Senior Science Society: STEM Modules

For Information about arranging a Senior Science Society presentation contact any member of the Society. If unknown, please contact Al Horst at horstat@msn.com or Bruce Burns at bonniesbru@comcast.net

There is no charge for these presentations. All presenters are unpaid volunteers and experts in their subject areas.

It is possible for the Senior Science Society to develop other topics of student/teacher interest.

1. Title: **Things that Fly - Birds, Planes, and More**

Presenters: Peter Plostins, Charlie Nietubicz

Description: Two modules, each a separate presentation which give increasingly more details of aerodynamics, are available as described below:

a. Aerodynamics of Flight – The nature of how things like birds, insects and aircraft fly will be discussed along with some fun demonstrations using balloons, mechanical birds, simple rockets and paper airplanes.
b. Aerodynamic Measurements – We discuss what constitutes air, how big is a molecule, how many are there, and what they have to do with flying? Students will learn about thrust, lift, and drag as they pertain to aircraft they see in the skies every day. A hands-on wind tunnel demonstration of wing lift and drag is presented.
c. Aerodynamics of Quadcopters – A short discussion is provided of how aircraft know their location, state, maintain that state and guide themselves within the global airspace. Finally, a discussion of quadcopter aerodynamics and flight control is presented and demonstrated.

Supplies: Furnished by SSS: models, hands on plane building, things from nature
Needed from the school: System capable of projecting computer presentation, table for the wind tunnel and open space to demonstrate the quadcopter.

Suitable for grades K – 12.
Recommended audience size: up to 50.
Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs, evening STEM events, including truncated table-top presentations.
Duration: At least 40-minute long sessions, but much less for table-top displays/presentations.

2. Title: **Mechanical Advantage**

Presenters: Dick Schwanke

Description: Presents the concepts of simple machines that are used every day to in the world around us. Students will experience the ability of levers, pulleys, and hand cranks to make things easier. The students measure the mechanical advantage of various concepts themselves and then calculate the mechanical advantage of each device in multiple ways.

Supplies: Furnished by SSS: wood lifting frame, weights, lever, pulleys and rope, crank, yard sticks, weight scale and photocopy original for optional handout.
Needed from school: open space of at least 10' x 10' for equipment, student seating in chairs or on open floor area is also good, whiteboard (or blackboard or flipchart with easel), Desktop or laptop with computer projection is optional.

Suitable for grades 3 through 8

Recommended Audience Size: 30 maximum, but 15 to 20 is better for all to have hands-on.

Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs, evening STEM events that use 50 minute sessions.

Duration: Typically run in 50 to 70 minute sessions. Not recommended for tabletop displays.

3. Title: **States of Matter**

Presenter: Rob Lieb

Description: Extends the understanding of gasses, liquids, and solids by demonstrating the kinetic theory of matter using a model of hard spheres and a dynamic visualization. We will find out what makes solids, liquids and gasses take the shapes they do, and examine how temperature, pressure, and volume cause matter to boil, condense, and crystallize. We will look at the different forms of matter from very cold to hot and show how nature does what it must do. The interactive part involves investigating the nature of atom and molecules from a simple model put together by the student. Complexity changes depending upon the age of the students, from pre-school to pre high-school.

Supplies: Furnished by SSS: All experimental materials
Needed from school: access to power, table (at least 30" x 60"), video projector and screen, to be driven by a laptop computer.

Suitable for grades K through 8: the topics and objectives are flexible and will be adjusted to fit the class level and the number of students.

Recommended Audience Size: up to 30

Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs, evening events.
Duration: At least 20-minute long sessions, with 40 or more minutes preferred.

4. Title: **Cataclips**

Presenters: David W. Webb, Dick Schwanke, Bob McKenzie

Description: Presents a description of accuracy versus precision, and how each can be estimated mathematically. Students then proceed to a hands-on launch exercise using pennies catapulted via a binder clip towards a target on a paper grid. Impact locations are measured and the data are then entered into a computer for display. The module is highly interactive, with the students forming teams and engaging in the experimental process to include the gathering and manipulating data. Experiment is statistics related, illustrating means and standard deviations.

Supplies: Furnished by SSS: binder clips, coins, vinyl targets, laptop with Microsoft EXCEL
Supplies furnished by school: Screen and digital projector, 5' x 8' open space for each group of three or four students.

Suitable for grades 4 through 8
Recommended Audience Size: 30 maximum, but 12 to 18 is much better.
Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs
Duration: Typically run in 45 to 60 minute sessions. Not recommended for tabletop displays.

5. Title: **Fun with Triangles**

Presenters: Fred Robbins, Al Horst

Description: Students are introduced to various types of triangles. Angles and side lengths of small and large triangles are measured using various instruments to demonstrate how larger distances can be determined using ratios of lengths of smaller similar triangles. A sample problem is presented showing how a stranded camper can estimate how wide a river is using a small right triangle to see if he can swim back to camp. The students are then broken into teams and presented with a challenge to measure the height of some distant object in or outside the classroom. They are allowed to use a large protractor-like sighting device that they can point at the object and measure the baseline (x) and vertical (y) values of the triangle defined by their measuring device. Calibrated ropes can then be used to measure the distance (large X value) to the actual object of interest, and they are asked to determine the height of the object by using the y/x values from their measuring device. Depending on their ages, reference to trigonometry and the ability to look up the tangent for any angle will be made.

Supplies: Furnished by SSS: protractor, triangulation device
Needed from the school: Classroom, cafeteria, or gymnasium with a high ceiling, screen, digital projector, white or blackboard or easel with a flipchart, and laptop.

Suitable for grades 4 through 8
Recommended Audience Size: up to 30
Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs, evening events.
Duration: At least 30-minute long sessions, with 40 or more minutes preferred.

6. Title: **The Sweet Sound of Music**

Presenter: Rob Lieb

Description: Have you ever wondered how the sound that you hear from your iPod or from your computer was made? Did you ever go to a concert and wonder why the performance does not sound like the track coming out of your earphones at home? How is the sound of music made, and how is it changed so that it sounds best. Most importantly, how do you get it so that it sounds best to you? It depends on your ears, the speakers, the electronics, and how they are manipulated.

In this presentation we will demonstrate this process and show you how it is done from the production of music in instruments, to the listening of the sound in concerts, at home, and in everyday life. You will learn how you hear, how to make good music better, and even how bad music can be made to sound good through amplifiers, filters, and the listening environment.

Suitable for grades 3 through 8: the topics and objectives are flexible and will be adjusted to fit the class level and the number of students.

Recommended Audience Size: up to 30
Flexibility: Typical daytime classes (up to 5 classes per day), after school and weekend clubs, evening events.
Duration: At least 30-minute long sessions, with 40 or more minutes preferred.

7. Title: **Click & Dunk Tabletop Demo**

Presenter: Rob Lieb, Al Horst

Description**:** Demonstrates common physical phenomena involving momentum and energy, and floatation and buoyant forces; shows the basic premise of science that understanding leads to prediction of events. First, the concept of momentum with examples of collisions is explained to include elastic and non-elastic collisions. Introduce prediction as part of science. Then the Cartesian Diver is used to explain buoyancy. Note: the order of presentation is not critical, with interaction stimulated by questions to the audience. The grade level of attendees and principles being demonstrated should determine the order.

Supplies: Furnished by SSS: Newton's Cradle (Balance Balls Physics Pendulum), rubber band, and Cartesian Diver.
Needed from school: Table.

Suitable for grades 2 through 8
Recommended Audience Size: 10 maximum, but 5 is better for all to have some hands-on experience.
Flexibility: table-top presentations at evening STEM events.
Duration: Variable; depends on audience, but as short as 10-minute long sessions.

8. Title: **Bicycle Wheel Gyroscope**

Presenters: Dick Schwanke, Bob McKenzie

Description: The principles of angular momentum are demonstrated using a bicycle wheel. A stationary wheel falls to the floor, while a spinning wheel stays upright. Students try to tilt the wheel from side to side and describe what they feel. (Just like a change in the speed or direction of linear motion requires a force, so does a change in the speed or direction of rotational motion require a torque.) Next students try holding the end of the wheel's axle with a rope. The rotational inertia will keep the wheel spinning vertically, and gyroscopic precession will cause the wheel to revolve around the rope.

The seemly simple spinning bicycle wheel actually represents an assemblage of (often) non-intuitive forces, which this module will demonstrate. Examples include spinning the wheel, tilting the wheel, pushing the axis of rotation horizontally and vertically, suspending the axle from a rope, plus rolling a tilted wheel. For each configuration, students will hypothesize the results, conduct particular experiments, then analyze what happened. Real world examples of gyroscope use are woven into the presentation. If the students are already familiar with vectors, then a more complete covering of the principle of conservation of angular momentum may be given. This module is applicable for classes studying Newton's Laws of Motion.

Supplies: Furnished by SSS: multiple bicycle wheels, ropes, stand.
Needed from the school: open area of at least 20' x 20' with a hard, smooth, surface such as a gym or cafeteria.

Suitable for grades 3 through 8 strictly as a hands-on demonstration. May also be used for grades 8 to 12 for discussion of the underlying physics (requires use of vectors).
Recommended Audience Size: Up to six students at one time if all are to have hands-on.
Flexibility: Daytime or evening STEM events, best used as a tabletop display.
Duration: Typically, students may complete the experiment in five to ten minutes. Complete explanation may take 45 minutes.

Bicycle Wheel Gyroscope –It is best conducted in a large open area with a hard, smooth surface such as the gym or cafeteria. For the full module, teachers should allow 50 to 90 minutes. A "fun without much science" version is available for walk-by tabletop uses. Primary presenter is Dick Schwanke.

9. Title: **What Can an Atom Do?**

Presenter: Greg Fox

Description: Atoms are the basic building blocks of all matter in the universe. Each type of atom is designated by a name of what we know as an element (hydrogen, carbon, copper, gold as examples) and the elements are organized by their characteristics into a chart called the "periodic table." This module will discuss the basic structure of the atom and, based on variations within atoms, how they behave, displaying one or more of five behaviors: 1. Combination of different atom types into compounds (H2O, for example), 2. Creation of electricity, 3. Change by generation of radioactivity, 4. Changes in state (solid, liquid, gas), 5. Absorption of light (producing heat or fluorescence). The module will combine white board/flip chart discussion, video clips, and table top demonstrations.

Supplies: Periodic Table poster; clay models of hydrogen and nitrogen atoms; lemon juice, baking soda, balloon, funnel, jar; example phase diagrams; candle, pint and quart jars, matches; samples of rusted iron; shortwave UV lamp, postage stamp, $10 & $20 bill, fluorescent rock samples, uV ink pen; computer, projector, Bill Nye and Hindenburg video clips; high resistance ohm meter; conductivity detector (LED, battery, resistor, alligator clip wires) and conductivity samples (wire, straw, wood, foil, plastic spoon, playdough, modeling clay, distilled water, ginger ale – plus several beakers and copper wire segments).

Needed from School: Six-foot long surface (table top or hard floor) for demonstrations, screen or blank wall for projection, ability to darken room (to see fluorescence examples), whiteboard or flip charts.

Suitable for grades 5 - 8.
Recommended Audience Size: Up to 30 (class will be divided into smaller groups to view some of the tabletop demonstrations)
Duration: 45-60 minutes (adjustable).

10. Title: **Laws of Science – Matter and Energy**

Presenter: Greg Fox

Description: Everything in the physical universe consists of either matter or energy. For many hundreds of years scientists have been studying the physical world and performing experiments using the scientific method. From these observations and experiments certain behaviors are found to always occur, and from these repeatable behaviors Laws of Science are established. Newton's Laws describe the motion of all forms of matter – a golf ball and the moon obey the same laws. Similarly, the Laws of Thermodynamics describe the behavior of energy including its motion. This module will combine white board/flip chart discussion, video clips, and table top demonstrations to develop an understanding of how these laws of science work

Supplies: Scientific Method chart, jars w/ baking soda, powder, cornstarch, lemon juice; 2 smooth balls of similar size and different weights plus force impulse mechanism

(simple homemade from wood); newton car (homemade) plus fishing weights, rubber bands, cotton string and matches; jar with two layers of colored beans; Sterling Engine (optional) with alcohol and matches; computer, projector, Bill Nye video clips; electromagnetic spectrum charts
Facility Requirements: Six-foot long surface (table top or hard floor) for demonstrations, screen or blank wall for projection, white board or flip charts

Suitable for grades 5 - 8
Recommended Audience Size: Up to 30
Duration: 45-60 minutes (adjustable)

11. Title: **When You're Hot You're Hot!**

Presenters: Al Horst, Fred Robbins

Description: This module addresses the definition of temperature, thermal energy, and heat; how they relate to one another; and how they are important in our lives. Temperature is defined with reference to molecular motion, and students build a simple thermometer. Thermal energy is explained as involving both the temperature and the amount of a substance. Raising the temperature of an object is shown to result from the transfer of thermal energy from a higher temperature body to a lower temperature body. Heat, this transfer of thermal energy, is shown to result from conduction, convection, and radiation, which are explained with hands-on examples. The students also perform simple experiments demonstrating the relationship among temperature, pressure, and volume of a gas. The module concludes by discussing how temperature and heat are important to us locally and globally, with the Greenhouse Effect being both essential to life on earth, yet dangerous to life when excessive greenhouse gases in the atmosphere upset the balance of radiation from the sun heating the earth and re-radiation back into space. The importance of science is stressed, and why students benefit from knowing the facts about temperature and heat.

Supplies: Numerous inexpensive items (beakers, plastic bottles with caps, straws, modeling clay, small and medium size balloons, plastic thermometers, plastic dosing syringes), liquid nitrogen or substitute cooling media, radiometer, light beam source, lava lamp, hair dryer, and bicycle pump and valve are needed to provide the simple demonstrations mentioned above.
Needed from Schools: The classroom, and laptop, projector, and screen.

Suitable for grades 3 through 8 with some modification of hands-on demonstrations to suit.
Recommended Audience Size: up to 30.
Duration: 40 to 50 minutes.

12. Title: **All Aboard for Digital Signals**

Presenter: Dick Schwanke

Students will operate a model railroad, running locomotives and throwing turnouts, to discover how digital signals are transmitted and received. This module begins by discussing students'

experiences with how cell phones communicate with each other. Noting the difference between digital and analog signals, leads to the description of how a digital signal is constructed. The final two-thirds of the session is putting this knowledge to use while using the model railroad to simulate a digital network such as used by the internet or cell phones.

Supplies: Furnished by instructor, except for tables furnished by school or club to make a 6 foot by ten foot flat area for demonstrations.

Suitable for all ages over seven.
Optimum class size is six to eight students with a maximum of ten.
Session time is 90 minutes. If students are not already familiar with binary (base two) operations, then add 10 minutes to the beginning. If the teacher wishes to have net neutrality demonstrated and discussed, then add 10 minutes to the end of the presentation.

13. Title: **Internet Operation and Net Neutrality**

Presenter: Dick Schwanke

The concept of net neutrality has been in the background news for several years, mostly getting people confused with the jargon. In this module students will discover what it all means by operating a model railroad to simulate the internet. Some students will run locomotives and hopper cars to simulate delivery of the data packets while other students will operate the turnouts to simulate the operation of the routers. Positions will be rotated so all students have a chance to try each type of position. Then additional rules (and locomotive) will be introduced to simulate net neutrality. Times for data packet delivery will be recorded and compared.

Supplies: Furnished by instructor, except for tables furnished by school or club to make a 6 foot by ten-foot flat area for demonstrations.

Suitable for all ages over seven.
Optimum class size is six to eight students with a maximum of ten.
Session time is 90 minutes.

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