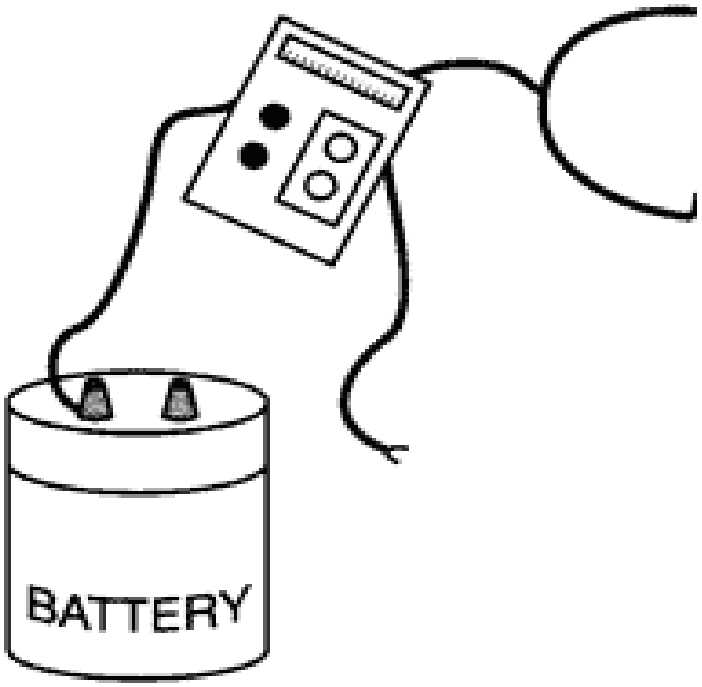
Physics



5E Inquiry Model of Learning

THE COPERNICUS PROJECT

Physics

Video Lesson: Series and Parallel Circuits

National Science Content Standard A: Science as Inquiry
Levels K-12: Understanding about Scientific Inquiry

National Science Content Standard B: Physical Science
Levels 5-8: Transfer of Energy
Levels 9-12: Motions and Forces, Interactions of Energy and Matter

Key Words: circuit, series, parallel, battery, conduction, insulation, resistance, energy transfer, electromagnetic force, Ohm's Law, voltage, watt/kilowatt, amp

5E Inquiry Model of Learning: Engage, Explore, Explain, Elaborate, Evaluate

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ENGAGE

The **ENGAGE** phase is designed to capture the interest of your students and create a "need to know." First grab their attention in order to generate their curiosity and focus them on the instructional mission of the lesson. This is generally a quick activity – 5-10 minutes – but could stretch over a period of time to heighten suspense.

Regardless of the lesson objectives, you can engage your students through the use of technology resources, by asking questions, or by offering a short hands-on activity. Use different methods for your lessons to maintain the novelty of the ENGAGE phase.

Ideas! for this Physics Video Lesson

Use Technology to Kick-Start Thinking!

Electrical Safety in the Home – http://www.worldofteaching.com/powerpoints/physics/Electrical%20Safety.ppt – Choose a section from this PowerPoint presentation on electrical safety, including the brief section "quiz", to generate interest in the practical aspects of studying electricity.

A Dangerous Servant: Electricity – http://yazx.mhedu.sh.cn/uploadfile/20086188560350.ppt – PowerPoint (for Chinese students learning English) with graphics, critical thinking questions, and brief "quizzes" to activate students' thinking about energy use and electrical appliances. Highlights the universality of electricity and English Language Learners!

Ashden Awards Films – http://www.ashdenawards.org/schools/films – Collection of short films to trigger interest in the global use of energy.

Ask Questions!

Have each student or group of students brainstorm every use of electricity during a 24-hour period, starting with the alarm clock (or cell phone?) that woke them up to the last light they turn off going to bed at night. How many electronic devices are used each day?

How much electricity does an average American household use each day? How much does it cost to run typical household appliances? Check your estimates at *Which appliances use the most power?* – http://home.howstuffworks.com/question272.htm – and its chart with the most common appliances and their related electrical costs.

Have you ever had a strand of Christmas lights suddenly go out? Or have you ever been using your hair blow dryer and have it stop working? What happened to those electrical "systems"? How did you fix them?

Hands-On!

Use a K-W-L chart to assess prior knowledge of electricity generally and surface any misconceptions. Revisit it during this unit and monitor your students' curiosity! Or use a butcher paper chart and have students add Post-its throughout the unit.

Give a pair or small group of students a small bag containing the following items: a battery, a light bulb (cut up a string of Christmas lights for an inexpensive source!), three 6"pieces of wire, and an assortment of items, like a jumbo paperclip, a wooden pencil, a toothpick, a button, a penny, etc. Challenge students to demonstrate which will light the bulb and which will not.

Time: 5-15 minutes

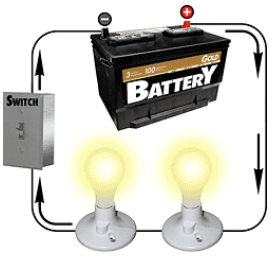
EXPLORE

In the **EXPLORE** phase, students interact with concrete materials to figure out an unanswered question, make observations, and/or problem solve within parameters.

Give the students a **TASK** that requires their exploration and reasoning about the concept(s) you are teaching and they are learning. Labs and hands-on activities work the best for this phase, but don't overlook available technology resources – including those of your textbook publisher!

Whatever method you choose for this phase, be sure to have your students collect data – completing tables and charts, drawing diagrams, noting facts and sources, etc. Science notebooks, lab notes, etc., provide convenient vehicles for recording collection procedures and data, analysis, and conclusions. Resist front-loading vocabulary, technical information, and expected results at this time – allow your students to discover information for themselves.

Ideas! for this Physics Video Lesson



Use Technology

Webquests

Basics of Electricity Web Quest – http://www.fargo.k12.nd.us/education/components/docmgr/download.php?sectiondetailid=10751&fileitem=5206&PHPSESSID=4fa69631187f70411835a1e7678d1a3d – Interact with several websites to develop an understanding of electricity from the basics to *Ohm's Law*.

Electricity – http://physicsquest.homestead.com/quest14.html – An electricity webquest broken down into three parts: Series and Parallel Circuits, Electric Hazards, and Measuring Current and Voltage.

Websites

Electrical Mystery – http://scifiles.larc.nasa.gov/kids/D_Lab/acts_electric.html – Assortment of simple simulations and explorations using electricity; additional links for experiments for homemade batteries and static electricity.

Current Electricity – http://www.skoool.ie/content/skoool_learning/junior/lessons/science/current_electricity/flash/h-frame-ie.htm – Animated lessons with audio narration about circuit electricity, voltage and resistance, fuses and plugs, etc. for students to explore.

Physics: Series and Parallel Circuits – http://videos.howstuffworks.com/hsw/20926-physics-series-and-parallel-circuits-video.htm – In this video [29:05], students gather and analyze quantitative data of simple series and parallel circuits. Their analysis develops mathematical equations describing the relationships among current, voltage, resistance and power in electric circuits.

Energy Quest – http://www.energyquest.ca.gov/index.html – Entrance to multiple links of varying depth and difficulty.

Ask Questions!

What elements are necessary for a working electrical circuit? How can you light a bulb and run a fan at the same time? How do electricians draw a diagram of a circuit?

What is happening when an electrical device is not working? How can you "trouble-shoot" problems with some common home appliances?

What are series and parallel circuits? What are the advantages and disadvantages of each kind of circuit? Where and when is each commonly used?

Hands-On!

Electricity and Magnetism Lesson Plans – http://www.teach-nology.com/teachers/lesson_plans/science/physics/electricity/ – Assorted lessons, including how to make your own battery and exploring electrochemistry,

Build an Electric Motor – http://msichicago.org/online-science/activities/activity-detail/activities/build-an-electric-motor/ – Step-by-step instructions for constructing a simple motor.

Make a Circuit Board – http://msichicago.org/online-science/activities/activity-detail/activities/make-a-circuit-board/ – Use a circuit board to design a game that lights a bulb when correct matches are made.

Resistances in Series and Parallel Circuits – http://www.iit.edu/~smile/ph9302.html – Construct each type of circuit, observe bulb illumination, and measure the current and voltage.

Circuit Comparison Chart – http://dmscc.typepad.com/files/comparison-of-circuits-answers-1.doc - A graphic organizer for studying the differences between parallel and series circuits.

Time: 25 – 30 minutes

EXPLAIN

In the **EXPLAIN** phase, students start by explaining the new understandings they gained in the EXPLORE process. Individual students need to write a summary of their understanding, and then discuss with their team or peers to clarify and solidify their language. Allow time for group presentations and/or several teams to share with each other.

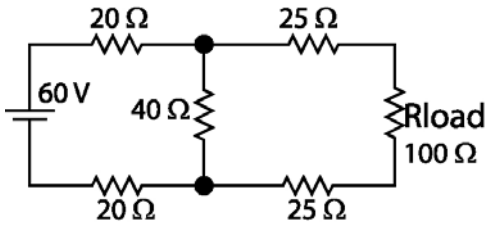
This phase provides you with the opportunities to check for understanding and informally assess the progress of your students. You can also note what vocabulary needs and possible misconceptions are surfacing as you prepare for your instructional time that concludes this EXPLAIN stage.

Background Information for this Physics Video Lesson:

A simple **Electric Circuit** is a closed connection of batteries, resistors, and wires, and consists of voltage loops and current nodes.

The following physical quantities are measured in an electrical circuit:
Current: Denoted by **I** measured in Amperes (**A**).
Resistance: Denoted by **R** measured in Ohms (**W**).
Electrical Potential Difference: Denoted by **V** measured in volts (**v**).

Three basic laws govern the flow of current in an electrical circuit:
1. **Ohm's Law**.
2. **Kirchhoff's Voltage Law** Conservation of Energy.
3. **Kirchhoff's Current Law** Conservation of Charge.



For circuits with series and parallel sections, break the circuit up into portions of series and parallel, then calculate values for these portions, and use these values to calculate the resistance of the entire circuit. That is, first, for each individual series path, calculate the total resistance for that path. Second, using these values and assuming each path as a single resistor, calculate the total resistance of the circuit.

We can apply the methods for solving linear systems to solve problems involving electrical circuits. In a given circuit if enough values of current, resistance, and potential difference are known, we should be able to find the other unknown values of these quantities. We mainly use the Ohm's Law, Kirchhoff's Voltage Law, and Kirchhoff's Current Law. (Source: *Electrical Currents* - http://www.math.ucdavis.edu/~daddel/linear_algebra_appl/Applications/Electrical_Circuits/Electrical_Circuits.html)

More Resources:
Electricity Library – http://science.howstuffworks.com/electricity-channel.htm – Informative articles broken into readable sections, including explanatory video clips.

Energy Story: Circuits (Chapter 4) – http://www.energyquest.ca.gov/story/chapter04.html – Clear explanations and descriptions of simple circuits, parallel and series, along with animations and drawings of each.

Ohm's Law Calculator – http://www.csgnetwork.com/ohmslaw.html – Calculate the voltage, amperage, and resistance based on the entered factors.

Great Lessons on Electricity:

Electricity Visualized (Student Manual) – http://web.archive.org/web/20060907103538/http://www.classrooms.usd383.org/fredn/physics/resources/STUDENT.PDF – Online student text with clear graphic explanations for investigations in electricity.

Take-Home Physics: 65 High-Impact, Low-Cost Labs. Michael Horton. 2009. NSTA Press. PB240X – http://www.nsta.org/store/product_detail.aspx?id=10.2505/9781935155058 – Save classroom time for complex concepts and assign challenging hands-on homework assignments using inexpensive, readily available materials. Students learn background knowledge, reinforce basic process skills, practice discovery, and bridge classroom learning with real-world application – all while getting excited about homework.

SMILE Program Physics Index – http://www.iit.edu/%7Esmile/physinde.html – Collection of lesson plans and activities ranging in detail and complexity.

PowerPoint Presentations on Circuits:

Electrical Circuits – http://www.worldofteaching.com/powerpoints/physics/electric%20circuits.ppt – Begins with a cell and then explains circuits and measuring current and voltage.

Electrical Circuits – http://education.jlab.org/jsat/powerpoint/0708_electricity.ppt#287 – Very detailed, easily understood presentation on Ohm's Law, voltage and simple circuits.

Electricity and Magnetism – http://www.greenville.k12.sc.us/eastside/simmons/docs/ps/elec_mag.ppt – A general overview of electricity and magnetism, with good illustrations and explanations.

Time: 20-30 minutes

ELABORATE

In the **ELABORATE** phase, students apply what they have learned in the EXPLORE and EXPLAIN phases and draw on their past experiences and interests. They expand their learning on new concepts and make connections to the world around them. This phase often leads to further inquiry.

Ideas! for this Physics Video Lesson

Use Technology

Dance Pad Mania - http://www.intel.com/education/designanddiscovery/ - Intel lesson plans for students to create a Dance Pad that lights up and/or buzzes in the process of learning how to build parallel and series circuits.

Electricity Jeopardy – http://dmscc.typepad.com/roth/ - In the Archive for March 31, 2009, there is a link to download a well-done Electricity Jeopardy game to use for test review. The dollar amount dims once the student has selected it, and the game could easily be enhanced with music. Also linked are several study guides and notes from their textbook chapter on circuits.

Static Magnet Pain Therapy Webquest http://www.geocities.com/physicsweblander/ – Using a current topic, a committee of students develop skills in critical evaluation of data from multiple sources and then present a consensus recommendation.

Enthusiastic About Edison Webquest – http://questgarden.com/41/48/7/061112165309/ – Informs students about the life, success, talent and achievements of one of America's greatest inventors.

Oil Market Basics WebQuest – http://www.eia.doe.gov/pub/oil_gas/petroleum/analysis_publications/oil_market_basics/default.htm – Start with crude oil exploration and production and proceed through each feature of petroleum use, processing, distribution, and pricing. The flow of oil from different supply sources through processing, distribution and end use are studied.

Ask Questions!

Why do many electrical outlets and plugs have three prongs? What does "grounding" have to do with it all? Resource: *Why Three Prongs?* – http://amasci.com/amateur/whygnd.html

How much do you know about batteries? Take a *Batteries Quiz* – http://electronics.howstuffworks.com/batteries-quiz1.htm

How much energy does your school use each day? Each month? How "green" is it now and what could be done to reduce consumption and conserve more energy? Resource: *Secondary Lesson Plans* – http://tonto.eia.doe.gov/kids/energy.cfm?page=activities_secondary

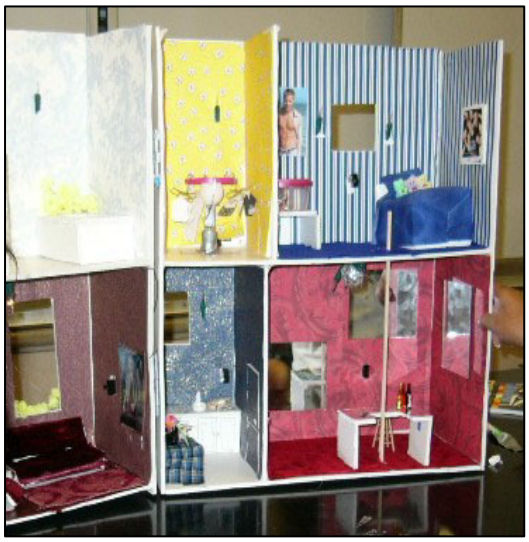
Hands-On!

Electric House – http://cpphysics.homestead.com/houseg.html – Design and create a "house" complete with four rooms and specific circuit requirements.

Electrochemical Cells – http://www.iit.edu/%7Esmile/ch8624.html – Explore the chemical changes that produce electrical energy.

Conducting Solutions – http://scifun.chem.wisc.edu/HomeExpts/CondTester/SolutionConductivity.htm – Construct a simple device and then use it to test how well a solution conducts electricity.

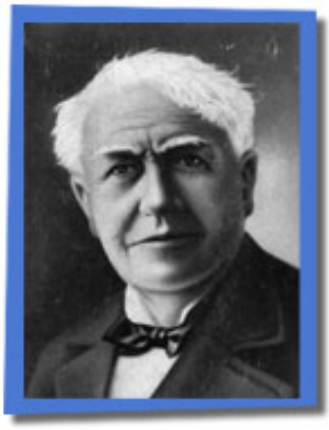
Chemical Models – http://tonto.eia.doe.gov/kids/resources/teachers/pdfs/IntSec_Chemical%20Models.pdf – Electricity powers our everyday devices, but natural gas is often used to produce the electricity. Construct models of the hydrocarbon gases that compose raw natural gas, and balance chemical equations of the combustion of hydrocarbon gases.



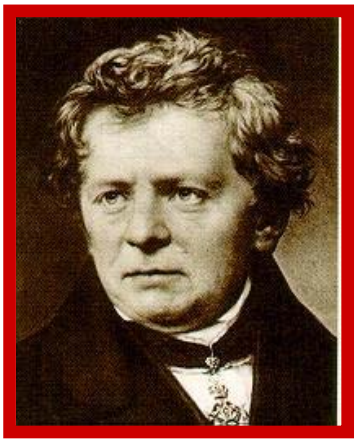
Time: 20-30 minutes

Scientist Connections:
Scientists/Inventors in Electricity – http://www.42explore.com/electric2.htm – Biographies of Inventors and scientists who have contributed to the understanding, use, and conservation of electricity.

Lewis Howard Latimer (1848 - 1928), an engineer at the Edison Electric Light Company, had the distinction of being the only African American member of "Edison's Pioneers" – Thomas Edison's team of inventors. As a young man, Lewis Latimer learned mechanical drawing while working for a Boston patent office. In 1880, he was hired by Hiram Maxim of the U.S. Electric Lighting Company to help develop a commercial electric lamp. He designed a device for efficiently manufacturing the carbon filaments then used in electric lamps and patented several inventions surrounding light bulbs and electric lamps. He supervised the installation of electric street lights for the cities of New York City, Philadelphia, Montreal, and London. His book, *Incandescent Electric Lighting,* was the first engineering handbook on lighting systems. Latimer's work contributed to the widespread use of electric lights.



Thomas Edison (1847 - 1931), considered by many as one of the greatest inventors in history, obtained patents on 1,093 inventions in such fields as telegraphy, phonography, electric lighting, and photography. He changed the lives of millions of people with such inventions as the electric light bulb and the phonograph. In 1882, he designed the first hydroelectric plant in Appleton, Wisconsin. In 1879, he and Sir Joseph Wilson Swan (in England) simultaneously invented similar carbon filament incandescent light bulbs. Edison improved upon Swan's design and by the end of 1880 had produced a 16-watt light bulb that would last for 1500 hours. As a boy, Edison had only three months of formal schooling. He was taught at home by his mother, a former teacher. He valued long, hard work. One of his famous sayings is "Genius is 1% inspiration and 99% perspiration."



Georg Simon Ohm (1787-1854) determined that the current that flowing through a wire is proportional to its cross sectional area and inversely proportional to its length. Analyzing the results of his experiments using equipment of his own creation, he was able to define the fundamental relationship between voltage, current, and resistance, known universally as *Ohm's Law*. These fundamental relationships are of such great importance that they represent the true beginning of electrical circuit analysis. This understanding laid the foundation for the inventions and developments that shaped our modern era.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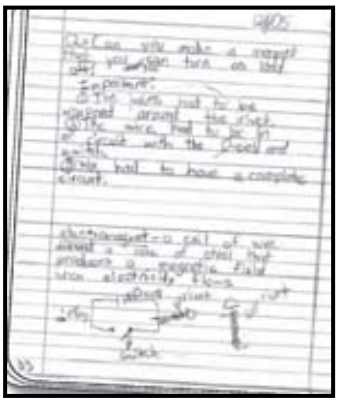
EVALUATE

In the **EVALUATE** phase, students engage in self-evaluation of the learning that has taken place in the lesson. Students can use reflective journaling in their science notebooks over the course of the lesson, an especially useful technique when comparing summative reflections at the conclusion of the lesson to a pre-lesson journal reflection of prior knowledge. Teachers will gather evidence of student progress all along the way, as evaluation occurs during all phases of a 5E lesson. Evidence of progress guides the teacher in the next steps of the lesson.

Written Record Methods: What's the Difference?



- **Journals**
  - Reflections of student learning
  - Used **after** work is done
- **Logs**
  - Records of process, observations, and data
  - Used **during** an investigation
- **Notebooks**
  - Tools for planning, thinking, data, and reflections
  - Used **before, during, and after** an investigation

If you choose to use science notebooks, one effective method uses facing pages for separate specific content:

Left Side (Student Side) Student interacts with the information from the right side in a creative and individual way.	**Right Side** (Teacher, Lecture, Textbook, Handouts) Student writes down and/or glues in information from lectures, readings, videos, labs, handouts, etc.
Even-Numbered Page	Odd-Numbered page
Examples: • Brainstorming • Concept Maps/Clustering • Pair/Share Notes • Questions • Brain Dump/Quick-Write • Flow Charts • Diagrams/Quick-Draws • Venn Diagrams • Cartoons/Illustrations • Graphs • Word Tents • Summaries	**Examples:** • Lecture Notes • Procedures • Vocabulary • Knowledge Questions • Reading Notes • Video/Internet Notes • Fill-in Lecture Notes/Graphic Organizers • Worksheets • Cornell-Style Notes

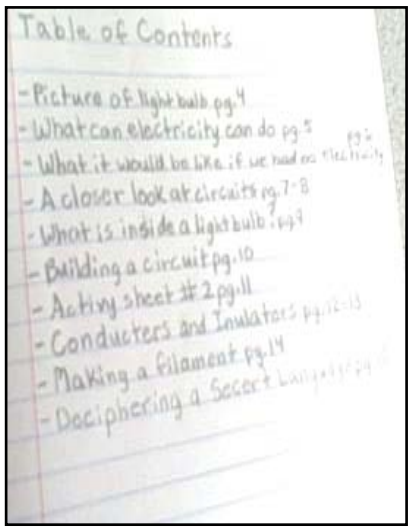
Further Information on Science Notebooks:

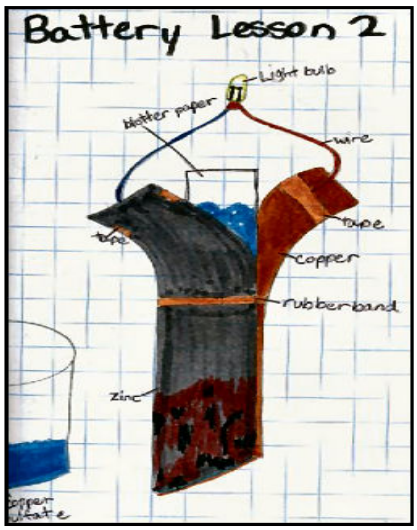
Scientist's Notebook Toolkit – http://www.ebecri.org/custom/toolkit.html – Rubrics, self-evaluation, feedback guides, PowerPoint presentations, examples.

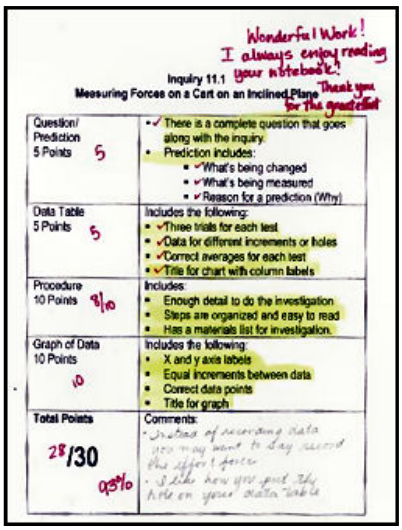
What Makes a Great Science Lab Notebook? – Practical applications and pointers. http://www.sciencebuddies.org/science-fair-projects/project-laboratory-notebook.pdf

Science Notebooks in K-12 Classrooms – http://www.sciencenotebooks.org/ – Instructional suggestions and Frequently Asked Questions for secondary teachers.

Science Notebook Essentials – A 4-page guide to effective notebook components. http://www.ebecri.org/media/Science%20Notebook%20Essentials%20by%20Klentschy.pdf

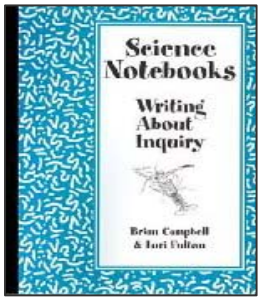




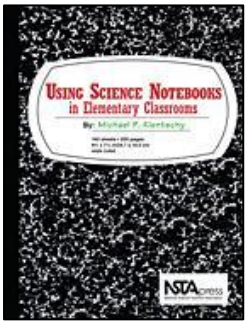


For more information and student examples, please refer to –

Science Notebooks: Writing About Inquiry.
Brian Campbell and Lori Fulton. 2003.
Heinemann.
ISBN 978-0-325-00568-3



Using Science Notebooks in Elementary Classrooms.
Michael Klentschy. 2008. NSTA Press.
PB209X

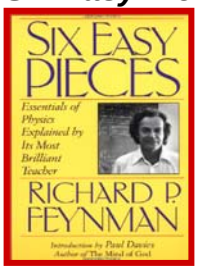


TECHNOLOGY CONNECTIONS

Webquests:	***PhysicsQuest*** – http://physicsquest.homestead.com/ – A smorgasbord of webquests on physics topics. ***Basics of Electricity Web Quest*** – http://www.fargo.k12.nd.us/education/components/docmgr/download.php?sectiondetailid=10751&fileitem=5206&PHPSESSID=4fa69631187f70411835a1e7678d1a3d ***Physics*** – http://webtech.kennesaw.edu/jcheek4/physics.htm – A weblist for everything physics, including some webquests, but nothing too specific to electricity!
Videos & Virtual Labs:	***United Streaming (Discovery Education Streaming)*** – http://streaming.discoveryeducation.com/ – This pay-for-use site offers over 180 video segments, 28 blackline masters, and 8 teacher units available for grades 7-12 on circuits. 14-day free trial available. ***Physics: Series and Parallel Circuits*** – http://videos.howstuffworks.com/hsw/20926-physics-series-and-parallel-circuits-video.htm [29:05] ***OHM Zone*** – http://www.article19.com/shockwave/oz.htm – build any kind of circuit, measure voltage on the voltmeter and current on the ammeter. After you build your circuit, you can click "Visualize" and see the direction the current is flowing. ***Brain POP movie list*** – http://highered.mcgrawhill.com/sites/0078600499/student_view0 /brainpop_movies.html# – Click on Current Electricity; also has several other middle school appropriate video links.
Websites/Resources:	***Design and Discovery Extension Activities*** – http://www.intel.com/education/designanddiscovery/ – Several sequences of hands-on sessions that follow a design process and build working prototypes. ***Take-Home Physics: 65 High-Impact, Low-Cost Labs*****.** Michael Horton. 2009. NSTA Press. PB240X – http://www.nsta.org/store/product_detail.aspx?id=10.2505/9781935155058 ***SMILE Program Physics Index*** – http://www.iit.edu/%7Esmile/physinde.html ***Electricity Library*** – http://science.howstuffworks.com/electricity-channel.htm ***Energy Information Administration – Energy Kids (K-12)*** – http://tonto.eia.doe.gov/kids/energy.cfm?page=Plans

LITERATURE CONNECTIONS

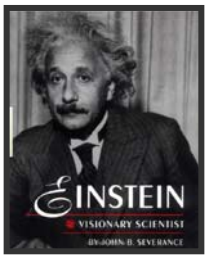
Six Easy Pieces: Essentials of Physics Explained by Its Most Brilliant Teacher



by Michael Feynman; Robert B Leighton. 146 Pages. Reading Level: Adult. ISBN 13: 9780201408256

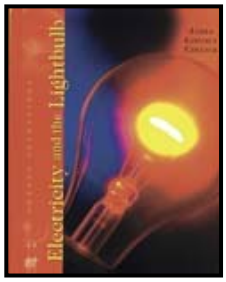
Feynman, a Nobel Prize-winning physicist, intended these lectures on atoms in motion, conservation of energy, and other topics for a wide, not necessarily scientific, audience. He presented these pieces at California Institute of Technology, but their lucidity makes them accessible to interested high school science students.

Einstein: Visionary Scientist **by John B. Severance. 144 Pages. Reading Level: Grades 6-8. ISBN 13: 9780395931004**



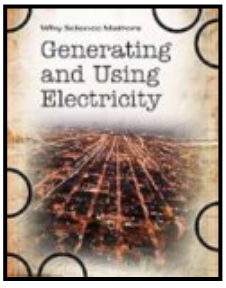
This well-documented biography is divided into seven chapters, each covering an important part of Einstein's life, contributions, and genius in the field of science and physics. Black-and-white photographs enhance the text along with a detailed chronology of his life.

Great Inventions: Electricity and the Lightbulb **by James Lincoln Collier. 112 Pages. Reading Level: Grades 5-8. ISBN: 0761418784**



The *Great Inventions* series is designed for students in grades 5-12, and is especially useful for integrating connections and understandings about technology and science. Each of these books describes the history of the inventions that changed the way we live. The nature of society at the time is integrated with the science concepts that made the invention possible. *Electricity and the Lightbulb* traces the history of our knowledge in the field from ancient to modern times, culminating in the development of light bulbs, generators, and motors. The book illustrates how scientific ideas develop slowly, with each new step building on the knowledge of earlier scientists. Information is presented in a clear and user-friendly manner, with many photographs and paintings that support the reading material.

Generating and Using Electricity **by Andrew Solway. 56 Pages. Reading Level: Grades 6-9. ISBN: 1432924818**



This book tells the story of the generation of electricity and methods of distributing, storing, and using it. The pros and cons of various ways to generate electricity are laid out in detail. Students learn basic electricity concepts, including such topics as static electricity, batteries, circuits, and the relation between electricity and magnetism. The book then presents the latest technology in developing new sources of electricity for people worldwide, from fuel cells to shore-to-platform power. The practical examples are powerful motivators because they explain why students need to know the information.

Physics NOTES

Use this page to jot down ideas, results from ideas tried, additional resources, and further thoughts.

Physics NOTES

Use this page to jot down ideas, results from ideas tried, additional resources, and further thoughts.

Ideas I would like to try . . .	Resources I have found useful . . .
Things that worked well . . .	Challenges I want to address . . .

Physics

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