We have listed our most popular "cool tools" that support the STEM curriculum. We work with teachers just like you to identify resources that will inspire your students to think about how the STEM disciplines affect them every day. These were chosen in large part because working with them requires critical thinking and hands-on activity across the four STEM disciplines, rather than addressing the disciplines separately. Plus, they have clear, real-world application.

AIR-POWERED PROJECTILE P4-2200

Why is this STEM?

Science

- Projectile motion can be studied; both vertical and angled motion, correlating with physical science studies.
- The rocket system's ability to be a TRUE projectile and exhibit repeatability is crucial to the physical science teacher
- The rocket system parallels the physics problems that students are given in class such as "…in a vacuum" word problems, given the minimal air resistance through its flight

Technology

- Helps tech students in designing their own rocket systems, using this as a template
- After designing their own rockets using a 3D shaper/printer, tech students will use the air-powered launch system to test the flight range and height, given the psi for each launch washer.

Engineering

- Students design a simulated air-powered rocket system on the computer that would surpass and improve the air-powered rocket's specifications, using Arbor's rocket as a default template.

Math

- Calculations can be made on multiple variables; vertical height of rocket given the time of flight, horizontal range of rocket, acceleration due to gravity
- Students will use trigonometry functions (Sine, Cosine and Tangent) through the launching process

- Graphing activities are varied and can allow students to graph single variable or multi-variable axes; range vs. angle, range vs. angle and launch velocity

WIND TURBINE KIT P6-7500

Why is this STEM?

Science

- The Wind Turbine Kit mirrors a real-life wind turbine that is used by National Grid and other electricity companies, demonstrating that their science classroom correlates to the actual device used in the real world
- Power from various blade angles and the number of blades can be experimented with to record output (in Watts)
- Generator concepts are crucial to turbine speed and how electrical energy is "stored" through wind power
- Similarities and differences between generators and alternators (DC vs. AC) are studied in Physics. Using the Wind Turbine Kit, the concepts of voltage production and EMF can be emphasized.

Technology

- Using this as a lab for tech students, it will bolster their knowledge of the up-and-coming renewable energy sources
- By using conventional fans (stand-alone fans, car cooling fans, air conditioner fans, hair-dryer fans), tech students can use the Wind Turbine Kit to study blade pitch angle and blade number to find efficiencies in appliances and other devices

Engineering

- Allows engineering students to experiment with the 6 different blade pitch angles as well as the number of blades for maximum efficiency
- Additional experiments can be performed with the to mirror the turbine's efficiency during strong or weak wind conditions

Math

- Calculations can be made on single variables; blade number vs. power output efficiency of the turbine
- Students will use angular rotational motion equations, input vs. output ratios, tangential and angular velocity of the blades vs. power output
- Graphing activities are varied and can allow students to graph single variable or multi-variable axes; blade number vs. power output, blade angle/pitch vs. power output, blade angle/pitch and blade number vs. power output

SOLAR CHARGER USB KIT P6-7260

SOLAR PHYSICS KIT P6-2130

BUILD-IT-YOURSELF SOLAR LED FLASHLIGHT KIT P6-7250

SOLAR ENERGY SCIENCE KIT P6-7000

DYE SENSITIZED SOLAR CELL KIT P6-2110

Why are these STEM?

Science

- All the above "solar" Kits allow students to study the workings of solar cells, demonstrating that their science classroom laboratory correlates directly to the actual device used in homes, businesses, electronic devices (e.g. calculators, toys) and the International Space Station
- The concept of solar cells (photovoltaics) is learned in conjunction with understanding how the solar charging device operates
- Light types (visible, UVA, UVB, Infrared) can be tested vs. voltage output. UVA and UVB can be tested in conjunction with the NeuLog data-collecting system, to monitor and record the % of each type of ultraviolet radiation incident upon the solar cells
- Students will explore how factory-made silicon photovoltaic solar cells compare to their own created dye-sensitized solar cells.
- Each student will get hands-on experience creating solar energy with the Dye Sensitized Solar Cell Kit while having fun applying principles of Physics, Chemistry, Biology and Nanotechnology

Technology

- Using this as a lab for tech students, the skills gained in building the solar cell kit encompass many areas including; assembly, soldering skills, electrical wiring and circuit knowledge
- Tech students will use multi-meters to test LEDs hooked up to silicon solar cells and motors
- Tech students can build a 1 watt LED flashlight with a flexible thin-film solar panel, using the Solar LED Flashlight Kit as a template for their own changeable designs
- The Dye Sensitized Solar Cell Kit replicates the research by Caltech scientists, bringing the creation of a photovoltaic cell in their own lab to the real world

Engineering

- Each Solar Charger/Solar Physics Kit has the flexibility to be designed in the most efficient way according to each individual student
- Solar cells can be mounted in any configuration and the kit allows for an unlimited array of designs, specific to the student's USB device requirements
- The Dye Sensitized Solar Cell Kit correlates to basic engineering of photovoltaic cells. Engineering students may use different fruit juices as the solar dye to observe the voltage output from their design.

Math

- Graphing of solar insolation vs. voltage output can be produced; solar intensity vs. voltage, incident angle of incoming light vs. voltage output
- Use of a multi-meter and recording Voltage, Resistance and Ampere readings in using the Dye Sensitized Solar Cell Kit can result in the use of Ohm's Law by students to calculate any of the three variables: R=V/I

BOAT & ROCK DEMO P1-1025

Why is this STEM?

Science

- Archimedes' principle is the fundamental concept using the Boat and Rock Demo, illustrating that the upward buoyant force that is exerted on a body immersed in a fluid, whether fully or partially submerged, is equal to the weight the fluid the body displaces
- With the clear visual of Archimedes' Principle for the student, the concept can be observed on a small scale, and then extrapolated to a larger scale, such as an oil tanker or submarine
- This demo parallels what NSTA and the Common Core are attempting to convey to the student; critical thinking skills and independent thought

Technology

- Technology students study fluids, buoyancy and fluid mechanics in their curriculum
- Experimentation and hands-on manipulation of placing various masses (…and "types" of masses… the classic "pound of gold vs. the pound of feathers concept) in the boat, and observe how the boat sinks farther down into the water
- Tech students can also develop and design their own containers out of different materials
- Experiments with different fluids can be used (e.g. glycerin, oils, alcohols) and record the fluid that overflows through the tube and into the container

Engineering

- Relating the Boat and Rock Demo to real-life scenarios is a staple of the engineering piece for the classroom
- Since the weight of fluid makes the pressure higher as you go deeper, engineering aspects can be studied involving objects in fluid where the bottom of the object is lower and will therefore have a higher pressure on it than the top of the object
- Buoyancy is crucial to engineering any water craft's buoyancy. If an object is floating, the buoyancy equals the weight of the object. Give students a real-life "watercraft" (tug boat, tanker, submarine, etc.) to design and find out if it will float!

Math

- Buoyancy calculations are different for different situations; fully submerged objects vs. density of objects and fluids
- Buoyancy calculations can be made using Archimedes' principle: An object immersed in a fluid is buoyed up with a force equal to the weight of the fluid displaced by the object
- Comparisons between Mass and Weight (a concept students struggle with) can be accomplished

POLY DENSITY BOTTLE P1-2200

Why is this STEM?

Science

- The Poly-Density Bottle is excellent for density lessons in middle school physical science, chemistry, physics and general science principles. Demonstrates the Second Law of Thermodynamics.
- Used as a discrepant event in chemistry, physics and physical science classrooms; two different density liquids that appea "invisible"
- Because of the Poly-Density Bottle's "ability" to seemingly defy the Second Law of Thermodynamics (the entropy of an isolated system never decreases, because isolated systems always evolve toward thermodynamic equilibrium… maximum entropy), student critical thinking is heightened

- This demo parallels what NSTA and the Common Core are attempting to derive from students i.e. critical thinking skills and independent thought

Technology

- Technology students will study density and flow of fluids in their curriculum
- Tech students can also develop and design their own Poly-Density Bottle demonstrations using different fluids

Engineering

- Relating the Poly-Density Bottle demo to real-life scenarios is fundamental for the engineering piece for the classroom
- Thermodynamics principles correlate to heat pumps, heating systems, refrigeration and general heat flow, all studied in engineering

Math

- Density calculations are a crucial part of any physical science, chemistry or physics lab. The Poly-Density Bottle is an excellent introduction to any math lesson on density.
- Students can calculate density given volume and mass and would also bolster their skills in dimensional analysis with units

STUNT CAR LAB P4-1340

Why is this STEM?

Science

- Projectile motion can be studied; both vertical motion and angled motion, correlating with physical science studies
- The Stunt Car itself is a TRUE projectile and upon numerous trials, it illustrates repeatability, crucial to the Physical Science/Physics teacher
- The Stunt Car Lab parallels the physics problems that students are given in class; "…in a vacuum" word problems, given the minimal air resistance through the car's trajectory.
- Students observe "stunt car and motorcycle jumps" on YouTube and television; the Stunt Car Lab emulates these principles.

Technology

- The Stunt Car Lab would help tech students in designing their own launch systems; using this as a template for their working designs, as this is an integral piece of their curriculum.

Engineering

- As part of their curriculum, engineering students presently design their own launch systems on the computer, finding an optimal angle and speed for their projectile. Designing a simulated launch system on the computer that may surpass and improve the Stunt Car Lab specifications, using Arbor's system as a default template would be potential student project.

Math

- Calculations can be made on multiple variables; maximum vertical height of car during it trajectory given the time of flight, horizontal range of car.
- Students will use trigonometry functions (Sine, Cosine and Tangent) through the launching of the Stunt Car Lab

- Advanced calculations can be made on a launch height above the landing height (AP Physics/Calculus)

LASER RAY BOX AND LENSES P2-7680

Why is this STEM?

Science

- Optics, including plane and spherical mirrors Ray Diagrams, Concave/Convex Thin Lens diagrams and prism reflections, all can be studied
- The Laser Ray Box and Lenses assembly covers a myriad of physics science and physics concepts including Snell's Law, total internal reflection, refraction, reflection in mirrors and dispersion

Technology

- The Laser Ray Box and Lenses would assist a tech teacher in illustrating the fundamental concepts of optical systems: telescopes, binoculars, microscopes, eyeglasses, etc.

Engineering

- As part of their curriculum, engineering students utilize LASERs as part of their designing systems
- Optical computing and lens systems are incorporated into the engineering concepts and the Laser Ray Box and Lenses will help students to understand the basics of these systems

Math

- Calculations are made with the Laser Ray Box and Lenses for Snell's Law; $n_1 \sin\theta_1 = n_2 \sin\theta_2$
- Students will use trigonometry functions (Sine, Cosine and Tangent) to measure angles with a protractor and draw ray diagrams with a straightedge

ECONOMY DIGITAL STROBE P2-9015
LOW FREQUENCY 100HZ TUNING FORK P7-5700

Why is this STEM?

Science

- Using the Economy Digital Strobe and Low Frequency 100Hz Tuning Fork as a demo for the concepts of frequency and longitudinal wave production
- Sound and their propagation through a medium are part of every physical science and physics curriculum
- With the Digital Strobe, a science teacher can "match" the frequency of many vibrating/oscillating objects including standing wave devices, water droplets, spinning discs and wave/ripple tank wave fronts

Technology

- The Economy Digital Strobe can be used to demonstrate the concept of engine timing, rotational motion in engines and measure periods in oscillations schemes

Engineering

- The fundamental concepts of tuning forks permeate the inner working of timing devices and cell phones where engineering basics build their more complicated devices from

Math

- Calculations can be made using the Economy Digital Strobe to determine speeds of vibrating strings, standing wave generators. Given the digital readout of the strobe, frequencies are obtained and wavelength can be measured directly on the display Students can calculate (v=f.l) the wavelength of sound with this demo using measured frequencies for the strobe/tuning Fork set-up and the given speed of sound (temperature dependent)

GALILEOSCOPE KIT 11-0020

Why is this STEM?

Science

- Using the Galileoscope Kit, students learn about lenses and double lens systems for telescopes
- With the hands-on kit, students learn about a telescope's operation alongside appreciating Galileo's historic observations of Jupiter's Moons and other celestial observations
- High school physics students can sketch the ray diagrams for the single and double convex lens systems and locate the real image produced by the telescope

Technology

- The hands-on aspect of the Galileoscope Kit fully correlates with the technology curriculum
- Using the kit as a template, students can computer-design their own telescope, given the focal lengths of the lenses and create the devices as a tech project

Engineering

- Relating the Galileoscope Kit to the real-world applications such as the Hubble Telescope brings credence to the engineering marvels in creating such a precise apparatus
- Given the template of the Galileoscope, students can use this as a starting basis for designing a larger telescope, capable of increased magnification

Math

- Calculations can be made given the focal lengths of the lenses and using the lens equation→ $1/f=1/do + 1/di$
  Sizes of the images can be calculated using the magnification equation→ $Si/So=Di/Do$

ELASTI-LAUNCHER SET P4-1963

Why is this STEM?

Science

- Projectile motion can be studied; both vertical motion and angled motion, correlating with Physical Science studies.
- The Elasti-Launcher system's ability to be a TRUE projectile and exhibit repeatability is crucial to the Physical science teacher.
- The Elasti-Launcher system parallels the physics problems that students are given in class; "...in a vacuum" word problems, given the minimal air resistance through its flight.

Technology

- The Elasti-Launcher "rocket" would help Tech students in designing their own rocket systems; using this as a template for their working designs.
- After designing their own rockets, Tech students will use the Elasti-Launcher rocket to test the flight range and height, given the launch setting (1-10), launch angle (35-90^{o}) and number of rubber bands.

Engineering

- Engineering students will design a simulated rocket system on the computer that would surpass and improve the Elasti-Launcher rocket's specifications, using Arbor's system as a default template.

Math

- Calculations can be made on multiple variables; vertical height of rocket given the time of flight and the horizontal range of the rocket.
- Students will use Sine, Cosine and Tangent functions (Trig. Functions) through the launching of the Elasti-Launcher projectile.
- Graphing activities are varied and can allow students to graph single variable or multi-variable axes;
    i. Horizontal range vs. launch angle
    ii. Horizontal range vs. launch angle and Launch setting angle
    iii. Horizontal range vs. launch angle and # of rubber bands.
    iv. Horizontal range vs. launch angle, Launch setting angle and # of rubber bands.

SUPER BOTTLE ROCKET LAUNCHER P4-2050

Why is this STEM?

Science

- Projectile Motion in the vertical plane, Free fall and Acceleration due to Gravity are all studied, correlating with Physical Science and Physics curriculum
- The Super Bottle Rocket Launcher can be timed during its launch to find the vertical distance of the bottle rocket, acceleration due to gravity, initial velocity of the bottle rocket, etc.
- The Super Bottle Rocket Launcher system parallels physics and physical science word problems that students are given in class e.g. "…a ball is thrown into the air for 3.2 seconds. Find the highest point of the ball during its flight. "

Technology

- The Super Bottle Rocket Launcher "rocket" would help tech students in designing their own rocket systems, using this as a template for their working designs
- After designing their own rockets with altered fin configurations, amount of "fuel" (water) in the bottle rocket, etc., tech students will use the Super Bottle Rocket Launcher rocket to test their designs

Engineering

- Engineering students can design a rocket system to test friction reduction and parachute design, using Arbor's Super Bottle Rocket Launcher system

Math

- Calculations can be made for vertical height of bottle rocket given the time of flight; $d=at^2/2$
- Graphing activities are varied and can allow students to graph their teams/class results for;
    i. Vertical height range vs. Fuel (water) amounts
    ii. Total time of flight vs. parachute design (team challenge)

ADVENTURES IN FIBER OPTICS KIT P2-5200
FIBER OPTICS SCIENCE PROJECT KIT P2-5100
OPTICAL VOICE LINK KIT P2-5300

Why are these STEM?

Science

- Fiber optics is the application of an important concept in physics; that of total internal reflection, optical density, indices of refraction and Snell's Law
- Adventures in Fiber Optics Kit, Fiber Optics Science Project Kit and the Optical Voice Link Kit, students learn by hands-on labs, creating fiber optic "flashlights" and "Star Charts"
- The Fiber Optics Kits all allow students to manipulate optical fibers and observe their properties, fundamental to the newest and cutting-edge science: Nanotechnology
- These kits provide labs to the physical science, physics and nanotechnology teachers that no pre-written science lab manual contains or "touches" upon. An excellent hands-on optional lab for the AP Physics teacher who teaches advanced optics; the students even get to take their projects home!

Technology

- With the manual that comes with the Adventures in Fiber Optics Kit, physics and technology students can use the Ulexite ("TV rock") fiber optic mineral to illustrate how "bundled" fiber optics are used in medicine e.g as an endoscope
- With the Optics Voice Link Kit, Technology students study how telecommunication signals are sent over long distances and how sound is converted from analog to digital outputs
- Adventures in Fiber Optics Kit, Fiber Optics Science Project Kit and the Optical Voice Link Kit are tangible for the technology student teams to create a variety of projects, expanding on the standard activities offered in the enclosed manuals

Engineering

- The fundamental principles of engineering are accentuated when students realize that high-end optical instruments such as binoculars (prisms are used for total internal reflection instead of plane mirrors due to a decreased loss of optical signal in transmittance) use these concepts in their manufacture process
- Engineering students can design their own optical fibers with glass, plastic or other transparent materials using these kits as starting points for their team projects

Math

- Calculations complete the understanding of how the Critical Angle equation (Critical q = 1/Sin q) is derived Snell's Law. Students can complete the derivation as an exercise.

- Students will utilize Sine, Cosine and Tangent functions as well as Tan^{-1}, Sin^{-1}, Cos^{-1} functions (Trig. Functions) in calculating critical angles and drawing the ray diagrams involving Total Internal Reflection

MOLECULAR SIZE AND MASS KIT C4-1000

Why is this STEM?

Science

- The Molecular Size and Mass Kit is an excellent way to introduce atomic structure for chemistry teachers, thin films for the physics classroom or measurement of an oil slick for the nanotechnology teacher
- Hydrophobic and hydrophilic molecules are fundamental to the Molecular Size and Mass Kit and a crucial concept to the chemistry student e.g. determining why oils are not miscible in water or why the oil film "floats" on the surface of the water
- Nanotechnology students use this kit to investigate history's first nanotechnologist, Ben Franklin, when he first stuck his oil-soaked cane into an English pond and observed how the waters "calmed"
- Understanding the size of molecules is also a fundamental concept realized by physics and chemistry students. The Molecular Size and Mass Kit introduce this concept in a hands-on environment for students.
- The thin film interference is also an outgrowth from this kit's main emphasis. The colors produced from these thin films are observed in birds (peacock feathers), insects, abalone shells and soap bubbles.

Technology

- With the Molecular Size and Mass Kit, tech students can experiment with related areas: oil leaks from automobiles and boats, thin films used in manufacturing (lenses, packaging, toys, etc.)

Engineering

- The fundamental principles of engineering are used when cleaning up oil spills from tanker and oil rig platform accidents. Hydrophilic and hydrophobic materials are widely used in cleaning up the oil.
- Engineering students also study the effects of other substances due to their molecular mass, size and structure seen in filtration systems, liquid and gas transport and waste management schemes

Math

- Calculations are carried out by students in determining the thickness of a drop of Oleic Acid (Olive Oil) in water. An excellent exercise in proportions and conversions from liters to milliliters and from meters to nanometers.
- Further extensions for AP Math students can be made in word problem scenarios: "A gallon of Olive Oil was dumped overboard in Lake Michigan. What total area was the lake covered in oil?"

RENEWABLE ENERGY EDUCATION SET P4-2023

Why is this STEM?

Science

- The Renewable Energy Education Set ties in the newest focus for the world's energy solutions and brought to the classroom with renewable solar power (photovoltaic) creating hydrogen gas from water (electrolysis)
- Renewable energy is the "hot topic" in today's news students will learn concepts such as solar photovoltaic cells, electrolysis, proton-exchange membranes (PEM's), concepts infused in Chemistry and Physics classes
- Students will be separating Hydrogen from distilled water, an activity accomplished in chemistry classrooms under very controlled environments. This kit offers a safe and easily observable way for students to experience this chemical reaction.

Technology

- Air-breathing proton-exchange membrane (PEM) fuel cell modules are devices generally unattainable to technology students, but with this kit, students have access to a PEM and can conduct a team project on environmental-friendly vehicles for example
- The tech teacher can use this kit to inspire his students to design vehicles that will emulate the Hydrogen fuel technology that the Renewable Energy Education Set clearly demonstrates

Engineering

- The principle of electrolysis is paramount to fuel cells and engineering students will see parallels in Hydrogen cars and buses and especially space travel, including Apollo missions and the International Space Station, in producing water

Math

- Calculations are made through the chemical reactions/equations that are required to understand the production of Hydrogen gas. Balancing equations in electrolysis reactions requires knowledge and math aptitude where the oxidation and reduction is well understood.

ELECTROCHEMISTRY AND CHROMATOGRAPHY KIT P6-2120

Why is this STEM?

Science

- The Electrochemistry and Chromatography Kit expands on the Dye-Sensitized Solar Cell Kit, but adds two fundamental labs to the Physical Science, Chemistry and Biology teacher's lab portfolio
- Students will be able to use the technique of thin layer chromatography (TLC) to separate the pigments found in spinach leaves to see the different components involved in photosynthesis. Chromatography is a required lab in most Chemistry and AP Biology curricula.
- Students will observe first-hand the pigments making up chlorophyll, the substance essential to photosynthesis (red and blue as the main color constituents)
- Hands-on activities highlight student labs including student-produced galvanic cells, and how batteries work. Most students do not understand the concepts that drive their AA batteries and this kit leads them to the basic chemistry of these common household objects.

Technology

- Although tech students typically do not study chemistry in the same structured way, the rudimentary principles of electrochemical cells/batteries is a very important aspect in designing electronic devices and their power requirements
- Tech students can dissect 9V batteries to observe that at the core, the outer shell contains merely 6-1.5V batteries wired in series. This kit is an excellent starting point for the tech teacher to demonstrate a basic electrochemical cell.

Engineering

- With the chromatography lab in the Electrochemistry and Chromatography Kit, engineering students can expand from spinach leaves to candy coating ("M & M's", Skittles), "magic" markers and highlighter pens, various inks and even bird feathers (bluebird feathers contain very little blue pigment)
- Engineering more efficient batteries is a major focus for manufacturers of cell phones and other electronic devices. Designing a "better" battery using the kit as a basic building block for an electrochemical cell could inspire many students.

Math

- The use of multi-meters to record voltage, resistance and ampere readings are necessary when creating the electrochemical cell with this kit. Calculations in balancing equations for electrochemical reactions would be a required math skill for chemistry students.