a pith ball and a charged plate is compared for a charge Q , a charge of $Q/2$ and a charge of $Q/4$ placed on the pith ball (constant charge on the plate).

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

Articles:

- *ChemMatters*, October 1983, pp. 4–7, “An Atomic Tour.” 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.

SAM Theme Activities, Day 1:

Day 1 of the SAM materials jumps right into one of the unexplained physical phenomena of the 19th century—Brownian motion. Newton’s First Law of Motion is applied at the atomic level and then the molecular level to understand this motion.

Prior to Day 2:

[ARISE Physics Topic 4: Dynamics](#) (pdf)

“Newton’s 2nd Law and Newton’s 3rd Law,” Worksheet 4: D-1, *ARISE Instructional Materials Guide, Part 1 - Physics*

Labs:

- Hewitt Lab 12, “Constant Force and Changing Mass.” A classic first–course physics lab where the mass of a low-friction rolling system is changed repeatedly while a constant force is applied. The acceleration is measured by whatever means the laboratory is prepared to measure it with.
- Hewitt Lab 16, “Balloon Rockets.” An open–ended activity where students build a "rocket" that is propelled one way, then the other along a guide wire. Ordinary materials are used for this exploration.
- Hsu Lab 3A, “Momentum and the Third Law.” A moving dynamics cart collides with one at rest. The momentum of each of the two dynamics carts is determined before and after a collision. The masses of both cars and the initial velocity of the initially moving car are varied.
- “Acceleration of a Constant Mass with a Variable Force,” *ARISE Instructional Materials Guide, Part 1 - Physics*. Rubber bands are used to produce several different amounts of force on a system. Acceleration is determined using a recording timer. Acceleration vs. force is plotted on a graph.
- “Acceleration of a Constant Force on a Variable Mass,” *ARISE Instructional Materials Guide, Part 1 - Physics*. Uses a rubber band stretched to a constant length to produce an acceleration. The changes in velocity are determined with a timer and a ruler and plotted on a graph.

SAM Theme Activities, Day 2:

Day 2 of the SAM materials begins and ends with a look at how physics plays a role in crime–scene forensics. Students study Newton’s second law using a simulated mass spectrometer. They then look at Newton’s third law of motion as it pertains to forces between atoms, bonds in molecules, and a simple rocket (a popped balloon).