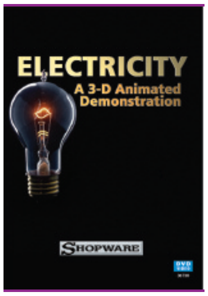


SHOPWARE

Instructor's Guide

Electricity: A 3-D Animated Demonstration

ELECTRICITY AND MAGNETISM

Introduction

This instructor's guide provides information to help you get the most out of *Electricity and Magnetism,* part of the eight-part series *Electricity: A 3-D Animated Demonstration.* The series makes the principles of electricity easier to understand and discuss. The series includes *Electrostatics; Electric Current; Ohm's Law; Circuits; Power and Efficiency; Electricity and Magnetism; Electric Motors;* and *Electric Generators*.

Electricity and Magnetism traces the relationship between magnetism and electricity from the first accidental discovery of induced current.

Learning Objectives

After watching the video program, students will be able to:

- Describe the relationship between electricity and magnetism
- Explain the difference between electric and magnetic fields
- Explain the construct, function, and use of solenoids
- Differentiate between, explain, and apply the left-hand and right-hand rules
- Demonstrate (via experiments) and explain aspects, and actions and functions of electricity, magnetism, and electromagnetism

Educational Standards

National Science Standards
This program correlates with the National Science Education Standards from the National Academies of Science, and Project 2061, from the American Association for the Advancement of Science.

Science as Inquiry
Content Standard A: As a result of activities in grades 9-12, all students should develop:
- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Physical Science
Content Standard B: As a result of their activities in grades 9-12, all students should develop an understanding of:
- Structure of atoms
- Motions and forces
- Conservation of energy and increase in disorder
- Interactions of energy and matter

History and Nature of Science
Content Standard G: As a result of activities in grades 9-12, all students should develop understanding of
- Nature of scientific knowledge
- Historical perspectives

English Language Arts Standards
The activities in this instructor's guide were created in compliance with the following National Standards for the English Language Arts from the National Council of Teachers of English.

- Standard 7: Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

- Standard 8: Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Mathematics Standards

This program correlates with the Principles and Standards for School Mathematics by the National Council of Teachers of Mathematics.

Problem Solving
Instructional programs from pre-kindergarten through grade 12 should enable all students to:
- Build new mathematical knowledge through problem solving
- Solve problems that arise in mathematics and in other contexts
- Apply and adapt a variety of appropriate strategies to solve problems

Reasoning and Proof
Instructional programs from pre-kindergarten through grade 12 should enable all students to:
- Select and use various types of reasoning and methods of proof

Principles and Standards for School Mathematics by the National Council of Teachers of Mathematics. Published 4/12/2000. Reprinted with permission.

Technology Standards

The activities in this Teacher's Guide were created in compliance with the following National Education Technology Standards from the National Education Technology Standards Project.

Standard 2: Communication and Collaboration
Students use digital media and environments to communicate and work collaboratively, including at a distance, to support individual learning and contribute to the learning of others.

Standard 3: Research and Information Fluency
Students apply digital tools to gather, evaluate, and use information.

Standard 4: Critical Thinking, Problem-Solving & Decision-Making
Students use critical thinking skills to plan and conduct research, manage projects, solve problems and make informed decisions using appropriate digital tools and resources.

The National Education Technology Standards reprinted with permission from the International Society for Technology Education. Copyright 2007.

Program Summary

The concepts of electric and magnetic fields are introduced and their representation explored. The features of coils and solenoids are examined to develop the construction of practical electro-mechanical devices such as solenoid switches and electromagnets. Hand rules are introduced to help determine the alignment of currents and fields.

Main Topics

Topic 1: Electric Fields
This segment focuses on the evolution and representation of the electric field theory.

Topic 2: Magnetism
In this section, students learn what magnetism is and explore the essence of the force between two magnetized objects.

Topic 3: Magnetic Fields
Students examine magnetic fields, the force that surrounds magnetized objects. They recognize how the placement of such fields indicates strength of magnetic force.

Topic 4: Electromagnetism
This segment introduces the discovery of electromagnetism — the link between electricity and magnetism.

Topic 5: The Left- (or Right-) Hand Rule
This section looks at two rules that help determine the flow of electricity: the left-hand rule, used to note the flow of electrons from negative to positive; and the right-hand rule, applied when studying the classic current flow model of positive to negative.

Topic 6: Electric Coils
In this segment, students study how an electric coil influences the magnetic field effect.

Topic 7: Solenoids
This segment features the solenoid — or a tightly wound helix of current-carrying wire — and the behavior of its magnetic field.

Topic 8: Solenoid Switches
Students learn that a solenoid, appropriately positioned, functions as a "mechanical switch" that can turn electricity on and off.

Topic 9: Electromagnets
Here, students learn that a ferromagnetic material, like iron, strengthens the magnetic field of a solenoid, thus creating an electromagnet.

Fast Facts

- A magnet has a north pole and a south pole, or, an attractive and repulsive region on every individual magnetized object that is brought near another magnet.
- Simple, two-dimensional arrows typically visually represent the electric field around a charge; in "real life," the lines of field force radiate in all directions.
- Electromagnetism is the foundation of many electric devices, including electric motors and electric generators.
- Magnetic force is strongest near a magnet's core.
- In 1819, Danish physicist Hans Christian Oersted discovered electromagnetism.
- The left-hand rule is used to measure the flow of electrons, which move from negative to positive.
- The right-hand rule is used to measure the classic current flow model — current moves from positive to negative.
- A solenoid's magnetic field pattern is similar to the magnetic field of a bar magnet.
- A solenoid, appropriately positioned, functions as a "mechanical switch" that can turn electricity on and off (solenoid switch).
- A ferromagnetic material, like iron, strengthens a solenoid's magnetic field, thus creating an electromagnet.

Vocabulary Terms

cylindrical: Having the form of a cylinder.

electric charge: An electromagnetic property of matter that can be positive or negative.

electric coil: A wound spiral of two or more turns of insulated wire.

electric field: Electric force per unit of charge.

electric force: A force that exists between two charged objects.

electromagnetism: The phenomena associated with electric and magnetic fields and their interactions with each other, as well as with electric charges and currents.

electromagnet: A magnet consisting essentially of a coil of insulated wire wrapped around a soft iron core that is magnetized only when current is flowing through the wire.

helix: A coiled structure.

left-hand rule: If fingers of the left hand are placed around a wire so that the thumb points in the direction of electron flow, the fingers will be pointing in the direction of the magnetic field being produced by the conductor.

magnetic field: The region around a magnet where the magnetic force acts.

magnetic force: The force exerted between magnetic poles, producing magnetization.

magnetism: Attraction properties possessed by magnets; phenomena by which materials exert attractive or repulsive forces on other materials.

pole: Either of the two regions or parts of an electric battery, magnet, or the like, that exhibits electrical or magnetic polarity.

repulsive: Describes a force that tends to push the two participating objects apart.

resistance: A substance's ability to resist a current flow. The rate at which electricity can flow through a circuit depends upon how much resistance it encounters.

right-hand rule: Rule that determines the directions of magnetic force, conventional current, and the magnetic field. Given any two of these, the third can be found. The right-hand rule also determines the direction of the magnetic field around a current-carrying wire and vice versa.

solenoid: A cylindrical coil of wire that becomes electromagnetic when a current runs through it.

vector: A quantity possessing both magnitude and direction, represented by an arrow, the direction of which indicates the direction of the quantity and the length of which is proportional to the magnitude.

Pre-Program Discussion Questions

1. What is an electromagnet? Describe what you think it is and how it might function.
2. What is the difference between a magnetic field and an electric field?
3. What is the connection between iron and magnets?
4. What might the relationship be between a magnetic field and an electric coil?
5. You've heard of the North and South Poles, at least in geography. How might a north pole and a south pole be linked to magnets?

Post-Program Discussion Questions

1. What is important about magnetic fields? Why should we understand what they are and how they function?
2. What is electromagnetism? How has its discovery influenced technology?
3. Describe the difference between the left-hand and the right-hand rules.
4. Describe how an electric coil interacts with magnetic lines of force.
5. Explain what a solenoid is and does.

Individual Student Projects

The Magnetism of Electromagnets

Students can select and conduct one or more experiments (individually, to test them, and then, if desired, before the class) centered on electricity and magnets. Students log their findings and explain the physics concepts associated with the phenomena they observe. Find experiments in books listed in the "Additional Resources" section and at the following Web sites:

- Electromagnetism Experiments: www.hsphys.com/electromagnetism.html
- Electromagnetism Experiments: www.hometrainingtools.com/articles/electromagnetism-science-project.html
- Electromagnet: http://www.galaxy.net/~k12/electric/elmag.shtml
- Electromagnets: http://www.iit.edu/~smile/ph9528.html

A Solenoid Does What?
Students build on the film's statement "Solenoids can control many other useful mechanical tasks by using electricity." Students conduct research to identify ways solenoids are used. They can present them to the class visually, by creating digital representations ("gizmos"), or by building a working model of a selected mechanical item to demonstrate. Web sites that jumpstart research include:

- Experiments with electromagnetics: http://my.execpc.com/~rhoadley/magsolen.htm
- How Doorbells Work: http://home.howstuffworks.com/doorbell3.htm
- Solenoids: www.nsfcontrols.co.uk/faq.cfm

Group Activities

What about Magnetism and Magnetic Fields?
Students can further explore the physics principles associated with magnetism and magnetic fields by conducting various experiments or participating in labs. Draw experiments from books listed in this guide's Additional Resource section and/or locate experiments at the following Web sites:

- Magnet Basics: http://my.execpc.com/~rhoadley/magpole.htm
- Visualizing Magnetic Fields: http://my.execpc.com/~rhoadley/magvisual.htm
- Understanding Magnetism:
  http://school.discoveryeducation.com/lessonplans/programs/understanding-magnetism

Exploring Electromagnets
Students can select and conduct one or more experiments (individually, to test them, and then, if desired, before the class) centered on electricity and magnets. Students log their findings and explain the physics concepts associated with the phenomena they observe. Find experiments in books listed in this guide's "Additional Resources" section and at the following Web sites (not inclusive; find additional experiment sources as needed):

- Electromagnetism Experiments: www.hsphys.com/electromagnetism.html
- Electromagnetism Experiments:
  www.hometrainingtools.com/articles/electromagnetism-science-project.html
- Electromagnet: http://www.galaxy.net/~k12/electric/elmag.shtml

Oersted's Discovery: Try It Yourself

So, how did Oersted come to discover electromagnetism? Here's an opportunity for students to put the scientist's experiment to the test. Log on to "How To Repeat Hans Christian Oersted's Experiment with Magnetic Fields" (http://inventors.about.com/od/lessonplans/ht/magnetic_fields.htm) and simply follow the instructions. Students keep a log of observations and findings.

Internet Activities

All About Oersted

Students further explore the work and life of Hans Christian Oersted to create an annotated timeline or a biography of his experiments, discoveries, and related work. Sites to jumpstart research include:

- About.com: History of Electromagnetism — Innovations Using Magnetic Fields
  http://inventors.about.com/od/estartinventions/a/Electromagnets.htm
- Hans Christian Orsted: http://chem.ch.huji.ac.il/history/oersted.htm
- NNDB: Hans Christian Oersted: www.nndb.com/people/341/000104029

Students may extend the timelines or biographies with sidebars highlighting the work or discoveries of other scientists on electromagnetism during or close to the time period of Øersted's work.

Surveying Electromagnetism Web Sites

Students locate and compare and contrast a variety of Web sites centered on electricity and magnets or electromagnetism. After logging on and using the sites' interactive tools, students rate them for things such as ease of use, quality of information provided, how easy content is to grasp, etc. Students create a site review for use by appropriate teachers and students.

Electromagnets: How They Work

Students log on to "How Electromagnets Work" at How Stuff Works (http://science.howstuffworks.com/electromagnet2.htm). Using this article as a model, students write a student-focused online article to describe how electromagnets work (or, they can describe how a solenoid or coil works in an electromagnet). Students may pitch this article to "How Stuff Works."

Assessment Questions

1: What does the left-hand rule indicate?

2: Draw a diagram that represents the activity of a magnetic field in a current-carrying solenoid.

3: Which is of the following does *not* describe magnetism?
- **a) Magnetism has repulsive and attractive properties.**
- **b) Magnetism is the force exerted by an electric current.**
- **c) Magnetism is the attraction between like particles.**

4: The magnetic field force produced by a straight current-carrying wire can be increased by shaping the wire into ______________.
- **a) a right angle**
- **b) a coil**
- **c) a solenoid switch**

5: A greater number of turns of wire around a solenoid require an increase in _______________________________________.

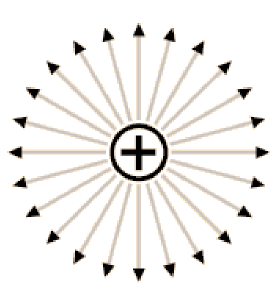
6: Draw a diagram of the magnetic lines of force for a bar magnet. Indicate polarity, direction of the lines of force, and where the magnetic force is stronger and weaker.

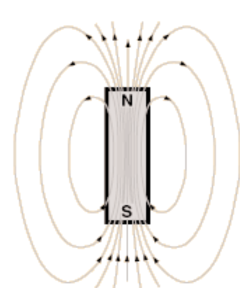
7: Using the diagram you created in question 6 above, indicate how a small magnet would orient itself within the magnetic field.

8. What is a vector?
- **a) A unit of measure within an electric field**
- **b) The force between electric charges**
- **c) A representation of an electric field's direction**

9: What do current-carrying solenoids and hollow bar magnets share?

10: Using the diagrams, describe the difference between electric and magnetic fields.





Assessment Questions Answer Key

1: What does the left-hand rule indicate?
A: The fingers of the left hand — if the left-hand thumb is aligned in the direction of the electron flow — will indicate the direction of the magnetic field around the wire.
Feedback: This is a mnemonic used to detect the flow of electrons from negative to positive. It is also used to detect the direction of magnetic fields.

2: Draw a diagram that represents the activity of a magnetic field in a current-carrying solenoid.
A: (The correct diagram can be found at www.physchem.co.za/Current10/Magnetic1.htm)
Feedback: A solenoid is a tightly wound coil (helix) of current-carrying wire. The magnetic field of a solenoid reinforces through the center of the helix, and dissipates on the outside of the solenoid, shown by fields further apart. The solenoid's magnetic field pattern is similar to that of a bar magnet.

3: Which is of the following does *not* describe magnetism?
a) Magnetism has repulsive and attractive properties.
b) Magnetism is the force exerted by an electric current.
c) Magnetism is the attraction between like particles.
A: c
Feedback: Magnetism is one of the phenomena by which materials exert an attractive or repulsive force on other materials. It is the field of force produced by a magnet or an electric current.

4: The magnetic field force produced by a straight current-carrying wire can be increased by shaping the wire into ______________.
a) a right angle
b) a coil
c) a solenoid switch
A: b
Feedback: A coil created with the wire looping continuously in the same direction has the current in each loop flowing in the same direction as the loops beside it. The magnetic lines of force also circle the coil in the same direction — from the outside, into the middle, and back outside the coil again. This magnetic field, flowing in the same direction at the center of the coil, causes the field to reinforce in this region, creating a stronger magnetic field.

5: A greater number of turns of wire around a solenoid require an increase in _______________________________________.
A: electric current
Feedback: The presence of an iron core in a coil greatly strengthens the magnetic field of the solenoid, creating an electromagnet. Increasing the current flowing through the solenoid will further increase the strength of the magnet. A greater number of turns of wire wound around the solenoid will also increase the strength of the electromagnet. Eventually, the potential increases in strength become diminished by the resistance caused by higher electric currents flowing through longer wires.

6: Draw a diagram of the magnetic lines of force for a bar magnet. Indicate polarity, direction of the lines of force, and where the magnetic force is stronger and weaker.
A: (The correct diagram can be found at www.windows.ucar.edu/tour/link=/physical_science/images/dipole_fieldlines_gif_image.html)
Feedback: Magnetic field lines often bend dramatically. It is believed that magnetic fields are closed loops that are oriented between the two poles of a magnet. Looping field lines are close together near the core of the magnet, where the magnetic force is strongest. The loops sweep further apart at a distance from the magnet where the magnetic field weakens.

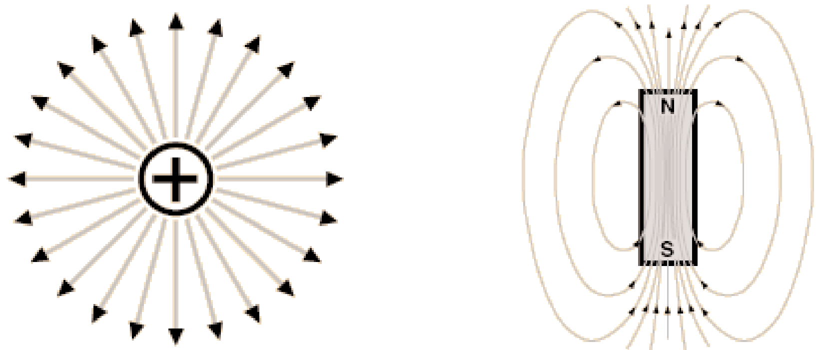
7: Using the diagram you created in question 6 above, indicate how a small magnet would orient itself within the magnetic field.
A: Diagram should indicate the small magnet aligning itself to the magnetic field lines.
Feedback: A small magnet placed in the magnetic field will not orient itself so that its north pole points directly to the south pole of the larger magnet. Instead, the magnet will align itself to the magnetic field lines.

8. What is a vector?
- **a) A unit of measure within an electric field**
- **b) The force between electric charges**
- **c) A representation of an electric field's direction**

A: c
Feedback: Arrows represent an electric field. Each arrow is a vector, the line and arrowhead together representing a direction, sometimes a changing direction, in which the force is acting. A set of arrows describes the shape of the field, and the distance between arrows indicates the intensity of the field.

9: What do current-carrying solenoids and hollow bar magnets share?
A: Magnetic field patterns.
Feedback: The magnetic field produced by electric current in a solenoid coil is similar to that of a bar magnet. The magnetic field of a solenoid reinforces through the center of a helix, and dissipates on the outside of the solenoid, shown by field lines further apart. This magnetic field pattern is similar to the field pattern of a bar magnet, suggesting that the field lines of a bar magnet behave like those of a solenoid, and connect loops through the body of the bar magnet.

10: Using the diagrams, describe the difference between electric and magnetic fields.



A: Arrows (vectors) represent the electric field around a charge. The line and arrowhead together represent a direction, sometimes changing direction, in which the force is acting. A set of arrows describes the shape of the field, and the distance between arrows indicates the intensity of the field. These lines of force, in actuality, radiate in all directions. The arrows are closer at their base, and the electric field is stronger close to an object.

The force between two magnetized objects, as with electric charges, changes inversely as the distance between them. But, unlike electric charges, there is both an attractive and a repulsive region on every individual magnet that is brought near to another magnet. Magnetized objects, like electrified objects, are surrounded by fields of magnetic force. Magnetic field lines can bend dramatically, particularly in comparison to electric fields. Unlike electric fields, magnetic fields are closed loops that are oriented between the two poles of a magnet. Looping field lines are close together near the core of the magnet, where the magnet is strongest. The loops sweep further apart at a distance from the magnet where the magnetic field weakens.

Additional Resources

BOOKS

Electricity and Magnetism, by Kyle Kirkland, Ph.D. Facts on File, 2007. ISBN: 978-0-8160-6112-9

Awesome Experiments in Electricity & Magnetism, by Michael A. DiSpezio. Sterling, 1999. ISBN: 0806998199

Basic Electricity, by Nooger and Neville Van Valkenburgh. Prompt; 1st edition, 1995. ISBN: 0790610418

Basic Electricity: Reprint of the Bureau of Naval Personnel Training Manual, by Staff of the Bureau of Naval Personnel. Barnes & Noble Books, 2004. ISBN: 9780760752388

Driving Force: The Natural Magic of Magnets, by James D. Livingston. Harvard University Press; 1st edition, 1997. ISBN: 0674216458

Electricity and Magnetism: Stop Faking It! Finally Understanding Science So You Can Teach It, by William C. Robertson, Ph.D. National Science Teachers Association, 2004. ISBN: 0873552369

Electric Universe: The Shocking True Story of Electricity, by David Bodanis. Crown, 2005. ISBN: 1400045509

Electromagnetism, and How It Works, by Stephen M. Tomecek. Chelsea House Publishers; 1st edition, 2007. ISBN: 0791090523

Principles of Electricity and Magnetism, by Saunak Palit. Alpha Science Int'l Ltd, 2005. ISBN: 1842652052

Schaum's Outline of Basic Electricity, 2nd edition, by Milton Gussow. McGraw-Hill; 2nd edition, 2006. ISBN: 0071474986

Science Projects About Electricity and Magnetism, by Robert Gardner. Enslow Publishers, Inc, 1994. ISBN: 0-89490-539-9

WEB SITES

BrainPOP
www.brainpop.com

comPADRE: Digital Resources for Physics & Astronomy Education
www.compadre.org

Electricity and Magnetism: Experiments
www.galaxy.net/~k12/electric/index.shtml

Exploratorium: Science Snacks About Magnetism
www.exploratorium.edu/snacks/iconmagnetism.html

Explore Learning: Electricity and Magnetism
www.explorelearning.com/index.cfm?method=cResource.dspResourcesForCourse&CourseID=334

Explore Learning: Intro to E & M
www.explorelearning.com/index.cfm?method=cResource.dspDetail&ResourceID=29

How Stuff Works: The Electromagnet
www.howstuffworks.com *(search for "Electromagnets")*

HyperPhysics: Magnets and Electromagnets
http://hyperphysics.phy-astr.gsu.edu/hbase/magnetic/elemag.html

IEEE
www.ieee.org

Introduction to Electricity
www.ndt-ed.org/EducationResources/HighSchool/Electricity/electricityintro.htm

MIT OpenCourseWare: Highlights for High School
http://ocw.mit.edu/OcwWeb/hs/home/home

National Science Teachers Association
www.nsta.org

NDT Resource Center: Electricity
www.ndt-ed.org/EducationResources/HighSchool/Electricity/hs_elec_index.htm

NETC: Magnet Facts
www.technicoil.com/magnetism.html

Phun Physics
http://phun.physics.virginia.edu

PhysicsCentral
www.hinsdale86.org/staff/jliaw

The Physics Classroom
www.physicsclassroom.com

The Physics Front.org
www.thephysicsfront.org

PhysicsLAB Online
http://dev.physicslab.org

Physics Teaching Technology Resource
http://paer.rutgers.edu/pt3/index.php

School for Champions: Electromagnetism
www.school-for-champions.com/science/electromagnetism.htm

Science Joy Wagon: The Physics Zone — Lessons on Magnetism
www.sciencejoywagon.com/physicszone/08magnetism/

Virtual Labs & Simulations: Electricity
www.hazelwood.k12.mo.us/~grichert/sciweb/electric.htm

Additional Resources from www.films.com • 1-800-257-5126

The Science of Electricity Poster

• 17" x 32" Poster
• Correlates to National Science Education Standards
• Item # 36854
Recommended for grades 7-12. © 2006

Electric Power on the Move

- **DVD #34288**
- **Preview clip online**
- **Correlates to national sceince educational standards**
- **Includes viewable/printable instructor's guide**

This *Science Screen Report* examines the production, transportation, and consumption of electricity. Using the Hoover Dam as an example of efficient hydroelectric power generation, the program illustrates how transformers raise or lower voltage to manageable levels and how electricity is specifically channeled to illuminate buildings, power devices, and propel vehicles. Vital electrical concepts are discussed, including the difference between alternating and direct current, the advantages of neon over filament bulbs, and the definitions and significance of ohms, volts, and amperes. Produced in association with the Accreditation Board for Engineering and Technology and the Junior Engineering Technical Society. (18 minutes) © 2004

Electricity and Electronics (10-part series)

- **DVD/ VHS #34798**
- **Preview clip online**
- **Close captioned**
- **Correlates to educational standards**
- **Includes viewable/printable instructor's guides.**

This ten-part series provides a comprehensive video guide to the study of electronics, ranging from the fundamental laws and principles of electricity at the atomic level to troubleshooting and repair of electronic components. Lively computer animation and hands-on demonstrations make these videos an ideal resource for the classroom. The series includes the following titles: *Electrical Principles • Electrical Circuits: Ohm's Law • Electrical Components Part I: Resistors, Batteries, and Switches • Electrical Components Part II: Capacitors, Fuses, Flashers, and Coils • Electrical Components Part III: Transformers, Relays, and Motors • Electronic Components Part I: Semiconductors, Transistors, and Diodes • Electronic Components Part II: Operation-Transistors and Diodes • Electronic Components Part III: Thyristors, Piezo Crystals, Solar Cells, and Fiber Optics • Electrical Troubleshooting • Electronic Circuit Repair.* A Shopware Production. (18-24 minutes each) © 2006

Electricity and Magnetism

- **CD-ROM #10267 (Windows/Macintosh)**
- **Preview clip online**
- **Correlates to the National Science Education Standards developed by the National Academies of Science and Project 2061 Benchmarks for Science Literacy from the American Association for the Advancement of Science.**
- **Includes activity sheets**

Since the early experiments with electricity over two hundred years ago, scientists have made many discoveries that help explain its nature. These discoveries have linked many areas of science including static electricity, electric current, magnetism, and materials. In all areas of our life at home and at school we rely on electricity, which has become a crucial part of modern society. Electricity and Magnetism examines the principles involved and gives students an insight into this fascinating topic, covering such subjects as: Static electricity; Attraction/repulsion; Current electricity and electrical circuits; Measuring electricity—current, voltage, meters; Electrical calculations; Magnetism—materials, fields, rules, Earth's field; Field around a current-carrying wire; Link between electricity and magnetism—induction. © 1999

Electromagnetism (6-part series)

- **DVD/VHS #3555**
- **Preview clip online**
- **Close captioned**
- **Correlates to educational standards**
- **Includes viewable/printable instructor's guides**

The historic discovery of the magnetic properties of lodestone led to the scientific understanding of Earth's magnetic field. This series of computer-animated programs explores this mysterious force, from early observation to modern theories about the role of Earth's magnetic field. The series includes *Earth's Magnetic Field • Magnetism and Electron Flow • Domain Theory • The Motor Principle • Electromagnetic Induction • Life in the Field.* (10 minutes each)

Magnetism: Invisible Fields of Force

- **DVD/VHS #34292**
- **Preview clip online**
- **Correlates to educational standards**
- **Includes viewable/printable instructor's guides**

This *Science Screen Report* studies the physical force known as electromagnetism and how it encircles, interacts with, and is generated by matter. Demonstrating attractive and repulsive forces with iron filings suspended in liquid, the program explains the significance of a magnet's poles and why some materials are more magnetic than others. The electromagnetic fields of the Earth and Sun are also explored, with attention to magnetism's role in animal migration, the aurora borealis, and solar storms. Animated sequences reinforce essential concepts. Produced in association with the Accreditation Board for Engineering and Technology and the Junior Engineering Technical Society. (14 minutes) © 2001

Energy I Video Library

- **DVD #30960**
- **Close captioned**
- **Correlates to educational standards**
- **Includes user guides**

Contains 22 video clips on forms of energy, nuclear energy, electricity, and magnetism:

- Fuel Cells
- Solar Energy
- Potential and Kinetic Energy
- Nuclear Energy Forms
- Nuclear Medicine
- Nuclear Submarines
- Electrical Energy
- The Body Electric
- Electricity Production
- Electromagnetism
- Lodestone
- Energy Production
- Chemical Energy
- Introduction to Nuclear Energy
- Natural Nuclear Reactions
- The Atomic Bomb
- Introduction to Electricity
- Harnessing Electricity
- High Wire Act
- Introduction to Magnetism
- Animal Navigation
- Earth as a Magnet

The Energy I Video Library is part of the complete Discovery Channel/Films for the Humanities & Sciences Science Video Library. © 2003

Physical Processes

- **CD-ROM #8116 (Windows/Macintosh)**
- **Preview clip online**

Pictures, diagrams, text, sound, and video help students understand electricity, electromagnetism, energy, forces and motion, and sound and light in this completely interactive CD-ROM.

- *Forces and Motion* includes information on forces of attraction and repulsion, gravity, friction, springs and elastic, balanced and unbalanced forces, speed, distance and time, moments and pivots, pressure, and measuring forces.
- *Light and Sound* answers questions such as: What are waves? What makes sounds? Topics include pitch and frequency; loudness and amplitude; sound traveling in different materials; hearing; effects of properties of light; how light is reflected; colors in white light; effects of color filters; and modern applications of light.
- *The Earth and Beyond* includes information on apparent movement of the sun and stars; night and day; relative positions and motion of the planets; eclipses; the earth as seen from space; comets and asteroids; and the life cycle of stars.
- *Energy Source and Energy Transfer* includes information on the variety of energy sources—coal, oil, natural gas, water, solar, nuclear, wind, wave, tidal, geothermal, and batteries. Generation of electricity is discussed, along with finite and renewable sources, energy transfer and conservation, and the impact of production on the environment.

What Magnets Do

- **DVD/VHS #1666**
- **" Effectively reinforces the main points in these concise, easy-to-follow, and repeatable demonstrations." —*Booklist***

A compass needle points North because the Earth has a magnetic force that attracts the metal in the needle. Bob Symes shows what happens to the compass needle if a wire with an electric current is placed next to the compass. He proves that this principle works backwards as well as forwards; electricity can be generated by pushing a magnet through a wire coil. (7 minutes)

Magnetism and Electron Flow

- **DVD/VHS #3557**
- **Close captioned**
- **Includes viewable/printable instructor's guides**

This program introduces the left-hand rule for predicting the relationship between the direction of the magnetic field and the direction of flow in a conductor, and demonstrates the extended magnetic field surrounding a helix. (10 minutes) © 1987