

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: Atoms and Energy

Prior to Day 1:

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

Work, Energy, Gravitational Potential, and Kinetic Energy Worksheet,
ARISE Instructional Materials Guide, Part 1 - Physics

Labs:

- Hewitt Lab 23, "Cut Short." Uses a pendulum to explore the relationship between kinetic energy and gravitational potential energy.
- Hewitt Lab 24, "Conserving Your Energy." Uses a pendulum to verify the Law of Conservation of Energy in a mechanical system.
- Hewitt Lab 26, "Wrap Your Energy in a Bow." Using a recurve or compound bow and a spring scale, data to produce a graph of string displacement vs. force is produced. The relationship of work done to the area under the curve of this graph is explored.
- Hewitt Lab 28, "Releasing Your Potential." A pendulum apparatus with a rigid arm is stopped suddenly at its low point while its "bob" is released and allowed to continue as a projectile. The horizontal distance traveled is measured and the experiment repeated at various start heights for the pendulum.
- Hsu Lab 3A, "Momentum and the Third Law." A mounted diffraction grating and a hydrogen emission tube are used to determine the wavelength of visible emissions from excited hydrogen atoms. The frequency and energy of those photons are subsequently calculated.
- Hsu Lab 3B, "Conservation of Energy." A dynamics car is released from each of several positions on a ramp. Its velocity is measured at the same position near the bottom of the ramp each time. The sequence is repeated for a cart with its mass incrementally increased several times.
- Hsu Lab 4B, "Work and Energy." A rubber band stretched to various

lengths is used to propel a dynamics cart. The cart's kinetic energy is determined after release. The force to stretch the rubber band and the distance that the rubber band is displaced are measured and used to determine work done. Work and kinetic energy are compared.

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[ARISE Physics Topic 15: Vibrations and Waves](#)(pdf)

- Hewitt Lab 64, "Tick–Tock." The properties of a pendulum are explored as students change its characteristics in order to build a pendulum with a period of exactly one second.
- Hewitt Lab 65, "Grandfather's Clock." The relationship between the period and the length of a pendulum is carefully explored by analysis of a graph.
- Hsu Lab 19A, "Harmonic Motion." A pendulum is studied. The effects of changing amplitude, mass and length are explored. A stop clock is used. The student is prompted to draw a smooth curve of period vs. angular amplitude.
- Hsu Lab 19B, "Natural Frequency." An oscillator is made from two rubber bands and a steel washer. The oscillator is stretched vertically between two pins on a support stand, set into vibration and its period and frequency measured. The number of washers, the number and tension of the rubber bands are varied and the experiment repeated.

SAM Theme Activities, Day 1:

Day 1 of the SAM materials on Atoms and Conservation of Energy does a very careful job of introducing the relationship between various kinds of mechanical energy. Included are kinetic energy, gravitational potential energy and elastic potential energy with interactions that illustrate the exchange of energy from one form to another within a dynamic system. While supporting these topics with a prior development of kinematics and dynamics (Newton's Laws) is common and traditional, some teachers like to start physics with the topics of work and energy in order to apply it as a unifying principle from the first day of the course. An instructor with that philosophy could successfully lead off with these interactions and very little prior study. The class that started here with these activities would follow with a subset of the labs and readings that follow below. In order to be prepared for this unit, the student should at least be able to define the basic forms of mechanical energy and list examples of where these forms are found.

Prior to Day 2:

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

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

Labs:

- Hsu Lab 15A, "Observing Electric Charge." A homemade electroscope is used to observe the properties of electric charge.
- "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).

SAM Theme Activities, Day 2:

Day 2 of the SAM materials builds on the previous day's explorations of the more traditional energy treatment in the physics classroom. The SAM materials show how mechanical energies apply to the atomic world, both when energy is conserved and when energy is added to or taken from the system. While the energies of different systems are analyzed, the distinction between energy transfer and energy conversion is made.