Real investigations in science and engineering for middle and high school

Program Overview and Title Descriptions

Enhance your existing curriculum
✔ Award-winning investigations
✔ Full teacher support
✔ Online multimedia
✔ Tablet-enabled lessons

CPO Science

16 TITLES AVAILABLE

cposcience.com/link

800-932-5227
Introducing CPO Science

Engage your students and boost understanding of key concepts with award-winning science and engineering investigations and innovative digital learning experiences from CPO Science. Four components combine to make the CPO Science Link Series a powerful tool for advancing student understanding.

Investigations and Teacher’s Guide
See page 4

Tablet-Enabled Investigations
See page 6

Hands-On Equipment
See page 8

Online Multimedia Content
See page 7
Enhance your existing curriculum with CPO Science Link™

✔ Increase student engagement
✔ Promote a deeper understanding of science concepts
✔ Accommodate differentiated instruction
✔ Connect to STEM for college and career readiness
✔ Prepare students for the Next Generation Science Standards

Whether you’re looking for an engaging, student-centered supplement to a traditional core curriculum program, or building your own alternative curriculum, Link has the tools and support you need to drive student achievement.

“I enjoy the way my students get excited about discovering science. I don’t lecture on Newton’s Laws; my students use their own data and derive them.”
— High School Teacher
South Lyon, MI

“I have seen more student engagement and interest in learning than I have seen in my previous ten years of teaching science.”
— Middle School Teacher
Pikeville, KY

AVAILABLE TITLES

Crazy Traits
Crazy Chromosomes
GeoBox
Wind Turbine

Marble Launcher
Energy Car
Car and Ramp
Optics with Light and Color

Electric Circuits
Electric Motor
Chemistry Models

NEW!
Gravity Drop
Colliding Pendulum
Simple Machines
Wave Models
Rollercoasters

Learn more at cposcience.com/link
Award-winning investigations and complete teacher support

Link series Teacher’s Guides provide complete lesson support to help you address STEM and the Next Generation Science Standards (NGSS). Every title includes 18–20 hands-on, inquiry-based investigations.

Key Questions focus investigation learning

Lesson Overviews reduce prep time

NGSS Connections provide quick coverage references

Science Background Information refreshes concepts for teachers

Teacher’s Guides also include:
- Title overview with learning goals, key questions, and vocabulary
- NGSS and CCSS alignment summary
- Student response sheet masters
- Engineering design log masters
- Tips for writing lab reports
- Lab safety guidance and contract

Collaborative Learning
This investigation is Explore-enabled for tablets. See page 39 for details.

B8 Conservation of Energy

Key Question: What limits how much a system may change?

In this investigation, students will use the Energy Car system to find out about the energy of speed and the energy of height. Students set up the Energy Car to collect data to determine the relationship between speed and drop height. Students then use their data to calculate potential energy and derive a new way to determine the speed of the car.

Learning Goals
✓ Analyze a speed vs. height graph
✓ Calculate potential energy
✓ Use energy conservation to derive a formula for the speed of the car in terms of energy

GETTING STARTED

Time: 45 minutes

Setup and Materials
1. Make copies of investigation sheets for students.
2. Make the equipment visible.
3. You will need access to AC outlets for the DataCollectors.
4. Review all safety procedures with students.

Materials for each group
- Energy Car and Track
- DataCollector and one photogate
- Balance or digital scale

Online Resources
Available at curriosity.com
- Equipment Videos: DataCollector, Energy Car and Track
- ESKIL and Practice Sheets
- Whiteboard Resources
- Animation: Energy Transformation
- Science Content Videos: Energy Transformations
- Student Reading: Conservation and Forms of Energy

Vocabulary
law of conservation of energy – states that energy can never be created or destroyed, only transformed into another form; the total amount of energy in the universe is constant
potential energy – the energy due to position
kinetic energy – the energy of motion

NGSS Connection
This investigation builds conceptual understanding and skills for the following performance expectations.

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

Science and Engineering Practices
- Using Mathematics and Computational Thinking
- Disciplinary Core Ideas

Potential Energy

The potential energy of a moving object is equal to one half its mass multiplied by the square of its speed. This formula comes from a combination of relationships, including Newton’s second law, the distance equation for acceleration (a = v^2), and the calculation of energy as the product of force and distance.

The kinetic energy of a moving object is the energy that results from the object’s motion. The law states that energy can never be created or destroyed, just converted from one form to another. The law of conservation of energy explains how a ball’s launch speed affects its motion. As the ball in the image below moves upward, its speed slows down and less kinetic energy. Eventually, it reaches a point where all the kinetic energy has been converted to potential energy. The ball has moved as high as it will go and its upward speed has been reduced to zero. If the ball had been launched with a greater speed, it would have started with more kinetic energy. It would have had to climb higher for all of the kinetic energy to be converted into potential energy. If the exact launch speed is given, the law of conservation of energy can be used to predict the height the ball reaches.

The ball’s conversion energy on the way down is opposite what it was on the way up. As the ball falls, its speed increases and its height decreases. The potential energy decreases as it converts into kinetic energy. If gravity is the only force acting on the ball, it returns to your hand with exactly the same speed and kinetic energy it started with—except that now it moves in the opposite direction.
Explore  INVESTIGATION B8

Conservation of Energy

Copyright © CPO Science
Can be duplicated for classroom use

The graph tells us that as drop height is increased, the car’s speed increases as well.

Analyzing the data

\[ E_k = \frac{1}{2}mv^2 \]

\[ mgh = \frac{1}{2}mv^2 \]

\[ 2gh = v^2 \]

Thinking about what you observed

The measured speed of the car was always a little less than the predicted speed of the car. This means not all of the potential energy available was converted into kinetic energy. The “missing energy” must have been converted into heat energy by friction, or lost to air resistance as the car rolled down the track.

Designing Energy Investigations

What aspects of learning about energy have students found most interesting or intriguing? Are there still questions that remain unanswered? Have students work in teams to investigate questions they still have or to design experiments to seek answers to their questions. Help students who are more interested in one specific aspect of energy to organize and execute research projects. Have students create a poster or use some other method to display their findings. Designate an area of your classroom to show off students’ work.

Thinking about what you observed

Discuss the effect of friction. It is also worth discussing the difference between the term “energy conservation” as used in physics and “conserving energy” as used in common speech. In physics, energy conservation means that energy can never be created or destroyed, just changed in form. In everyday language, conserving energy means using less energy in the form of electricity and fossil fuels. Discuss the energy transformations that occur with the car. The energy starts as potential energy, becomes kinetic energy as the car rolls along the level section, then becomes elastic potential energy as the rubber band stretches. The elastic potential energy becomes kinetic again as the car bounces off

Guiding the INVESTIGATION

Guiding the Investigation tips support inquiry-based investigation

A complete 5E Lesson Plan structures the investigation

STEM Connections highlight real-world applications

Annotated Student Sheets provide easy access to answers

Learn more at cposcience.com/link

Explore

<table>
<thead>
<tr>
<th>Drop Height (m)</th>
<th>Potential Energy (J)</th>
<th>Predicted Speed (m/s)</th>
<th>Measured Speed (m/s)</th>
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<td>0.190</td>
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</table>
Several investigations in each title are tablet-enabled for 1:1 classrooms using the Exploros app. Enhance the power of collaborative learning experiences in the science classroom as students become active participants in unique tablet-based interaction, allowing them to digitally:

- build group word clouds
- respond to polls and questions
- add photos and videos
…and much more!

Teachers can access a powerful student progress dashboard enabling them to receive and respond to student work in real time. Link provides permanent access to each experience—no annual subscription!

Compatable with:
- iOS/Apple iPad®
- HTML 5
- Android™

Post pictures and videos of investigations in progress

Teachers and students can view responses and provide feedback

Real-time progress monitoring for formative assessment
Teachers and students receive **lifetime access** to their CPO Science Link series investigation materials and bonus online content through the CuriosityPlace.com online toolbox—no annual subscription!

- Keep investigation resources at your fingertips
- View or print what you need, when you need it
- Access from the classroom, at home, or on the go

Online-only resources enhance each investigation. Animations, science content videos, whiteboard resources, and student readings reinforce and extend lesson concepts.

**Evaluate**

**Explore**

**B5 Pedigrees and Genetic Disorders**

**Title**

**Explore**

**Solving Problems: Potential and Kinetic Energy**

[Image of laptop with online resources]

**Student background/extension reading**

**Skill and practice worksheets**

**Online Teacher’s Guide and answer keys**

**Learn more at cposcience.com/link**
Investigations are centered on exclusive, easy-to-use lab equipment that is engineered and manufactured by CPO Science right here in the USA. Each piece of equipment is calibrated to professional standards to yield accurate measurements and repeatable results.

- Durable, classroom-tested construction
- Set up in two minutes or less
- Better quality student data

### Full Modules Include:
- Spiral-bound Teacher’s Guide
- Online Multimedia Access
- Exploros™ Investigation Access
- One Equipment Unit

### Classroom Packages Include:
- Spiral-bound Teacher’s Guide
- Online Multimedia Access
- Exploros™ Investigation Access
- Six Equipment Units

### Teacher’s Guides with Digital Access Include:
- Spiral-bound Teacher’s Guide
- Online Multimedia Access
- Exploros™ Investigation Access

Save 30% on all Modules
Save 20% on all Classroom Packages
See pages 10–20
The CPO Science three-level advantage

The unique three level structure of CPO Science Link investigations ensures that all students can participate successfully in the program.

Multiple levels allow you to
- IMPLEMENT differentiated learning strategies
- CHALLENGE each student at his or her own pace
- TEACH effectively in a multilevel classroom
- USE one curriculum for different grades or classes

<table>
<thead>
<tr>
<th>Level A</th>
<th>ACTIVITIES</th>
<th>GOALS</th>
<th>MATH SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Simple experiments with two variables</td>
<td>Build confidence, practice teamwork</td>
<td>Multiplication, division, ratios</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Level B</th>
<th>ACTIVITIES</th>
<th>GOALS</th>
<th>MATH SKILLS</th>
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</thead>
<tbody>
<tr>
<td>Use measurement to discover scientific laws; apply scientific practices</td>
<td>Further explore concepts and apply to new situations</td>
<td>Intro algebra, simple geometry, functions, graphing</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Level C</th>
<th>ACTIVITIES</th>
<th>GOALS</th>
<th>MATH SKILLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deduction of science laws through experimental and theoretical analysis</td>
<td>Extend and reinforce problem solving and application skills</td>
<td>Algebra, trigonometry, geometry, and calculus concepts</td>
<td></td>
</tr>
</tbody>
</table>
Crazy Traits is a fun and innovative tool for helping students learn about genetics and evolution. Through a series of games and activities, students learn that the traits people and animals inherit from their parents are based on chance. Alleles, genotypes, and phenotypes are also explored. Students flip special coins that represent each parent, record their outcomes, and build a "Crazy Creature" based on the results. Special Environment Cards add to the excitement, allowing students to explore how environment influences the traits in a population.

Concepts Covered
- Adaptation
- Biodiversity
- Dominant and Recessive Traits
- Environmental Influence
- Genetic Disorders
- Genetic Engineering
- Hardy–Weinberg Principle
- Inheritance

NGSS Connections
Crazy Traits addresses the following performance expectations:
- MS-LS3-2, MS-LS4-4,
- MS-LS4-5, HS-ETS1-2,
- HS-LS2-7, HS-LS3-1,
- HS-LS3-3, HS-LS4-2,
- HS-LS4-4, HS-LS4-5

Investigations
- 8 Level A
- 7 Level B
- 2 Level C

Crazy Traits Full Module
(1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 1 Equipment Unit)
- 292-3069-717
- $389.90
- SAVE 30%
- $274.95

Crazy Traits Full Classroom Package
(1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 6 Equipment Units)
- 292-4019-717
- $1,089.65
- SAVE 20%
- $869.95

Crazy Traits Teacher’s Guide with Digital Access
- 492-1090-717
- $249.95

Crazy Traits Equipment Only
- 792-1470-717
- $139.95

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
Take your study of genetics to the next level. **Crazy Chromosomes** helps students make the connection between DNA, genes, chromosomes, and phenotypes. Use these colorful manipulatives to build sets of chromosomes, model gamete formation through meiosis, and model fertilization. **Crazy Chromosomes** is designed to work in tandem with the **Crazy Traits** heredity module (available separately). Build a diploid set of chromosomes for a “crazy creature.” Then, model how gametes are formed and combine them to produce genetically diverse offspring.

**Concepts Covered**
- Biodiversity
- Chromosomes
- DNA
- Evolution
- Genetic Disorders
- Genetic Variation
- Meiosis
- Mitosis
- Mutations
- Natural Selection
- Sexual Reproduction
- Sex-Linked Traits
- Traits
- Recombination
- Linked Genes
- Crossover

**NGSS Connections**
**Crazy Chromosomes** addresses the following performance expectations:
- MS-LS3-2, MS-LS4-5
- HS-LS3-1, HS-LS3-2, HS-LS3-3, HS-LS4-2, HS-LS4-3, HS-LS4-5

**Investigations**
- 8 Level A
- 7 Level B
- 2 Level C

**Prices**
- **Crazy Chromosomes Full Module**
  - **292-3070-717**
  - **Teacher’s Guide, Curiosity Place Access, Exploros Access, 1 Equipment Unit**
  - **$339.90**
  - **SAVE 30%**
  - **$239.95**

- **Crazy Chromosomes Full Classroom Package**
  - **292-4020-717**
  - **Teacher’s Guide, Curiosity Place Access, Exploros Access, 6 Equipment Units**
  - **$789.65**
  - **SAVE 20%**
  - **$629.95**

- **Crazy Chromosomes Teacher’s Guide with Digital Access**
  - **492-1100-717**
  - **$249.95**

- **Crazy Chromosomes Equipment Only**
  - **792-1740-717**
  - **$89.95**

See examples of lessons, online resources, and tablet investigations at [cposcience.com/link](http://cposcience.com/link)

Learn more at cposcience.com/link
GeoBox

Concepts Covered
- Buoyancy
- Convection
- Environmental Engineering
- Erosion
- Floating
- Floods
- Groundwater
- Heating and Cooling of Land and Water
- Liquid Convection
- Pollutants
- Salinity
- Sinking
- Topographic Mapping
- Water Cycle
- Wave Speed
- Wetlands

NGSS Connections
GeoBox addresses the following performance expectations:
- MS-PS1-4, MS-PS4-1, MS-PS4-2, MS-ESS2-2, MS-ESS2-6, MS-ESS3-2, HS-ESS2-1, HS-ESS2-5, HS-ESS3-4, HS-PS4-1

Investigations
- 8 Level A
- 7 Level B
- 2 Level C

This exclusively-designed transparent plastic container with two interchangeable lids offers hands-on exploration of many earth and physical science topics. The flat topographical lid, along with the included landforms, allows students to trace contours of elevation and create a topographic map. The convection chamber lid with two 3” high smokestacks gives students an upfront view of the development of a convection cell. Also use the versatile GeoBox to demonstrate the water cycle, investigate the difference between heating and cooling of land and water, study wave speed, and much more.

Phone: 800-932-5227            Fax: 800-282-9560

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
CPO Science makes it easy to bring real-world engineering and STEM to your classroom. With the Wind Turbine, students explore concepts in engineering design, energy transformation, electromagnetism, and forces. Students will design, test, and refine a working turbine and challenge each other to see which model can generate the highest voltage with this unique equipment module. Investigate design variables such as: number of blades, blade shape, blade angle, number of magnets, magnet polarity, distance from magnets to core, and more!

### Concepts Covered
- Acceleration
- Blade Mass
- Blade Shape
- Constraints
- Criteria
- Electric Current
- Electricity
- Electromagnetic Induction
- Engineering Design
- Force
- Human Environmental Impact
- Inertia
- Kinetic Energy
- Magnetic Braking
- Magnetism
- Wind Farm Simulation
- Wind Power
- Engineering Design

### NGSS Connections
Wind Turbine addresses the following performance expectations:
- MS-PS2-2, MS-PS2-5,
- MS-PS3-5, MS-ETS1-1,
- MSET1-2, HS-PS2-1,
- HS-PS2-5, HS-PS3-1,
- HS-PS3-3, HS-PS3-5,
- HS-ETS1-3, HS-ETS1-4

### Investigations
- 8 Level A
- 7 Level B
- 2 Level C

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
With the Energy Car, students can explore speed, force, velocity, acceleration, Newton’s Laws, graphs of motion, conservation of energy, conservation momentum, and more. Excellent versatility and a variety of options allow students to control multiple variables while performing fun and engaging experiments. Change the mass of the cars by 50%, 100%, or 150%. Perform elastic and non-elastic collisions. Make calculations with friction and measure speed and acceleration with precision. Set it up as a one-meter straight track or as a slope and level combo track, and more!

Concepts Covered
- Acceleration
- Collisions
- Efficiency
- Energy
- Experiments
- Friction
- Measuring Time
- Motion on a Ramp
- Newton’s Laws
- Speed
- Systems
- Two Part Motion
- Variables
- Momentum

NGSS Connections
Energy Car addresses the following performance expectations:
- MS-PS2-1, MS-PS2-2
- HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-PS3-1

Investigations
- 8 Level A
- 9 Level B
- 3 Level C

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
A fantastic starting point for understanding force and motion, the Car and Ramp module engages students in accurate and repeatable investigations of gravity, friction, speed, acceleration, Newton's laws, and simple machines. Plus, students see how algebra has real-world applications as they use it to express their discoveries. Precision markings and extensive variable control ensure accurate, repeatable results.

**Concepts Covered**
- Acceleration
- Action/Reaction
- Collisions
- Distance
- Energy
- Equilibrium
- Experiments
- Force
- Friction
- Graphing
- Gravity
- Inclined Planes
- Mass
- Models
- Momentum
- Newton's Laws
- Prediction
- Speed
- Systems
- Time
- Uniform Accelerated Motion
- Variables
- Weight

**NGSS Connections**
Car and Ramp addresses the following performance expectations:
- MS-PS2-1, MS-PS2-2,
- MS-PS2-4, HS-PS2-1,
- HS-PS2-2, HS-PS2-4,
- HS-PS3-2

**Investigations**
- 8 Level A
- 9 Level B
- 3 Level C

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
The Marble Launcher will bring excitement into your classroom and inspire your students with true hands-on investigations. Lead your students through engaging activities covering science and math topics such as projectile motion, vectors, data analysis, statistics, looking beyond simple theories, problem solving, real numbers, measurement, algebra, geometry, trigonometry, and probability. The convenient protractor scale printed right on the launcher makes it easy to acquire accurate measure of launch angle, while use of the Timer or DataCollector provides precise launch speeds.

**Concepts Covered**
- Accuracy
- Engineering Design
- Launch Angle
- Precision
- Projectile Motion
- Range
- Range Equation
- Reliability
- Speed and Velocity

**NGSS Connections**
The Marble Launcher addresses the following performance expectations:
- MS-PS2-2, HS-PS2-1, HS-PS2-2, HS-ETS1-2

**Investigations**
- 3 Level A
- 4 Level B
- 3 Level C

**Teacher’s Guide**
Lifetime Access to Curiosity Place and Exploros

**Marble Launcher Equipment Unit**

**REQUIRED ACCESSORIES** (Included in Full Module and Classroom Package)
- DataCollector with Photogates
  - $499.95

**See examples of lessons, online resources, and tablet investigations at cposcience.com/link**
Chemistry Models includes the Atom Building Game and Periodic Table Tiles, engaging hands-on tools for exploring the structure of atoms and the periodic table. Students build atoms using colored marbles that represent electrons, protons, and neutrons. Pockets in the board correspond to the energy levels of the s, p, and d orbitals for electron shells one to five. The reverse side of each periodic table tile displays a common element, allowing students to construct and balance equations for many molecules and compounds.

Concepts Covered
- Atomic Structure
- Balancing Equations
- Carbon Chemistry
- Chemical Bonding
- Chemical Formulas
- Chemical Reactions
- Compounds
- Electron Shells
- Elements
- Emission Spectra
- Energy Levels
- Isotopes
- Lasers
- Molecular Structure
- Nuclear Reactions
- Organic Compounds
- Periodic Table
- Properties Of Matter
- Quantum Theory
- Radioactivity
- Valence Electrons

NGSS Connections
Chemistry Models addresses the following performance expectations:
- MS-PS1-1, MS-PS1-2,
- MS-PS1-5, HS-LS1-6,
- HS-PS1-1, HS-PS1-2,
- HS-PS1-8, HS-PS4-3

Investigations
- 8  Level A
- 9  Level B
- 3  Level C

Note: Some investigations require a multimeter with .001V resolution. See page 26 for additional options.
Lead students on fascinating investigations with light bulb circuits and resistor circuits using this intuitive and easy-to-use module. Students will discover and retain key concepts such as Ohm’s Law, Kirchoff’s Laws, current, voltage, and series and parallel circuits.

**Concepts Covered**
- Capacitors
- Compound Circuits
- Current
- Electromagnets
- Engineering Design
- Ohm’s Law
- Parallel Circuits
- Resistance
- Semiconductors
- Series Circuits
- Voltage

**NGSS Connections**
*Electric Circuits* addresses the following performance expectations:
- MS-ETS1-1, MS-PS2-3, HS-PS2-5, HS-PS2-6, HS-PS3-5

**Investigations**
- 6 Level A
- 8 Level B
- 2 Level C

**See examples of lessons, online resources, and tablet investigations at cposcience.com/link**
Why do magnets behave as they do? How does an electric motor work? The Electric Motor helps students answer these and a series of other fascinating questions as they design, build, and test motors with different configurations of permanent magnets, electromagnets, and switching discs. The DataCollector or Timer and Photogates provide precise measurements of motor speed, while the multimeter measures the current and voltage of each motor or generator configuration.

Concepts Covered
- Current
- Electric Motors
- Electromagnetic Induction
- Engineering Design
- Generators
- Magnetism
- Motor Function
- Voltage

NGSS Connections
Electric Motor addresses the following performance expectations:
- MS-PS2-3, MS-PS2-5
- HS-PS2-5, HS-PS2-6,
- HS-PS3-3, HS-PS3-5

Investigations
- 6 Level A
- 7 Level B
- 3 Level C

See examples of lessons, online resources, and tablet investigations at cposcience.com/link

Note: Some investigations require a multimeter with .001V resolution. See page 26 for additional options.
Investigate first-hand the properties of light, lenses and mirrors, real and virtual images, constructive and destructive interference, polarization, color theory, and much more! Optics with Light and Color brings flexibility and portability to your study of light and optics with large, battery operated light sources. It includes three LED lights, a laser, light holders, colored filters, lenses, mirrors, a prism, diffraction grating glasses, and more. Requires two AA batteries per light, and two AA batteries for the laser (not included).
What happens in free fall? Students drop marbles, make accurate measurements, build graphs, and calculate the acceleration of gravity \((g)\) to within 2 percent. The Gravity Drop module allows students to make consistent marble drops and precise measurements, with reduced human error, controllable variables, and easy dropper/catcher alignment. Exploring the concepts of free fall, acceleration, and Newton’s Laws will be fun for your students!

### Concepts Covered
- Average and Instantaneous Speed
- Force and Motion
- Acceleration
- Gravity
- Acceleration Due to Gravity
- Free Fall
- Newton’s Laws of Motion

### NGSS Connections
Gravity Drop addresses the following performance expectations:
- MS-PS2-4
- HS-PS2-3
- HS-PS2-4

### Investigations
- 3 Level A
- 4 Level B
- 4 Level C

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Note: Some investigations require a multimeter with .001V resolution. See page 26 for additional options.
Colliding Pendulum

Concepts Covered
Harmonic Motion
Frequency
Period
Graphing
Mass
Forces
Newton’s Laws of Motion
Elastic and Inelastic Collisions
Momentum
Conservation of Momentum

NGSS Connections
Colliding Pendulum addresses the following performance expectations
MS-PS2-1, MS-PS4-1, HS-PS2-1, HS-PS2-2, HS-PS2-3, HS-PS3-1, HS-PS4-1

Investigations
4 Level A
4 Level B
4 Level C

Colliding Pendulum features colliding steel bobs that conserve energy and momentum to better than 97 percent. Through experimentation, students discover first-hand that bobs of equal mass transfer momentum as they collide. By colliding bobs of unequal mass, students learn how momentum conservation allows them to predict the mass of an unknown object. Topics explored include frequency, mass, velocity, Newton’s laws, conservation of energy and momentum, and more.

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
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<tbody>
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<td>1515972-717</td>
<td>Colliding Pendulum Full Module (1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 1 Equipment Unit, 1 Physics Stand, 1 DataCollector)</td>
<td>$989.80</td>
<td>SAVE 30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$689.95</td>
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</tr>
<tr>
<td>1515978-717</td>
<td>Colliding Pendulum Full Classroom Package (1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 6 Equipment Units, 6 Physics Stands, 6 DataCollectors)</td>
<td>$4,699.05</td>
<td>SAVE 20%</td>
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<td>1515961-717</td>
<td>Colliding Pendulum Basic Module (1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 1 Equipment Unit)</td>
<td>$389.90</td>
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<td>Colliding Pendulum Basic Classroom Package (1 Teacher’s Guide, Curiosity Place Access, Exploros Access, 6 Equipment Units)</td>
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<td>$869.95</td>
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<td>1515952-717</td>
<td>Colliding Pendulum Teacher’s Guide with Digital Access</td>
<td>$249.95</td>
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<td>792-1400-717</td>
<td>Colliding Pendulum Equipment Only</td>
<td>$139.95</td>
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REQUIRED ACCESSORIES (Included in Full Module and Classroom Package)

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
<tr>
<td>792-1670-717</td>
<td>DataCollector with Photogates</td>
<td>$499.95</td>
</tr>
<tr>
<td>792-1110-717</td>
<td>Physics Stand</td>
<td>$99.95</td>
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</tbody>
</table>

See examples of lessons, online resources, and tablet investigations at cposcience.com/link
Simple Machines includes the CPO Science Ropes and Pulleys, Gears, and Levers. In the Ropes and Pulleys investigations, your class will explore the principles of force and work as they discover how to arrange the strings for increased mechanical advantage. Ropes and pulleys are the ideal hands-on tools to enable you to teach the concepts of work and energy to your students. In the Gears investigations, important ideas such as ratios, angles, and the geometry of the circle become “real” to your students. Through the Levers investigations, students easily derive the relationship between force and distance on a lever. They also explore the concepts of work and torque. In addition, students explore how engineers design, test, and refine machines.

Concepts Covered
- Work
- Energy
- Mechanical Advantage
- Simple Machines
- Levers
- Gears
- Gear Ratios
- Compound Machines
- Ropes and Pulleys
- Forces
- Efficiency
- Rotational Motion
- Torque
- Lever in the Human Body
- Engineering Design

NGSS Connections
Simple Machines addresses the following performance expectations:
- MS-PS3-2, MS-PS3-5
- MS-ETS1-2, HS-PS2-4
- HS-PS3-3, HS-ETS1-2

Investigations
- 7 Level A
- 6 Level B
- 3 Level C

See examples of lessons, online resources, and tablet investigations at cposcience.com/link

Simple Machines]

Teacher's Guide

Simple Machines Equipment Unit includes:
- Ropes and Pulleys
- Lever Set
- Gears Set

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
<th>Original Price</th>
<th>Discounted Price</th>
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<tr>
<td>1515973-717</td>
<td>Simple Machines Full Module</td>
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<td>1515979-717</td>
<td>Simple Machines Full Classroom Package</td>
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<td>1515953-717</td>
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<td>1515957-717</td>
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REQUIRED ACCESSORIES (Included in Full Module and Classroom Package)

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<tbody>
<tr>
<td>792-1110-717</td>
<td>Physics Stand</td>
<td>$99.95</td>
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</table>
With **Wave Models**, your students have everything they need to develop a deep understanding of harmonic motion, waves, and sound. The Pendulum investigations provide students with an ideal introduction to harmonic motion, sound, and waves. The concepts of cycle, period, frequency, and amplitude are intuitively illustrated, while advanced concepts such as extrapolation, rate of change, and functions can also be explored. The Sound and Waves investigations open up fascinating questions for hands-on explorations that are guaranteed to grab your students’ attention. Wavelength, frequency, resonance beats, natural frequency, and interference are among the many topics that you will explore with your students.

### Concepts Covered
- Harmonic Motion
- Harmonic Motion Graphs
- Period
- Frequency
- Amplitude
- Waves
- Sound
- Music
- Harmony
- Natural Frequency
- Interference
- Resonance
- Wavelength
- Energy
- Wave Speed

### NGSS Connections
**Wave Models** addresses the following performance expectations:
- MS-PS4-1
- MS-PS4-2
- HS-PS3-1
- HS-PS4-1

### Investigations
- 5 Level A
- 7 Level B
- 4 Level C
Students will explore models of Rollercoasters that utilize both a hilly track and a loop track. Students observe potential and kinetic energy in action, and work together to make precision measurements and graphs. They continue their exploration to discover the law of conservation of energy as they develop explanations for the motion they observe. Using the Loop Track, students investigate how the marble stays on the track, even upside down on the loop. Students discover that the marble must maintain a minimum speed to make it around the loop. This module also supports STEM activities and includes a rollercoaster-building kit. Students research, design, test, and refine a model of a rollercoaster and apply the science concepts they learned in earlier investigations.

**Rollercoasters Equipment Unit consists of:**
- Rollercoaster Track
- Loop Track
- Rollercoaster Design Kit

**Concepts Covered**
- Speed
- Energy
- Engineering Design
- Potential Energy
- Kinetic Energy
- Law of Conservation of Energy
- Friction
- Graphing
- Centripetal Force
- Motion
- Forces
- Gravity
- Mass

**NGSS Connections**
Rollercoasters addresses the following performance expectations:
- MS-PS3-1, MS-PS3-5,
- HS-PS2-1, HS-PS2-4,
- HS-PS3-1, HS-PS3-3

**Investigations**
- 4 Level A
- 6 Level B
- 4 Level C

**See examples of lessons, online resources, and tablet investigations at cposcience.com/link**
Starter Kits
Each starter kit includes six Physics Stands and six each of either the DataCollector or Timer, and six pairs of photogates. Perfect for getting started with CPO Science!

<table>
<thead>
<tr>
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<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>792-1620-717</td>
<td>DataCollector Starter Kit</td>
<td>$3,359.95</td>
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<tr>
<td>792-1105-717</td>
<td>Timer Starter Kit</td>
<td>$2,399.95</td>
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DataCollector
DataCollector is an innovative device that allows easy viewing and recording of data during an experiment. Four modes of operation (data collection, CPO Timer, meter, and stopwatch) provide complete classroom versatility. Available with or without photogates.

For use with Energy Car, Car and Ramp, Marble Launcher, Electric Motor, Wind Turbine, Colliding Pendulum, Wave Models, Gravity Drop, and Rollercoasters

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<tr>
<th>Code</th>
<th>Description</th>
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<tr>
<td>792-1660-717</td>
<td>DataCollector 2e</td>
<td>$374.95</td>
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<tr>
<td>792-1670-717</td>
<td>DataCollector 2e w/Photogates (2)</td>
<td>$499.95</td>
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<tr>
<td>392-5055-717</td>
<td>Photogate (2)</td>
<td>$159.95</td>
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Photogate (2) (Compatible with Vernier Data Logger)

Digital Multimeter
Manual ranging multimeter.
200 mVDC–1,000 VDC,
2 VAC–50 VAC,
200 MA–20 ADC,
200 MAAC–20 AAC,
200 SL–20 MSL

For use with Wind Turbine, Electric Circuits, and Electric Motor

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<tr>
<th>Code</th>
<th>Description</th>
<th>Price</th>
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<tbody>
<tr>
<td>531976-717</td>
<td>Digital Multimeter</td>
<td>$53.99</td>
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</table>

Timer
This tool allows students to make successful predictions and develop confidence with what they learn in the classroom. Features five modes of operation (interval, frequency, period, stopwatch, and counter). Includes two photogates.

For use with Energy Car, Car and Ramp, Marble Launcher, Electric Motor, Wind Turbine, Colliding Pendulum, Wave Models, Gravity Drop, and Rollercoasters

<table>
<thead>
<tr>
<th>Code</th>
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<th>Price</th>
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<tbody>
<tr>
<td>792-1100-717</td>
<td>Timer II w/Photogates (2)</td>
<td>$364.95</td>
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</table>

Physics Stand
A custom stand to support select CPO Science equipment. Includes a 1 m aluminum pole with mounting holes every 5 cm and a triangular wood base with built-in bubble level, adjustable leveling feet, and accessory storage well.

For use with Energy Car, Car and Ramp, Gravity Drop, Rollercoasters, Colliding Pendulum, Wave Models, and Simple Machines

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</table>

Complete professional development solutions

Make effective, inquiry-based science instruction a reality in your classroom with in-depth professional development. No matter what your school or district’s academic challenges, CPO Science can customize half-day or full-day development workshops to meet your individual needs. Using Link series investigations, equipment, and technology together you can explore:

✔ Inquiry-based science best practices
✔ STEM-aligned teaching strategies
✔ Effective technology usage
✔ Content gaps based on your latest test data

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Half- or full-day implementation and staff development training

Multi-day summer institutes

Conference workshops

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Introducing CPO Science

Engage your students and boost understanding of key concepts with award-winning science and engineering investigations and innovative digital learning experiences.

Make the CPO Science Link Series a part of your classroom to:

✔ Increase student engagement
✔ Promote a deeper understanding of science
✔ Accommodate differentiated instruction
✔ Connect to STEM for college and career readiness
✔ Prepare for the Next Generation Science Standards

Link features four integrated components:

✔ Teacher’s guide with 15–20 hands-on investigations
✔ Classroom-tested wooden equipment
✔ Online course multimedia and whiteboard resources
✔ Tablet-enabled collaborative investigations

Look inside for detailed information on sixteen life, earth, and physical science titles!

Crazy Traits
Crazy Chromosomes GeoBox
Wind Turbine

Marble Launcher Energy Car
Car and Ramp Optics with Light and Color

Electric Circuits Electric Motor Chemistry Models

NEW!
Gravity Drop Colliding Pendulum Simple Machines Wave Models Rollercoasters