STEM
Activities & Labs

Cost Effective Activities for
Middle School & High School Students

Earth Science, Biology, Chemistry, Physics,
Math, Engineering, and Computer Science

Center for Excellence in Education
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www.cee.org
About the Center for Excellence in Education

Mission
CEE’s mission is to nurture high school students and university scholars to careers of excellence and leadership in science, technology, engineering and mathematics, and to encourage collaboration among leaders in the global community.

History
The Center for Excellence in Education (CEE) has contributed to the scientific leadership of this country since its founding in 1983 by the late Admiral H. G. Rickover, the father of the nuclear navy and civilian uses of nuclear power, and Joann P. DiGennaro, CEE’s President. They recognized that nurturing young scholars to careers of excellence and leadership in science and technology was an essential investment in our national and global future. CEE recruits the most intellectually gifted and talented students and nurtures them through exceptionally designed programs to reach new academic heights to become tomorrow’s leaders in science, technology, engineering and mathematics.

CEE is a private, 501(c)3 not-for-profit corporation that provides cost-free programs to students and teachers through collaborations with educational institutions, private foundations, corporations, government agencies, and individuals who share a commitment to educational excellence and leadership.

Programs
In 1984, CEE launched the Research Science Institute (RSI), a six-week intensive summer science and engineering program for the world’s most accomplished high school students. The program combines on-campus course work in scientific theory with off-campus work in science and technology research. This program is collaboratively sponsored with MIT.

CEE launched the USA Biology Olympiad (USABO) in 2003, the premier competition in biology for high school students. The following year, the USA participated for the first time in the 2003 International Biology Olympiad (IBO). This program is offered in collaboration with the University of California, San Diego.

The CEE’s Teacher Enrichment Program (TEP) helps to assure a future talented and diverse U.S. workforce in STEM and focuses on best practices and resources. The program is broadly scoped, interdisciplinary and is comprised of four components: Bite of Science, STEM Teacher Roundtables, TEP Lab Bench, and Public/Private Partnerships.

*High school teachers are invited to encourage their schools to register in the fall for the USABO. All students who have completed 11th grade or comparable are encouraged to apply to RSI, offered at no cost to students.

Please visit the Center’s website at www.cee.org to learn more about our programs and educational initiatives.
About STEM Activities & Labs

This resource was developed as part of CEE’s Teacher Enrichment Program as an additional support for our middle school and high school teachers. It is comprised of a selection of hands-on activities and labs for student to investigate key concepts within Earth Science, Biology, Chemistry, Physics, Math, Engineering and Computer Science. Activities were selected for their cost-effectiveness and ability to teach key scientific concepts with minimal time investment.

Each activity description includes: summary, lesson objectives, approximate set-up time, approximate classroom time and a link to the digital resource. Activities have been divided into three levels:

- **Level 1** activities are appropriate for introductory classes and up
- **Level 2** activities are appropriate for regular/college-prep classes and up
- **Level 3** activities are appropriate for advanced, honors, AP, or IB classes.

Additionally, this resource includes activities that explore scientific inquiry and experimental design, instructions for improvised laboratory equipment, chemical substitutions, and STEM career resources.

This free resource was developed by Kim Edwards, Educational Programs Outreach Manager, and is available to TEP teachers and our partners. Support for TEP comes from corporations, foundations, individuals and organizations committed to improving STEM teaching and learning.

For more information about this resource and other CEE programs, please contact **Kim Edwards**, Educational Programs Outreach Manager, at kedwards@cee.org or (703) 448-9062, ext. 230.
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Additional Resources

Experimental Design Activities
- Designer Planes
- Designing a Science Experiment

Improvised Laboratory Supplies & Apparatus

Additional Curriculum Resources

STEM Career Information
Earth Science

Parking Lot Gravel

Description: Using a gravel parking lot, students determine local rock types and consider the human impact of natural resources.

Lesson Objectives:
- Increase awareness of human impact and use of a natural resource
- Use models to observe differences in properties of materials

Set-Up Time: 30 – 60 minutes
Activity Time: One 45 minute class period (1 period for Further Challenge)
Source: https://tinyurl.com/yd54yl3z

Let’s Talk Trash

Description: Students inspect a bag of trash and discuss recycling and re-use.

Lesson Objectives:
- Determine how to recycle, reuse or dispose of items in the trash
- Understand the impact of trash on the environment

Set-Up Time: 30 minutes
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/y7lsh9tz

Epicenters

Description: Students calculate the distance of locations from an earthquake to determine and map the epicenter.

Lesson Objectives:
- Locate the epicenter of an earthquake on a map
- Calculate distance to epicenter using arrival times of P-waves and S-waves

Set-Up Time: 30 - 60 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/y8ec8ucd

Cosmic Calendar

Description: Students equate the full span of cosmic time with one calendar year.

Lesson Objectives:
- Understand the order of cosmic events
- Understand the scale of time in the universe

Set-Up Time: 30 minutes
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/yc2cwl84

Variable Rivers

Description: Students design and conduct an experiment to investigate variables that affect the size and shape of rivers.

Lesson Objectives:
- Understand experimental design and how to investigate a variable
- Understand how amount of water, velocity of water, and riverbed steepness affect rivers

Set-Up Time: 60 minutes
Activity Time: Two 45 minute class periods
Source: https://tinyurl.com/yaytyegk
**Mudcracks: A Clue to the Earth’s Past**
*Activity Level 1*

**Description:** Students layer mud to understand how geologists use sedimentary deposits to learn about historical changes in landforms.

**Lesson Objectives:**
- Understand how sedimentary deposits form and their use to study landform changes
- Determine how infilled mudcracks can be used to determine “which way is up?”

**Set-Up Time:** 30 minutes
**Activity Time:** Two to three 45 minute class periods
**Source:** [https://tinyurl.com/y99jbyks](https://tinyurl.com/y99jbyks)

**Uptake of Carbon Dioxide from Water by Plants**
*Activity Level 1*

**Description:** Students experiment to understand the role of plants in mitigating ocean acidification.

**Lesson Objectives:**
- Understand the role of photosynthesis in environmental homeostasis
- Understand the effects of ocean acidification on marine life

**Set-Up Time:** 30 minutes
**Activity Time:** One to two 45 minute class periods
**Source:** [https://tinyurl.com/y8m7crfw](https://tinyurl.com/y8m7crfw)

**Nitrates and Phosphates and Algae, Oh My!**
*Activity Level 2*

**Description:** Students create their own algae blooms and investigate the causes and consequences of excessive algae growth through satellite imagery.

**Lesson Objectives:**
- Understand the factors that influence the occurrence and duration of algae blooms
- Explain the potentially harmful consequences of algal blooms

**Set-Up Time:** 30 minutes
**Activity Time:** One to two 45 minute class periods
**Source:** [https://tinyurl.com/ybz2dzl8](https://tinyurl.com/ybz2dzl8)

**A River Runs Through It**
*Activity Level 2*

**Description:** Students learn about the interconnectedness of land use, water quality, and water resource management. Students separately develop a parcel of river front and then connect them together to explore the effects of development and downstream water quality issues.

**Lesson Objectives:**
- Understand the connection between land use and water quality
- Understand how human activity affects land, freshwater and ocean resources

**Set-Up Time:** 30 minutes
**Activity Time:** Two 45 minute class periods
**Source:** [https://tinyurl.com/yd9oc8be](https://tinyurl.com/yd9oc8be)

**Volcano Monitoring with GPS**
*Activity Level 2*

**Description:** Students use graphs of GPS data to determine how the shape of Westdahl Volcano, Alaska.

**Lesson Objectives:**
- Describe how the surface of a volcano is measured to understand what is happening below ground
- Interpret and calculate velocity vectors from GPS time series graphs

**Set-Up Time:** 30 minutes
**Activity Time:** Two to three 45 minute class periods
**Source:** [https://tinyurl.com/ybl46sun](https://tinyurl.com/ybl46sun)
Beat the Uncertainty: Planning Climate-Resilient Cities  
**Activity Level 2**
**Description:** Students act as policy makers of a coastal city, working to increase the city’s resilience to climate change.

**Lesson Objectives:**
- Understand how cities plan for environmental challenges
- Understand the impact of climate change on coastal cities

**Set-Up Time:** 30 minutes
**Activity Time:** Two 45 minute class periods
**Source:** https://tinyurl.com/ybdkkwk7

And the Winner Is…  
**Activity Level 2**
**Description:** Students perform a weathering experiment to observe and compare the effects of running water on limestone and sandstone.

**Lesson Objectives:**
- Observe and compare the effects of running water on limestone and sandstone
- Collect and interpret data to explain results

**Set-Up Time:** 30 minutes
**Activity Time:** 5 weeks (45 minute set-up and 5 minutes per class)
**Source:** https://tinyurl.com/ybsdeb4g

Analogy of Relative Humidity  
**Activity Level 2**
**Description:** Students collect experimental data to determine the relationship between air temperature and the amount of water in the air.

**Lesson Objectives:**
- Develop a graph with experimental data to determine the relationship between air temperature and the amount of water the atmosphere can hold
- Relate this to depositional environment and economic importance.

**Set-Up Time:** 60 - 90 minutes
**Activity Time:** One 45 minute class period
**Source:** https://tinyurl.com/yboby8dt

How Much Lime is in Limestone?  
**Activity Level 2**
**Description:** Investigate the percentage of calcium oxide in a limestone sample and determine its optimal economic use.

**Lesson Objectives:**
- Determine the percentage of calcium oxide in a limestone sample and its optimal use
- Recognize the integrated nature of chemistry and geology

**Set-Up Time:** 30 - 60 minutes
**Activity Time:** One to two 45 minute class periods (allot additional time for drying)
**Source:** https://tinyurl.com/y72cgfkp
**Discovering Plate Boundaries Using Data**

*Activity Level 2*

**Description:** Using real data, students map plate boundaries and explore the processes that occur at plate tectonic boundaries.

**Lesson Objectives:**
- Understand the processes that occur at plate boundaries
- Interpret data to explain results

**Set-Up Time:** 1 - 3 hours

**Activity Time:** Three to four 45 minute class periods

**Source:** [https://tinyurl.com/ycdld2s2](https://tinyurl.com/ycdld2s2)

**Investigating the Precipitation-Streamflow Relationship**

*Activity Level 2*

**Description:** Students explore the impact that precipitation, soil porosity, the slope of the ground, and the time of year has on the water by graphing real data.

**Lesson Objectives:**
- Understand the various ways the water cycle can be impacted
- Understand the interactions between the water cycle and the geosphere

**Set-Up Time:** 30 minutes

**Activity Time:** Three to four 45 minute class periods

**Source:** [https://tinyurl.com/ybrrxzy7](https://tinyurl.com/ybrrxzy7)

**Rocky-to-Sandy Beach: A Weathering Model**

*Activity Level 3*

**Description:** Students apply their geology and the engineering design a potential method to create a sandy beach from rocky island shorelines.

**Lesson Objectives:**
- Explain how environmental conditions affect the weathering of rocks
- Demonstrate how abrasion weathering is an effective method to create beaches

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class period

**Source:** [https://tinyurl.com/ycf34nbn](https://tinyurl.com/ycf34nbn)

**Interconnected Atmosphere, Hydrosphere and Biosphere**

*Activity Level 3*

**Description:** Using a systems dynamics approach, students will work in groups to conceptualize and construct a model of the global carbon cycle considering five major Earth systems: atmosphere, hydrosphere, geosphere, cryosphere, and biosphere.

**Lesson Objectives:**
- Create a systems diagram to illustrate reservoirs, feedbacks, and fluxes within a system composed of the atmosphere, biosphere, and permafrost
- Modify the systems diagram to account for perturbations in the system resulting from a global catastrophic event

**Set-Up Time:** 30 minutes

**Activity Time:** Two 45 minute class periods

**Source:** [https://tinyurl.com/ybl5oxyt](https://tinyurl.com/ybl5oxyt)
**Heavy Metal Toxicity and Phytoremediation**  
**Activity Level 3**

**Description:** Students will explore heavy metal pollution through a series of activities including a 50% lethal dose lab (LD-50 lab), and remediating the contaminated solutions using phytoremediation.

**Lesson Objectives:**
- Students will learn about types and sources of heavy metal contaminants in water and soil
- Students will remediate a contaminated solution of copper sulfate using phytoremediation

**Set-Up Time:** 1 – 3 hours  
**Activity Time:** Ten 45 minute class periods  
**Source:** [https://tinyurl.com/y72ch8tg](https://tinyurl.com/y72ch8tg)

**Is Warming Natural or Anthropogenic?**  
**Activity Level 3**

**Description:** Students examine climate model output for the past, present, and future. They compare changes in temperature and precipitation patterns between experiments, and consider what factors contribute to those changes.

**Lesson Objectives:**
- Understand climate models to determine human impacts on climate over the 20th century
- Understand the impacts of anthropogenic land surface change and feedbacks of this on climate

**Set-Up Time:** 1 hour  
**Activity Time:** Three 45 minute class periods  
**Source:** [https://tinyurl.com/y637j68x](https://tinyurl.com/y637j68x)

**Flood Analysis**  
**Activity Level 3**

**Description:** Students learn how to use and graph real-world stream gage data to create event and annual hydrographs and calculate flood frequency statistics using Excel. Students learn how engineers make decisions about water resources and flooding.

**Lesson Objectives:**
- Plot an event hydrograph and make calculations using streamflow data
- Use peak streamflow data to perform a flood frequency analysis for a particular region

**Set-Up Time:** 1 hour  
**Activity Time:** Two 45 minute class periods  
**Source:** [https://tinyurl.com/y2x2ogx5](https://tinyurl.com/y2x2ogx5)

**Warm with a Chance of Melting**  
**Activity Level 3**

**Description:** Students use atmospheric and geodetic data to investigate the location, magnitude, and causes of ice mass changes in Greenland.

**Lesson Objectives:**
- Understand Greenland’s 21st century, non-uniform ice mass changes using snowmelt, ice velocity, ice elevation, and GRACE data
- Develop ocean-atmosphere-cryosphere explanations for the spatial and temporal variations observed

**Set-Up Time:** 1 hour  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/yxlnhe6w](https://tinyurl.com/yxlnhe6w)
Biology

**Photosynthesis Investigation**  
**Activity Level 1**

**Description:** Students first measure the rate of net photosynthesis (Part 1) and then develops and experiment to test factors that influence the rate of photosynthesis (Part 2).

**Lesson Objectives:**
- Understand the process of photosynthesis
- Understand how photosynthesis contributes to matter cycles

**Set-Up Time:** 1 hour

**Activity Time:** (Part 1) One 45 minute class period; (Part 2) Two to three 45 minute class periods

**Source:** [https://tinyurl.com/y7lt6waz](https://tinyurl.com/y7lt6waz)

**Food Webs, Energy Flow, Carbon Cycle, and Trophic Pyramids**  
**Activity Level 1**

**Description:** Students construct a food web to analyze the production and utilization of organic molecules in ecosystems.

**Lesson Objectives:**
- Understand how organic molecules move and are transformed through trophic pyramids
- Understand the trophic relationships in food webs, photosynthesis, cellular respiration, and biosynthesis

**Set-Up Time:** 30 minutes

**Activity Time:** Two to three 45 minute class periods

**Source:** [https://tinyurl.com/yc7klczy](https://tinyurl.com/yc7klczy)

**The Role of Microorganisms in the Ecosystem**  
**Activity Level 1**

**Description:** Students use a controlled experiment to demonstrate different rates of decomposition for a variety of man-made and natural materials.

**Lesson Objectives:**
- Compare and contrast the nutritional requirements for microbes and humans
- Develop an understanding of populations, resources, and environments

**Set-Up Time:** 15 minutes

**Activity Time:** One 45 minute class period & 4-12 weeks of observations

**Source:** [https://tinyurl.com/ybpcax7q](https://tinyurl.com/ybpcax7q)

**Moldy Jell-O**  
**Activity Level 1**

**Description:** Students design experiments to determine how substrate and environmental conditions influence growth of common molds.

**Lesson Objectives:**
- Understand how molds and fungi are different from plants
- Understand how molds and fungi grow

**Set-Up Time:** 1 hour

**Activity Time:** Two 45 minute class periods (set apart to allow mold to grow)

**Source:** [https://tinyurl.com/y8nl885t](https://tinyurl.com/y8nl885t)
**Pasta Critters**  
**Activity Level 1**  
**Description:** Students use a simulation to explore how dominant and recessive alleles are inherited. Students compare the population of "offspring" by combining randomly chosen parental alleles and predict offspring using a Punnett square.

**Lesson Objectives:**  
- Learn how dominant and recessive alleles are inherited and examine crosses using one or two traits  
- Observe how the independent assortment of alleles leads to predictable alleles and appearances in offspring  

**Set-Up Time:** 1 - 2 hours  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/y7238wev](https://tinyurl.com/y7238wev)

**Elements of Experimental Design**  
**Activity Level 1**  
**Description:** Students analyze an experiment and identify the experimental design components.

**Lesson Objectives:**  
- Develop an understanding of experimental design  

**Set-Up Time:** 10 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/ycgkqotn](https://tinyurl.com/ycgkqotn)

**Potato Cells**  
**Activity Level 1**  
**Description:** Students investigate how potato cells change as a result of osmosis.

**Lesson Objectives:**  
- Examine the how potato cells’ volume and flexibility change as a result of osmosis  
- Develop an understanding of how cells react to environmental changes  

**Set-Up Time:** 60 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** [https://tinyurl.com/yadg6q3n](https://tinyurl.com/yadg6q3n)

**The Hunger Games: Hiding in Plain Sight**  
**Activity Level 1**  
**Description:** Students act as predators searching for prey, represented by plastic Easter eggs. Students explore the concept of evolution by natural selection using mimicry as an example.

**Lesson Objectives:**  
- Understand the process of evolution by natural selection  
- Understand that populations evolve and that evolution occurs across generations  

**Set-Up Time:** 1 hour  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/ybqplpjg5](https://tinyurl.com/ybqplpjg5)

**Fruit Loops DNA**  
**Activity Level 2**  
**Description:** Students extract DNA from fruit and compare the amount of DNA collected.

**Lesson Objectives:**  
- Understand how to extract DNA from cells  
- Understand the scale of DNA  

**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/ycppqdk8](https://tinyurl.com/ycppqdk8)
**Tough Decisions**

**Activity Level 2**

**Description:** Using real DNA testing case studies, students are asked to make ethical decisions about each case and compare their decisions with ethicists.

**Lesson Objectives:**
- Understand the ethical issues surrounding DNA testing and technology

**Set-Up Time:** 15 minutes

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/y72qbbj](https://tinyurl.com/y72qbbj)

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**Influenza Virus: A Tiny Moving Target**

**Activity Level 2**

**Description:** Students explore how influenza viruses infect cells and replicate. Students also explore where influenza viruses come from, how they change, and why some become deadly.

**Lesson Objectives:**
- Understand how influenza viruses infect and replicate in cells
- Understand how influenza viruses can become an epidemic

**Set-Up Time:** 1 hour

**Activity Time:** Two to three 45 minute class periods

**Source:** [https://tinyurl.com/y7e88emz](https://tinyurl.com/y7e88emz)

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**Do Apples Tan?**

**Activity Level 2**

**Description:** Students design experiments to identify factors that affect an enzyme in apples. The enzyme studied turns some fruits, such as apples, to brown when cut.

**Lesson Objectives:**
- Determine the factors that turn some fruits, such as apples, to brown when they are cut
- Identify conditions that prevent browning
- Examine the variables that change the rate or stop an enzyme-controlled activity

**Set-Up Time:** 4 hours

**Activity Time:** Four 45 minute class periods

**Source:** [https://tinyurl.com/ya2ey6q6](https://tinyurl.com/ya2ey6q6)

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**Finger Fitness**

**Activity Level 2**

**Description:** Students investigate the capacity of the index finger to sustain repeated muscle contractions. Students design an experiment to determine the effects of variables on the rate of finger tapping.

**Lesson Objectives:**
- Explain how and why muscles fatigue
- Design an experiment to determine the effect of variables on the ability of finger muscles to maintain a maximum rate of contraction

**Set-Up Time:** 10 minutes

**Activity Time:** Four 45 minute class periods

**Source:** [https://tinyurl.com/ycmytlby](https://tinyurl.com/ycmytlby)
Modeling the Rise of Antibiotic Resistance  
**Activity Level 2**

**Description:** Students develop models of the impacts of multiple rounds of antibiotic treatment on the gut microbiome.

**Lesson Objectives:**
- Describe how antibiotic resistance in bacterial populations demonstrates natural selection
- Understand how standing trait variation, heritability, and a link to reproductive success are necessary for evolution by natural selection within a population

**Set-Up Time:** 60 minutes

**Activity Time:** Four to five 45 minute class periods

**Source:** [https://tinyurl.com/y9f5m9bk](https://tinyurl.com/y9f5m9bk)

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Up and Away  
**Activity Level 3**

**Description:** Students design and conduct experiments to determine the effects of factors, such as tropisms, on the growth and development of dandelion stalks without flower heads.

**Lesson Objectives:**
- Describe the abiotic factors that influence the growth and development of a dandelion stalk
- Explain the cellular mechanisms that dandelion stalks might employ in response to gravity that show measurable growth within one class period

**Set-Up Time:** 45 minutes

**Activity Time:** Three 45 minute class periods

**Source:** [https://tinyurl.com/ya49g2uq](https://tinyurl.com/ya49g2uq)

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Biosphere 3  
**Activity Level 3**

**Description:** Students will investigate and analyze mathematically the interactions that take place among several variables of a closed ecosystem.

**Lesson Objectives:**
- Develop a simple mathematical model that investigates the complicated processes and systems of an artificial ecosystem
- Describe the role that each biotic and abiotic variable plays within the ecosystem
- Observe, record, and interpret how different components of the ecosystem change as they interact with each other and the environment

**Set-Up Time:** 15 minutes (basic); 3 hours (set-up optional “closed bottle” display)

**Activity Time:** Three 45 minute class periods

**Source:** [https://tinyurl.com/yb769rod](https://tinyurl.com/yb769rod)

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Finding Mr. Right  
**Activity Level 3**

**Description:** Using real data, answer the question: How does mate choice by high- and low- elevation female mountain chickadees contribute to local adaptation?

**Lesson Objectives:**
- Understand and explain local adaption and its relation to evolution

**Set-Up Time:** 30 minutes (Must request access to free lesson plan)

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/y63ru9fn](https://tinyurl.com/y63ru9fn)
Which Way to Grow

**Description:** Students will assess the influence of seed orientation on the direction of root growth in corn seeds.

**Lesson Objectives:**
- Explain how gravity is thought to cause the geotropic response in a corn plant
- Measure angular differences in root growth and interpret these data with statistical analysis

**Set-Up Time:** 10 minutes (gather supplies); 12 hours (soak seeds)

**Activity Time:** Two to three 45 minute class periods

**Source:** [https://tinyurl.com/yawdt5kk](https://tinyurl.com/yawdt5kk)

Bioinformatics

**Description:** Using real data sets, students learn how to use bioinformatics to link genotype and phenotype.

**Lesson Objectives:**
- Understand the link between genotype and phenotype
- Understand how bioinformatics is used

**Set-Up Time:** 1 - 2 hours

**Activity Time:** Three 45 minute class periods

**Source:** [https://tinyurl.com/yyo5a522](https://tinyurl.com/yyo5a522)

What's the Connection?

**Description:** Students elicit and observe reflex responses and distinguish between types of reflexes. They then design and conduct experiments to learn more about reflexes and their control by the nervous system.

**Lesson Objectives:**
- Identify common reflexes of the human body and the neural circuitry involved in these reflexes
- Distinguish between stretch and protective reflexes

**Set-Up Time:** 1 hour

**Activity Time:** Four 45 minute class periods

**Source:** [https://tinyurl.com/y2abenup](https://tinyurl.com/y2abenup)

Expression and Epigenics

**Description:** Using real data, students compare expression and epigenetics in stem cells to determine if engineered iPSC and ES cells have similar molecular signatures.

**Lesson Objectives:**
- Understand how gene expression is measured
- Understand epigenetics

**Set-Up Time:** 1 hour

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/y2c9yz8v](https://tinyurl.com/y2c9yz8v)
Chemistry

**Countertop Chemistry**  
**Activity Level 1**

**Description:** Packet contains over 20 different types of chemical reactions that can be used as demonstrations or labs using household supplies.

**Set-Up Time:** Varies depending on activity

**Activity Time:** One to two 45 minute class periods

**Source:** https://tinyurl.com/y9do4sb8

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**What is a Chemical Reaction?**  
**Activity Level 1**

**Description:** Students use atom model cut-outs to model the reaction of a candle burning to see that all the atoms in the reactants show up in the product.

**Lesson Objectives:**
- Explain the how a chemical reaction occurs

**Set-Up Time:** 30 minutes

**Activity Time:**  One 45 minute class period

**Source:** https://tinyurl.com/9lr54ns

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**Controlling the Amount of Products in a Chemical Reaction**  
**Activity Level 1**

**Description:** Students analyze the chemical equation for the reaction between water and vinegar and change the amounts of reactants to see how the change affects the amount of products.

**Lesson Objectives:**
- Explain, on a molecular level, why changing the amount of one or more reactants changes the amount of products

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class period

**Source:** https://tinyurl.com/lqk3bjb

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**Temperature and the Rate of a Chemical Reaction**  
**Activity Level 1**

**Description:** Students design an experiment to determine if temperature affects the rate of a chemical reaction.

**Lesson Objectives:**
- Understand how to identify and control variables in their experimental design
- Explain, on a molecular level, why the temperature of reactants affects the rate of reaction.

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class period

**Source:** https://tinyurl.com/nbf3ems

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**A Catalyst and the Rate of Reaction**  
**Activity Level 1**

**Description:** Students use salt as a catalyst in a reaction between aluminum foil and a solution of copper II sulfate.

**Lesson Objectives:**
- Explain how a catalyst works

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class period

**Source:** https://tinyurl.com/loomx2h
Molecules in Motion

Description: Students add food coloring to hot and cold water to see whether heating or cooling affects the speed of water molecules.

Lesson Objectives:
- Explain, on the molecular level, that heating and cooling affect molecular motion

Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/omme3os

Using Dissolving to Identify an Unknown

Description: Students explore solubility and design a solubility test to identify an unknown sample.

Lesson Objectives:
- Identify and control variables when designing a solubility test
- Explain why different substances dissolve to different extents in water

Set-Up Time: 1 – 2 hours
Activity Time: Two to three 45 minute class periods
Source: https://tinyurl.com/yaop2wl9

Can Liquids Dissolve in Water?

Description: Students test the solubility of different liquids in water to expand their definition of solubility and “dissolving”.

Lesson Objectives:
- Identify and control variables to help design a solubility test for different liquids
- Explain, on the molecular level, that the solubility of a liquid is a characteristic property of that liquid

Set-Up Time: 1 – 2 hours
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/yd9hyvkx

Forming a Precipitate

Description: Students combine clear colorless solutions (baking soda and calcium chloride) to form a solid and a gas.

Lesson Objectives:
- Explain the conditions needed for a chemical reaction to take place
- Explain how this definition applies to the production of a solid called a precipitate

Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/oeas7jk

Using Chemical Change to Identify an Unknown

Description: Students observe the chemical changes of reactions and design a test to identify and unknown sample.

Lesson Objectives:
- Identify and control variables when designing a test to identify and unknown powder
- Explain how to use characteristics of chemical reactions to identify an unknown substance

Set-Up Time: 1 hour
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/y7gs62kc
Chemical Reactions & Engineering Design  
**Activity Level 2**

**Description:** Students are presented with an engineering design challenge: Build a portable device which can warm, support, and protect one reptile egg as it is moved from a construction site to a nearby reptile conservation center.

**Lesson Objectives:**
- Understand the Engineering Design Process
- Understand how engineering uses scientific principles to solve real-world problems

**Set-Up Time:** 1 – 2 hours

**Activity Time:** Activity times vary

**Source:** https://tinyurl.com/hhnqjev

Natural Resources & Synthetic Materials  
**Activity Level 2**

**Description:** Students research a synthetic product and make an advertisement, poster, short video, or article it.

**Lesson Objectives:**
- Describe the chemical processes that are used to convert natural resources into synthetic materials and products
- Explain how the production of synthetic products impacts the environment and society

**Set-Up Time:** 1 – 2 hours

**Activity Time:** Activity times vary

**Source:** https://tinyurl.com/hapnm2k

Blowing Up Balloons, Chemically  
**Activity Level 2**

**Description:** Students conduct a closed system experiment that does not permit matter to enter or exit the apparatus to observe changes in a chemical reaction.

**Lesson Objectives:**
- Determine what observable factors are changed in a chemical reaction
- Determine what observable factors remain constant in a chemical reaction

**Set-Up Time:** 30 - 60 minutes

**Activity Time:** Two to three 45 minute class periods

**Source:** https://tinyurl.com/yac4dmbp

Chemistry Clicks Your Bic  
**Activity Level 2**

**Description:** Students conduct an experiment to determine the molecular mass of butane.

**Lesson Objectives:**
- Experimentally determine the molecular mass of butane
- Understand how to use the Ideal Gas Law and Dalton's Law of Partial Pressures

**Set-Up Time:** 30 - 60 minutes

**Activity Time:** One to two 45 minute class periods

**Source:** https://tinyurl.com/y73aendr
Creepy Metals  
**Activity Level 2**  
**Description:** Students conduct an experiment to determine the tensile strength and creep of metals.  
**Lesson Objectives:**  
- Determine the tensile strength and creep of three common metals  
- Understand tensile strength and creep of metals  
**Set-Up Time:** 30 - 60 minutes  
**Activity Time:** One to two 45 minute class periods  
**Source:** [https://tinyurl.com/y9ogijwe](https://tinyurl.com/y9ogijwe)

Hot & Cold Reactions  
**Activity Level 2**  
**Description:** Students experimentally determine the caloric change of endothermic and exothermic reactions.  
**Lesson Objectives:**  
- Understand the difference between endothermic and exothermic reactions, the relative safety of each type of reaction and how chemists design reactions for safety  
- Understand how to calculate the energy in a reaction  
**Set-Up Time:** 30 - 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/yb352uxe](https://tinyurl.com/yb352uxe)

The Flavor of Organic Chemistry  
**Activity Level 2**  
**Description:** Students explore organic chemistry through the study of flavor.  
**Lesson Objectives:**  
- Understand the organic chemistry behind flavors  
- Understand the applications of organic chemistry in food science  
**Set-Up Time:** 10 – 80 minutes per activity  
**Activity Time:** One to two class 45 minute class periods per activity  
**Source:** [https://tinyurl.com/y9yyy5fr](https://tinyurl.com/y9yyy5fr)

Out Spot, Darn Spot  
**Activity Level 3**  
**Description:** Cleaning stains from clothing is an example of how to apply solubility chemistry. Students design and conduct their own experiment to remove stains from fabric.  
**Lesson Objectives:**  
- Learn about experimental design  
- Learn about solubility  
**Set-Up Time:** 30 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/y876hfbv](https://tinyurl.com/y876hfbv)

The Solution to the Solubility is the Solvent  
**Activity Level 3**  
**Description:** Students experimentally determine the solubility of various solvents.  
**Lesson Objectives:**  
- Determine the solubility of three different types of solvents  
- Collect and interpret data to explain results  
**Set-Up Time:** 30 - 60 minutes  
**Activity Time:** One to two 45 minute class periods  
**Source:** [https://tinyurl.com/yb3hfdas](https://tinyurl.com/yb3hfdas)
**Close Encounters of the Polymer Kind**

**Activity Level:** 3  
**Description:** Students learn about polymers and their application and use in industry. Students create their own thermoset materials and mechanically test them.

**Lesson Objectives:**  
- Understand and describe polymers and their behaviors  
- Understand thermoplastics and thermosets  

**Set-Up Time:** 1 hour  
**Activity Time:** One to two 45 minute class periods  
**Source:** [https://tinyurl.com/y7l4uc5c](https://tinyurl.com/y7l4uc5c)

**Researching Ocean Acidification**

**Activity Level:** 3  
**Description:** Students design and carry out a project around the rate of ocean acidification and explore concepts of kinetics, equilibrium, acid-base chemistry and solubility.

**Lesson Objectives:**  
- Understand ocean acidification and the chemistry of oceans  
- Understand kinetics, equilibrium, acid-base chemistry and solubility  

**Set-Up Time:** 2-3 hours  
**Activity Time:** Minimum of 6 45 minute class periods  
**Source:** [https://tinyurl.com/y4uyxh7m](https://tinyurl.com/y4uyxh7m)

**Exothermic, Endothermic, & Chemical Change**

**Activity Level:** 3  
**Description:** Students explore the relationship between an observed change in temperature and the classification of a change as chemical or physical.

**Lesson Objectives:**  
- Understand energy changes during chemical reactions and the heat of reaction  
- Understand the connection between energy changes and chemical changes  

**Set-Up Time:** 2 hours  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/y52juj6w](https://tinyurl.com/y52juj6w)

**Energy & Entropy of a Stretched Rubber Band**

**Activity Level:** 3  
**Description:** Students use a rubber band to explore the concepts of Gibbs free energy, enthalpy, and entropy and their relation to the spontaneity of a physical process.

**Lesson Objectives:**  
- Understand Gibbs free energy, enthalpy and entropy  
- Understand how those concepts relate to the spontaneity of stretching or contracting a rubber band  

**Set-Up Time:** 1 hour  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/yy425h9b](https://tinyurl.com/yy425h9b)
Physics

**Exploring Energy Conservation with Rulers and Cars**  
*Activity Level 1*  
**Description:** Students investigate how to maximize the conservation of potential energy into kinetic energy using a flexible ruler and a Hot Wheels car.  
**Lesson Objectives:**  
- Understand the law of conservation of energy  
**Set-Up Time:** 30 – 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/ya5tl8c6

**Acceleration and Velocity Through Paces and Excel**  
*Activity Level 1*  
**Description:** Students investigate the relationship between distance, time, speed and acceleration.  
**Lesson Objectives:**  
- Understand the relationship between distance, time, velocity and acceleration for an object traveling in a straight line  
- Understand how to use excel to make graphs to draw conclusions about the relationship between distance, time, velocity and acceleration  
**Set-Up Time:** 15 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/ycczzf4c

**Pendulum Time**  
*Activity Level 1*  
**Description:** Students explore how the pendulum has been a reliable way to keep time for centuries. Students teams work to develop a pendulum from everyday objects that can measure time and operate at different speeds.  
**Lesson Objectives:**  
- Understand how pendulums work  
- Understand the use of pendulums to keep time  
**Set-Up Time:** 30 - 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/ycwcsa3q

**Simple Machines**  
*Activity Level 1*  
**Description:** Students experiment with a variety of simple machines such as: pulleys, levers, wedges and wheels through a series of activities.  
**Lesson Objectives:**  
- Understand how simple machines work  
- Understand how simple machines reduce work  
**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period per activity  
**Source:** https://tinyurl.com/ycben7qu
**On Target!**  
*Activity Level 1*

**Description:** Students modify a paper cup so it can zip down a line and drop a marble onto a target.

**Lesson Objectives:**
- Learn about the Engineering Design Process
- Learn about energy, motion and forces

**Set-Up Time:** 30 - 60 minutes  
**Activity Time:** One 45 minute class periods  
**Source:** https://tinyurl.com/yczwpma4

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**Acceleration Lab**  
*Activity Level 2*

**Description:** Students conduct an experiment to find the acceleration of a toy car.

**Lesson Objectives:**
- Use graphs of distance vs. time and velocity vs. time to find the acceleration of a toy car
- Observe the relationship between the angle of an inclined plane and the acceleration of a toy car on the inclined plane

**Set-Up Time:** 30 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** https://tinyurl.com/y8z5de3u

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**Force Lab**  
*Activity Level 2*

**Description:** Lab contains three different activities/stations: (1) Students use a cart and pulley system to study Newton’s 2nd Law. (2) Students determine the coefficient of static friction. (3) Students use a Hook’s Law Apparatus to determine the spring constant.

**Lesson Objectives:**
- Understand Hook’s Law and Newton’s Second Law
- Observe how friction can affect an experiment

**Set-Up Time:** 1-3 hours (depending on material needs)  
**Activity Time:** Two 45 minute class periods  
**Source:** https://tinyurl.com/y86mw5jv

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**Motion in Two Dimensions**  
*Activity Level 2*

**Description:** Students conduct two experiments to (1) Determine the range of a projectile and (2) Determine at what point a balanced ruler will no longer be in equilibrium.

**Lesson Objectives:**
- Use kinematic equations for motion in two dimensions to determine the range of a projectile.
- Use the equation for torque to determine at what point a balanced ruler will not continue to be in equilibrium

**Set-Up Time:** 30 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** https://tinyurl.com/yd5xwa9m
Motion of Mass on a Spring
Description: Students investigate the rest mass on a spring and the simple harmonic motion that is formed by it.

Lesson Objectives:
• Understand the concepts of frequency, period, amplitude, and displacement of the mass during simple harmonic motion
• Understand how to calculate frequency, period, amplitude and displacement of a mass during simple harmonic motion

Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/yd5vyc6n

Angular Momentum Experiment
Description: Using a bicycle, students investigate momentum, conservation of momentum, angular momentum, and conservation of angular momentum.

Lesson Objectives:
• Distinguish between angular momentum and linear momentum
• Understand the formula for and how to calculate angular momentum

Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/yd2rfn56

How Much Does it Take to Win the Race?
Description: Students are presented with two objects (typically cars) that have different constant speeds and that will race each other. Without being given all of the characteristics of the situation, students must determine which object will win the race, as well as how much time elapses between the objects crossing the finish line.

Lesson Objectives:
• Understand position, time and speed as they apply to two objects moving simultaneously along the same axis
• Develop real-world problem solving skills

Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/y7rexzn2

Mass of Object Falling at Terminal Velocity
Description: Students estimate the mass of a coffee filter falling at terminal velocity.

Lesson Objectives:
• Understand gravity and terminal velocity
• Understand how the relationship between mass and terminal velocity

Set-Up Time: 15 minutes
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/ya4f44ly
**Measuring Viscosity**  
**Activity Level 2**  
**Description:** Students calculate the viscosity of various household fluids by measuring the amount of time it takes marble or steel balls to fall given distances through the liquids. They experience what viscosity means, and also practice using algebra and unit conversions.  
**Lesson Objectives:**  
- Understand viscosity and how to measure the viscosity of a fluid  
- Understand how to describe a fluid as having “high” or “low” viscosity  
**Set-Up Time:** 1 hour  
**Activity Time:** One to two 45 minute class periods  
**Source:** https://tinyurl.com/yblq5svy

**Electric Circuit Puzzles**  
**Activity Level 3**  
**Description:** Students solve electrical circuit puzzles using a battery pack, small light bulbs and an F capacitor.  
**Lesson Objectives:**  
- Understand how electric circuits work  
**Set-Up Time:** 1 – 2 hours  
**Activity Time:** One to two 45 minute class periods  
**Source:** https://tinyurl.com/ya74d9uo

**Hot Wheels Friction**  
**Activity Level 3**  
**Description:** Students design an experiment to measure the effective friction coefficient between a Hot Wheels car and track.  
**Lesson Objectives:**  
- Understand friction and how to measure friction coefficient  
**Set-Up Time:** 15 minutes  
**Activity Time:** One to two 45 minute class periods  
**Source:** https://tinyurl.com/yao26ttt

**Monitoring Noise Levels**  
**Activity Level 3**  
**Description:** Students learn about the physical properties of sound, how it travels and how noise impacts human health-including the quality of student learning by collecting data through a smart phone.  
**Lesson Objectives:**  
- Calculate the frequency, wavelength and amplitude of waves  
- Describe how sound moves through various media and the difference between noise and sound  
**Set-Up Time:** 1 hour  
**Activity Time:** Three 45-minute class periods  
**Source:** https://tinyurl.com/yysdxays

**Loop the Loop**  
**Activity Level 3**  
**Description:** Students design and test a model of an amusement ride that has a car completing a loop using Hot Wheels.  
**Lesson Objectives:**  
- Understand centripetal motion and inertia  
**Set-Up Time:** 15 minutes  
**Activity Time:** One to two 45 minute class periods  
**Source:** https://tinyurl.com/yaaxthvx
**Roller Splash**

**Activity Level 3**

**Description:** Students design and test a model of an amusement ride that has a car that lands in a pool of water using Hot Wheels.

**Lesson Objectives:**
- Understand projectile motion

**Set-Up Time:** 15 minutes

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/y7tgknw2](https://tinyurl.com/y7tgknw2)

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**Make That Invisible!**

**Activity Level 3**

**Description:** Students determine the refractive index of a liquid. Then they predict the refractive index of a material (a Pyrex glass tube) by matching it with the known refractive index of a liquid using the percent light transmission measurement.

**Lesson Objectives:**
- Determine the relationship of the angle of incidence and the angle of refraction between two different media
- Determine the refractive index of an unknown material using percent light transmission

**Set-Up Time:** 2 hours

**Activity Time:** Four 45 minute class periods

**Source:** [https://tinyurl.com/y5oqy3k2](https://tinyurl.com/y5oqy3k2)

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**Applying Hooke's Law to Cancer Detection**

**Activity Level 3**

**Description:** Students use Hooke's Law to explore a tissue of known surface area. Students then use Hooke's Law and the stress-strain equation to depict a cancerous tumor amidst normal tissue by creating a graph in Microsoft Excel.

**Lesson Objectives:**
- Understand and explain Hooke's Law
- Apply Hooke’s law relationships to analyzing tissue of a known surface area

**Set-Up Time:** 1 hour

**Activity Time:** Three 45 minute class periods

**Source:** [https://tinyurl.com/y4vmcwby](https://tinyurl.com/y4vmcwby)
Math

Math Problem of the Week
Description: Variety of math problems for students to solve in Algebra, Geometry, Statistics and Algebra 2.
Set-Up Time: 5 minutes
Activity Time: Varies
Source: https://tinyurl.com/y8yna6ay

Falling Filters
Description: Students determine the number of coffee filters present in a trial once you know the magnitude of their terminal velocity.
Set-Up Time: 15 minutes
Activity Time: One 45 minute class period
Source: https://tinyurl.com/ycue3f7a

Bills, Bills, Bills
Description: Students use algebra equations to explore budgets and paying bills through a series of four activities.
Set-Up Time: 30 minutes
Activity Time: One 45 minute class period per activity
Source: https://tinyurl.com/y7b9wyt2

Heavy Candy
Description: Students weigh and count M and M’s. Using their data, they will write an equation predicting the weight of M and M’s from the number.
Set-Up Time: 30 minutes
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/ydhyat5g

Candy Hunt
Description: Students write and solve a system of inequalities and equations with a creative candy twist.
Set-Up Time: 30 minutes
Activity Time: Two 45 minute class periods
Source: https://tinyurl.com/y8o25cdr

Linear Equations Game
Description: Students groups act as aerospace engineering teams competing to create linear equations to guide space shuttles safely through obstacles generated by a modeling game in level-based rounds.
Set-Up Time: 2 hours
Activity Time: Two to three 45 minute class periods
Source: https://tinyurl.com/ycf4kjlx

Remodel
Description: Students take a floorplan and calculate the cost to install new flooring.
Set-Up Time: 30 minutes
Activity Time: One to two 45 minute class periods
Source: https://tinyurl.com/y7fajprk
**Sizing Up Pluto**  
**Description:** Using measurements taken by the New Horizons spacecraft as it flew by Pluto in July 2015, students calculate dimensions and the density of Pluto.  
**Set-Up Time:** 15 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/yc68zonw](https://tinyurl.com/yc68zonw)

**Geometry Puzzles**  
**Description:** A series of geometry puzzles that ask students to use logic to solve.  
**Set-Up Time:** 15 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/y9lxmlzn](https://tinyurl.com/y9lxmlzn)

**All Burned Out**  
**Description:** Students will write equations of lines and geometric series using experimental data from burning candles.  
**Set-Up Time:** 30 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/y9t2r6nr](https://tinyurl.com/y9t2r6nr)

**Disappearing Discs**  
**Description:** Students collect data using plastic chips to write a model of exponential decay that fits their data.  
**Set-Up Time:** 30 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** [https://tinyurl.com/yayb444p](https://tinyurl.com/yayb444p)

**Pizza Pi**  
**Description:** Students use the formula for the area of a circle to calculate how much of a pizza is actually pizza, and how much is crust. Then students write linear and quadratic equations for these functions and also express these areas as a percent of the whole pie’s area.  
**Set-Up Time:** 30 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/y8g5aqtt](https://tinyurl.com/y8g5aqtt)

**Credit Cards Unit**  
**Description:** Students explore interest and compounding interest through a series of five activities about credit and credit cards.  
**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period per activity  
**Source:** [https://tinyurl.com/ybg5kf4k](https://tinyurl.com/ybg5kf4k)

**Let’s Go to Mars! Calculating Launch Windows**  
**Description:** Students calculate the next launch opportunity to Mars using planetary-position data.  
**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/ycrhrugu](https://tinyurl.com/ycrhrugu)
Fall of Javert  Algebra 2
Description: Students use quadratic functions about how objects fall to determine how high Javert’s bridge in the Les Miserables must have been and explore this even further in two optional project tasks.
Set-Up Time: 30 minutes
Activity Time: Three 45 minute class periods (Optional project tasks total 10 class periods)
Source: http://pblu.org/projects/fall-of-javert

On the Rebound  Algebra 2 or Statistics
Description: Students will write the equation of an exponential function using data from an experimental situation.
Set-Up Time: 30 minutes
Activity Time: One 45 minute class period
Source (Algebra 2): https://tinyurl.com/yamvt6pw
Source (Statistics): https://tinyurl.com/y7qi5uy3

Three Shots  Statistics
Description: Students calculate the probability of a win, loss, or tie when a player has three free throws and his team is down by two, and then after the player has taken his first and second shots. Students also calculate the conditional probability of a win or loss for the defensive team, given that they foul or don't foul.
Set-Up Time: 30 minutes
Activity Time: Two to three 45 minute class periods
Source: https://tinyurl.com/y7a6vyhj

A Sweet Task  Statistics
Description: Working in pairs and with class discussion, students will gain an understanding of how to create two-way frequency tables and interpret relative frequencies in the context of types and colors of candy.
Set-Up Time: 30 minutes
Activity Time: Two 45 minute class periods
Source: https://tinyurl.com/ybpzvwuu8

Odd or Even?  Statistics
Description: Students use the Addition Principle to calculate the probability of mutually exclusive and non-mutually exclusive events. Students explore the probabilities of complementary events and develop the Complement Principle.
Set-Up Time: 30 minutes
Activity Time: Two 45 minute class periods
Source: https://tinyurl.com/yd92v8k8
Engineering

Spaghetti Bridges

**Description:** Student teams explore the field of civil engineering by making bridges from spaghetti and then test the bridges to see how much weight the bridge can hold.

**Lesson Objectives:**
- Learn about the Engineering Design Process
- Understand building techniques used by civil engineers

**Set-Up Time:** 30 minutes

**Activity Time:** Two to three 45 minute class periods

**Source:** [https://tinyurl.com/yb5tw77x](https://tinyurl.com/yb5tw77x)

On Target!

**Description:** Students modify a paper cup so it can zip down a line and drop a marble onto a target.

**Lesson Objectives:**
- Learn about the Engineering Design Process
- Learn about energy, motion and forces

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class periods

**Source:** [https://tinyurl.com/yczwpma4](https://tinyurl.com/yczwpma4)

Build Your Own Robot Arm

**Description:** Students design and build a robot arm using common materials to explore design, construction, teamwork, and materials selection.

**Lesson Objectives:**
- Learn about simple machines
- Learn about the Engineering Design Process

**Set-Up Time:** 60 minutes

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/qcx899q](https://tinyurl.com/qcx899q)

Do Materials Get Tired?

**Description:** Students investigate how materials fail under prolonged stress by testing the fatigue of paperclips.

**Lesson Objectives:**
- Conduct an experiment mimicking a torsion test
- Determine the shear stress on a paperclip

**Set-Up Time:** 30 minutes

**Activity Time:** One to two 45 minute class periods

**Source:** [https://tinyurl.com/y8szwuzl](https://tinyurl.com/y8szwuzl)
**Conveyor Engineering**  
*Activity Level 1*

**Description:** Students learn about the engineering behind the conveyor belt and impact on manufacturing and the shipping of goods. Students work in teams to design and build a conveyor system out of everyday materials within the given constraints.

**Lesson Objectives:**
- Learn about manufacturing processes and conveyor systems
- Learn about the engineering design process

**Set-Up Time:** 1 hour  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/k4tdyws](https://tinyurl.com/k4tdyws)

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**Polygons and Popsicle Trusses**  
*Activity Level 2*

**Description:** Students design and build a bridge within given constraints. After a compressive load test, students evaluate their results and redesign for improvement.

**Lesson Objectives:**
- Understand why a triangle is the strongest shape in bridge design
- Understand how the deformation of a shape affects its surrounding shapes

**Set-Up Time:** 30 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/y9iju6zk](https://tinyurl.com/y9iju6zk)

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**Question of Balance**  
*Activity Level 2*

**Description:** Students design a system to fill jars with a specific weight or count of products such as marbles or paperclips.

**Lesson Objectives:**
- Learn about manufacturing engineering and systems
- Learn about the Engineering Design Process

**Set-Up Time:** 30 minutes  
**Activity Time:** Three to four 45 minute class periods  
**Source:** [https://tinyurl.com/yapydgyr](https://tinyurl.com/yapydgyr)

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**Smart Buildings and the Internet of Things**  
*Activity Level 2*

**Description:** Students explore how engineering has made possible the development of adaptive devices that serve to help individuals with physical challenges.

**Lesson Objectives:**
- Explain how sensors, event handling, and message passing are used to support ‘the Internet of things’
- Design experiments to collect data on the environmental and social needs of a physical environment and develop a proposal for a solution to an identified need in a physical environment

**Set-Up Time:** 30 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** [https://tinyurl.com/ya9x965k](https://tinyurl.com/ya9x965k)
**Planting with Precision**  
*Activity Level 2*  
**Description:** Students explore agricultural and engineering challenges. Students engineer a system out of everyday materials that can drop a seed every 15 cm over a 60 cm distance.  
**Lesson Objectives:**  
- Learn about machinery and systems for planning crops  
**Set-Up Time:** 1 hour  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/yayp92mm](https://tinyurl.com/yayp92mm)  

**Flight Test**  
*Activity Level 2*  
**Description:** Planes are slowed by drag from air friction, which also reduces fuel efficiency. In this activity, students compete to design a “spoon plane” that glides down a zip line the fastest.  
**Lesson Objectives:**  
- Understand the engineering design process  
**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class periods  
**Source:** [https://tinyurl.com/yd763tej](https://tinyurl.com/yd763tej)  

**Trebuchet Toss**  
*Activity Level 3*  
**Description:** Teams of students construct trebuchets from everyday materials. They then test their trebuchets to determine the farthest distance they can hit a target with a marshmallow projectile.  
**Lesson Objectives:**  
- Design and build a trebuchet  
- Test and refine designs based on the Engineering Design Process  
**Set-Up Time:** 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** [https://tinyurl.com/yc626d6](https://tinyurl.com/yc626d6)  

**Proof of Concept: Miracle Drug Encapsulation**  
*Activity Level 3*  
**Description:** Students act as biomedical engineers and design, fabricate, test and redesign their own methods for encapsulation of a (hypothetical) new miracle drug. Teams make large-size prototypes to test proof of concept using household objects.  
**Lesson Objectives:**  
- Explain how diffusion works for their prototypes  
- Elaborate on the importance of design considerations for engineers  
**Set-Up Time:** 1 -2 hours  
**Activity Time:** Four to five 45 minute class periods  
**Source:** [https://tinyurl.com/y33awc3z](https://tinyurl.com/y33awc3z)
**A Zombie Got My Leg Challenge**  
**Activity Level 3**

**Description:** Students design and construct lower-leg prostheses in response to a hypothetical zombie apocalypse scenario within material constraints.

**Lesson Objectives:**
- Explain how forces that the body incurs affect the design of a device
- Understand the factors that need to be considered when designing a prosthesis

**Set-Up Time:** 1 - 2 hours  
**Activity Time:** Three 45 minute class periods  
**Source:** https://tinyurl.com/ybafwwe

**Water Tower Challenge**  
**Activity Level 3**

**Description:** Students work in teams to design and build a water tower out of everyday materials that can "supply" and "shut off" water as needed. The system will need to deliver water in a controlled manner to a paper cup that is about 36 inches or 90 cm away.

**Lesson Objectives:**
- Learn about water delivery systems
- Learn how engineering can help solve society's challenges

**Set-Up Time:** 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/ycxjpsscr

**Designing Harmonic Timing Devices**  
**Activity Level 3**

**Description:** Students are asked to design simple yet accurate timing devices using limited supplies. The challenge is to create a device that measures out a time period of exactly three minutes in order to enable a hypothetical prison escape.

**Lesson Objectives:**
- Explain the concept of conservation of energy in relationship to kinetic and potential energy
- Understand and describe simple harmonic motion

**Set-Up Time:** 1 hour  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/y4hze2o2

**Convertible Shoes: Function, Fashion and Design**  
**Activity Level 3**

**Description:** Student teams design and build shoe prototypes that convert between high heels and athletic shoes.

**Lesson Objectives:**
- Understand the different parts of walking and running gaits
- Understand how a shoe is built to accommodate the different forces that running and walking have on the foot

**Set-Up Time:** 2 hours  
**Activity Time:** Five 45 minute class periods  
**Source:** https://tinyurl.com/y5sr3ex4
Computer Science

**Alice**

*Activity Level 1*

**Description:** Alice is a block-based programming environment that makes it easy to create animations, build interactive narratives, or program simple games in 3D. Alice is designed to teach logical and computational thinking skills and fundamental principles of programming.

**Source:** [https://www.alice.org/](https://www.alice.org/)

**LightBot**

*Activity Level 1*

**Description:** LightBot is a puzzle game based on coding that teaches programming logic through play.

**Source:** [http://lightbot.com/index.html](http://lightbot.com/index.html)

**Scratch**

*Activity Level 1*

**Description:** Students program interactive stories, games, and animations. Teacher accounts allow teachers to create accounts for groups of students and to manage student projects and comments.

**Source:** [https://scratch.mit.edu/educators](https://scratch.mit.edu/educators)

**BrainPop Creative Coding**

*Activity Level 1*

**Description:** Students program interactive stories, games, and animations and can be integrated into subjects like Science, English, Math, Engineering and Technology.

**Source:** [https://about.brainpop.com/coding/](https://about.brainpop.com/coding/)

**Codesters**

*Activity Level 1*

**Description:** Students program web applications in Python. They can either type code directly, or drag and drop commands from a Drag-To-Text Toolkit.

**Source:** [https://www.codesters.com/](https://www.codesters.com/)

**Vidcode**

*Activity Level 1*

**Description:** Vidcode provides a pathway to competency in computer science, from a foundational creative coding course to an advanced college-level AP Computer course

**Source:** [https://www.codesters.com/](https://www.codesters.com/)

**Binary Basics**

*Activity Level 1*

**Description:** Students explore how binary numbers work.

**Lesson Objectives:**
- Learn about binary numbers and by inference how computers work

**Set-Up Time:** 30 minutes

**Activity Time:** Two 45 minute class periods

**Source:** [https://tinyurl.com/yc3248ak](https://tinyurl.com/yc3248ak)

**My Robot Friend**

*Activity Level 1*

**Description:** Teams of two see what it’s like to program a robot as one (the programmer) delivers instructions for building a structure that the other team member (the robot) tries to follow.

**Lesson Objectives:**
- Understand how coding gives instructions for a computer to take an action

**Set-Up Time:** 30 minutes

**Activity Time:** One 45 minute class periods

**Source:** [https://tinyurl.com/y9ouguzus](https://tinyurl.com/y9ouguzus)
**Coding without Computers**  
*Activity Level 1*

**Description:** Using a predefined “robot programming vocabulary”, students will write a program a student “robot” will follow to build cup pyramids as efficiently as possible without verbal conversation.

**Lesson Objectives:**
- Understand how coding gives instructions for a computer to take an action

**Set-Up Time:** 15 minutes  
**Activity Time:** One 45 minute class periods  
**Source:** https://tinyurl.com/y8rpknv

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**Choose Your Best Way**  
*Activity Level 2*

**Description:** Students learn to solve a real problem with the help of discrete mathematic models. Students work in teams to build a graph model of their city map while learning how mathematic models work.

**Lesson Objectives:**
- Learn about discrete mathematic modeling and graph theory  
- Learn about computer algorithms

**Set-Up Time:** 60 – 90 minutes  
**Activity Time:** 90 minutes  
**Source:** https://tinyurl.com/yd5laszs

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**Complexity - It's Simple**  
*Activity Level 2*

**Description:** Students learn about complexity through illustrative games, teamwork activities and design tasks. They gain an intuitive understanding of different growth rates and how growth rates determine the performance of algorithms, such as sorting.

**Lesson Objectives:**
- Learn about the growth of sequences  
- Learn fundamental algorithms in computer science

**Set-Up Time:** 60 minutes  
**Activity Time:** Two 45 minute class periods  
**Source:** https://tinyurl.com/y7ouqeuo

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**Fun With Sorting**  
*Activity Level 2*

**Description:** Students learn about sorting, one of the most basic and fundamental problems in Computer Science. They then learn about sorting algorithms to come up with ways to sort numbers.

**Lesson Objectives:**
- Observe how an algorithm is a “procedure” and should not be dependent on the input.  
- Learn that an algorithm must be very explicit in its instructions.

**Set-Up Time:** 60 minutes  
**Activity Time:** Two to three 45 minute class periods  
**Source:** https://tinyurl.com/yc2c4ker
**Simple Maze**

**Description:** Students build a simple maze and design an algorithm to solve the maze. If the background of students permits the use of basic programming, implementing the algorithm in a preferred programming language is recommended.

**Lesson Objectives:**
- Learn about the usage of algorithms to solve real problems
- Learn about applications of algorithms in the world of robotics algorithms, artificial intelligence, etc

**Set-Up Time:** 60 minutes

**Activity Time:** Three 45 minute class periods

**Source:** https://tinyurl.com/ky7hd5r

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**Solving Problems with Decision Trees**

**Description:** Students explore how simple computing concepts/algorithms have contributed to solving real life problems. Students learn how to solve problems using decision trees.

**Lesson Objectives:**
- Recognize a problem where a decision tree can be useful
- Relate algorithms and decision trees, and be able to list some algorithms that can be matched to a decision tree

**Set-Up Time:** 60 minutes

**Activity Time:** Three 45 minute class periods

**Source:** https://tinyurl.com/y7cqqw7d

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**Vector Graphics Use Functions**

**Description:** Students are introduced to vector graphics and their dependence on functions through a collaborative design activity.

**Lesson Objectives:**
- Understand how vector graphics technology works, and contrasts with raster graphics.
- Understand the role that functions play in vector graphics.

**Set-Up Time:** 30 minutes

**Activity Time:** Two 45 minute class periods

**Source:** https://tinyurl.com/yapu8eu6

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**Fibonacci via Recursion and Iteration**

**Description:** Students learn how to calculate an arithmetic series through the iterative solution and the recursive solution. Students then explore why the iterative solution is faster for large values.

**Lesson Objectives:**
- Understand how series occur in nature
- Understand iterative and recursive solutions and their comparative efficiency

**Set-Up Time:** 1 hour

**Activity Time:** Two to three 45 minute class periods

**Source:** https://tinyurl.com/y4yak3kn
Additional Resources

Experimental Design Activities

**Designer Planes**
**Description:** Students make, test and modify paper airplanes to gain a better understanding of hypotheses, dependent variables and independent variables.

**Set-Up Time:** 15 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/y8khoz28](https://tinyurl.com/y8khoz28)

**Designing a Science Experiment**
**Description:** Students will design and conduct a short science experiment to gain a better understanding of how to conduct a science experiment.

**Set-Up Time:** 30 – 60 minutes  
**Activity Time:** One to two 45 minute class periods  
**Source:** [https://tinyurl.com/y924dbq](https://tinyurl.com/y924dbq)

**Paper Helicopters: Variables and Experimental Design**
**Description:** Students will design and conduct a short science experiment to gain a better understanding of variables and experimental design.

**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/y96ug7ad](https://tinyurl.com/y96ug7ad)

**Accuracy and Precision Lab**
**Description:** Students make measurements using common lab equipment and practice a wide range of calculations, including percent error and uncertainty.

**Set-Up Time:** 30 minutes  
**Activity Time:** One 45 minute class period  
**Source:** [https://tinyurl.com/ybvxo6v](https://tinyurl.com/ybvxo6v)

Improvised Laboratory Supplies & Apparatus

- General: [https://tinyurl.com/y2az2359](https://tinyurl.com/y2az2359)
- Earth Science: [https://tinyurl.com/yvdef42w](https://tinyurl.com/yvdef42w)
- Biology: [https://tinyurl.com/y2lenafs](https://tinyurl.com/y2lenafs)
- Chemistry: [https://tinyurl.com/y3por93m](https://tinyurl.com/y3por93m)
- Physics: [https://tinyurl.com/y3fclalv](https://tinyurl.com/y3fclalv)
- Engineering: [https://tinyurl.com/y3skeb7u](https://tinyurl.com/y3skeb7u)
- Local Resources for Common Chemicals: [https://tinyurl.com/yb239xkk](https://tinyurl.com/yb239xkk)

Additional Curriculum Resources

Additional activities: [https://tinyurl.com/y3cczhv](https://tinyurl.com/y3cczhv)

**STEM Career Information**

Websites about STEM careers: [https://tinyurl.com/y65cscsm](https://tinyurl.com/y65cscsm)
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