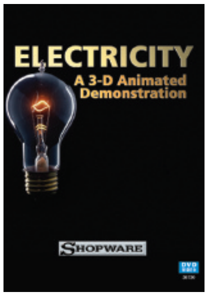

Instructor's Guide

Electricity: A 3-D Animated Demonstration

ELECTROSTATICS

Introduction

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

The *Electrostatics* program explores basic electricity, as it was perceived by Benjamin Franklin and other early theorists, as well as the principles of positive and negative charge, conduction and induction, atoms and electrons, and elementary charge.

Learning Objectives

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

- Describe what electricity is
- Describe electricity's properties
- Explain how charges are created
- Demonstrate and observe the creation, action, and transference of charges

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

National Science Education Standards, from the National Academies of Science, and Project 2061 come from the American Association for the Advancement of Science. Copyright 1996 by the National Research Council of the National Academy of Sciences. Reprinted with permission.

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.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English. Copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

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

This program explores basic electricity, as well as the principles of positive and negative charge, conduction and induction, atoms and electrons, and elementary charge. Coulomb's Law is related in detail, including the torsion balance experiment that led to the breakthrough. Insulators, semiconductors, and superconductors are also explained and demonstrated.

Main Topics

Topic 1: Electricity
This introductory segment describes how a "mysterious invisible substance" would come to be known as electricity.

Topic 2: Positive and Negative
This segment examines the role of positive and negative charges — to understand the principles of attraction and repulsion — in the development of an electric charge.

Topic 3: Conduction and Induction
Students explore how electrostatic charges move from one object to another through the processes of conduction and induction.

Topic 4: Atoms and Charge
This section describes the integral role an atom's electrons and protons play in an electric charge.

Topic 5: Elementary Charge
Students learn about the elementary charge, which is the single smallest possible charge on an electron or proton. Also explained is the coulomb, or a measurement of the quantity of an electrical charge.

Topic 6: Coulomb's Law
This segment introduces Coulomb's Law, which centers on the repulsive and attractive patterns at play between a pair of electric charges.

Topic 7: Insulators and Conductors
In this final chapter, students learn about substances that conduct electricity and about insulators, or elements that prevent the occurrence of an electric charge.

Fast Facts

- Electrostatics is a branch of physics that deals with electric charges at rest (static electricity) and phenomena associated with the buildup of charge on an object's surface due to its contact with other surfaces.

- The human body can be electrically charged, as demonstrated by static cling.

- Opposite charges — positive and negative — attract.

- Conduction occurs when the same electric charge transfers from one object to another.
- Induction can occur in a complete vacuum.
- Over 2,500 years ago, philosophers in India proposed the existence of the atom. The idea was further developed by the ancient Greek Democritus.
- In the 20th century, scientists began to understand that the atom could be separated into even smaller particles.
- Electrons, which are negatively charged, are not created or destroyed.
- By 1916, American scientist Robert Millikan had measured the charge on a single electron.
- In 1785, Charles-Augustin de Coulomb discovered the proportional relationship between force and the distance between charges.
- Not all atoms lose their electrons.
- Pure water is an insulator, but water with impurities can conduct electricity.

Vocabulary Terms

ampere: A unit of electric current equal to one coulomb per second.

atom: The smallest unit of matter that still retains the properties of whichever element it is a part of. Atoms are composed of subatomic particles called protons, neutrons, and electrons.

charge: The amount of electricity carried by a body.

conduction: Energy transfer from one material to another by direct contact.

conductor: A material (like a metal) through which electricity and heat flow easily.

Conservation of Charge: The idea that the total amount of charge in a system has been observed to remain constant.

coulomb: The amount of electricity transported by a current of one ampere flowing for one second; once coulomb is equal to 6.25×10^{18} elementary charges.

Coulomb's Law: Coulomb's Law describes the interaction between two objects that have electric charges.

electric charge: An electromagnetic property of matter that can be positive or negative and will cause either an attractive or repulsive force on another charge.

electricity: The area of physical phenomena dealing with the behavior of electric charges.

electron: A negatively charged particle that is a very small part of an atom.

electroscope: An instrument for detecting the presence of static electricity.

electrostatics: The study of charged particles at rest.

elementary charge: The electrical charge carried by a single electron.

force: That which produces or prevents motion; that which can impose a change of velocity on a material.

induction: The property by which one body, having electrical or magnetic polarity, causes or induces it in another body without direct contact.

negative: Having a minus charge.

positive: Having a plus charge.

proton: A positively charged subatomic particle usually found in the nucleus of an atom.

repel: To drive away or force backwards.

semiconductor: A substance that, at room temperature, conducts some electricity, but not as much as metal does.

static cling: A property of substances that makes them cling to each other because of opposite electrical charges.

superconductor: A substance that has very low or no electrical resistance.

Pre-Program Discussion Questions

1. What is electricity? How do you think electricity was discovered?

2. What exactly is an electric charge? And, how is a charge generated?

3. How would you explain — or even define — the terms "positive" and "negative" when thinking about electricity and/or an electric charge?

4. What is an atom? How do you think it figures into the world of electricity?

5. Describe static cling: how and why do you think it happens?

6. What happens when water and electricity interact?

Post-Program Discussion Questions

1. Describe what is necessary for electrostatic charges to move from one object to another. Provide examples of the processes that allow this movement to occur.

2. What might be a common myth associated with water and electric charges? What is true about water and electricity?

3. What is the role of force in electric charges, as discovered by Charles-Augustin de Coulomb? What is significant about this role?

4. What does the equation/formula in Coulomb's Law indicate? Describe each aspect of the formula and what it represents.

5. Explain the significance of the atom in an electric charge. Why is Conservation of Charge important in this context?

6. Describe the difference between a semiconductor and a superconductor.

Individual Student Projects

Experimenting with Electrostatics
Students conduct one of the following experiments at home or for their classmates. If done for homework, students document their observations and findings.

<u>Materials</u> *(draw from this list for each experiment)*
- Two clean dry combs of plastic or hard rubber or two plastic rods
- A spool of thin sewing thread
- About a dozen quarter inch squares of paper
- A three-inch by quarter-inch strip of paper
- Several pieces of dry doughnut- or ball-shaped cereal
- Several balloons, not inflated
- Sink and water faucet or water-filled squeeze bottle
- Dehumidified room (dryness, dry weather)
- A head of long hair or a wool sweater or a wool hat

<u>**Experiment 1: Charging and Attraction**</u>
1. Neutralize the comb by wetting and air-drying it before beginning.
2. Spread small pieces of tablet paper randomly on a tabletop.
3. Touch the neutralized comb to paper and note the reaction. There should be no effect.
4. Run the comb through long hair about six times or rub it on a wool sweater or wool hat.
5. Slowly lower the comb over the paper squares. Note the behavior. (Squares rise up on edge, held down by their weight. As the comb gets closer, the field strength increases and exerts a force greater than gravity, which causes the papers to leap to the comb, and attach themselves to it and to each other.)
6. Remove the paper from the comb. Notice that the paper squares will remain attached to each other for a period of time. Why? (Each piece has taken on the charge identity of the comb, thereby drawing each neighbor to itself. This reaction repeats itself from piece to piece as long as there is enough charge remaining to sustain the effect.
7. To examine the charge distribution at both ends of a strip of paper, charge the second comb by running it through long hair. Also charge the first comb. Both combs are now negatively charged. Bring one comb near the three-inch strip of paper. It will be drawn to the comb at the narrow edge. Allow it to dangle below the comb. Now, slowly approach the paper ribbon with the other comb. The free end of the strip will be repelled, indicating that it is negatively charged at the free end and positively charged at the comb end, since it is still attached to a negative comb.

Explanation: It is interesting to note the distance at which the paper strip begins to react to the presence of the second comb. This demonstrates the existence of the force field between two charges. It is like an electrostatic wind: this phenomenon is defined in Coulomb's Law.

Experiment 2: Attraction and Repulsion

1. Obtain one comb, a piece of cereal, and about one foot of thread.
2. Tie the thread around the cereal piece. Neutralize the cereal, if necessary.
3. Dangle the suspended cereal clear of nearby objects.
4. Neutralize comb by wetting and air-drying before beginning.
5. Run the comb through long hair about six times.
6. Slowly approach the hanging cereal with the charged comb.
7. The cereal will swing toward the comb. Note the distance where this begins to happen. It is the extent of the field for the level of charge on the comb.
8. The cereal will attach itself to the comb because the positive charges on the cereal are attracted to the comb.
9. Hold the comb still and wait.
10. The cereal will leap from the comb because the negative charge of the comb has now saturated the cereal. Since both comb and cereal are now negatively charged, repulsion happens.

Explanation: This experiment demonstrates attraction and repulsion between charges. Less obvious concept is that of induction, which begins to take place as soon as the neutral cereal piece feels the tingle of the approaching electrons. The cereal protons crowd toward the comb, causing a switch to attraction. However, the comb electrons continue to invade the positive region of the cereal until it becomes entirely negatively charged. There is now a large repelling force and the cereal violently ends the relationship.

Experiment 3: Water and Electrostatics

1. Obtain a dry clean comb, a sink and water faucet or a water-filled squeeze bottle.
2. Turn on the water and adjust the flow for a stream that is about 1/8th inch in diameter.
3. Charge the comb by running it through long dry hair or by rubbing it on a wool sweater or a wool hat.
4. Slowly bring the comb near the water stream. Place it about three inches from the faucet.
5. Note what happens. The water stream will be attracted to the comb and the flow will bend in that direction.

Explanation: This demonstrates the attraction of atomic particles in water, proof that water follows the same electrostatic behavior as solids. For this reason, it is possible to draw a spark from finger to water from a faucet, in much the same way as when touching a doorknob or car door in the dry winter months.

Experiment 4: Static Cling

1. Inflate a balloon.
2. Charge the balloon by rubbing it on hair or a wool sweater or a wool hat.
3. Approach a wall and touch it with the balloon. Not surprisingly, it sticks to the wall.

Explanation: The positive charges in the wall's atoms are drawn to the contact point of the wall well before the balloon touches it: this is induction. The balloon induces the charge in the neutral wall: this is static cling.

Electrostatics: A History Lesson

Students create a narrated timeline (print or digital) illustrating the history of electrostatics, including references to very early "discoveries," such as those the Greeks made. For each period, students identify experiments, theories, individuals, etc., that played a role in advancing the understanding of electrostatics. Where possible, students note the most recent discoveries in electrostatics.

Group Activities

Detecting Charges

Students construct a simple electroscope to observe a variety of charged objects. They document their observations in a science journal, recording the activity that occurs between the charged items and the electroscope, as well as noting the explanation for this activity.

Absorbing and Expanding on Coulomb's Law

Students review and apply the formula/equation of Coulomb's Law by determining what occurs should the formula's variables change.

Conduction or Induction: Which Is It?

Student teams each conduct a different conduction/induction experiment to observe how these processes occur across diverse objects, and to share this knowledge with their peers. Link to these sites for ideas:

- Electricity activity: www.iit.edu/~smile/ph9213.html
- Electrostatics activity: www.unt.edu/scope/Lesson%20Plans/Electrostatics/electrostatics1.htm
- Electrostatics experiment: www.phy.olemiss.edu/~thomas/weblab/222%20Lab%20Manual/Exp16_Electrostatics_fall01.pdf

Internet Activities

Surveying Electrostatic Web Sites

Students locate and compare and contrast a variety of Web sites centered on electrostatics. 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.

Electrostatics: How It All Works

Students log on to "How Electricity Works" at the How Stuff Works Web site (http://science.howstuffworks.com/electricity.htm). Using this electricity article as a model, students write similar online articles for other aspects of electrostatics, such as insulators and conductors. Students may pitch for inclusion on the site.

Virtual Electrostatics

Students visit several sites that offer virtual, interactive presentations of electrostatic principles. Students then create a presentation design/storyboard (such as a virtual online exhibit or field trip, slide show, or video): the design must be based on and illustrate the relevant technical aspects of the selected principle. Sites to jumpstart ideas include:

- All About Atoms: http://education.jlab.org/atomtour/index.html
- The Atoms Family: www.miamisci.org/af/sln/frankenstein/index.html
- Electricity: Conductors and Insulators: www.quia.com/cm/25645.html
- UVA Virtual Lab: Pithball Ping Pong: www.virlab.virginia.edu/VL/Ping_pong.htm

Assessment Questions

1: Why was Benjamin Franklin's theory about positive and negative charges incorrect?

2: 6.25 x 10^{18} elementary charges is a measure of________________________.
- **a) a single electron**
- **b) a coulomb**
- **c) the force between charges**

3: The symbol "q" in Coulomb's Law equation represents the ________________.
- **a) mass of a charged object**
- **b) distance between charged objects**
- **c) charge of a charged object**

4: What is significant about the symbol "k" in Coulomb's Law equation?

5: What is true about electric charges?
- **a) Opposite charges repel each other.**
- **b) An atom's nucleus triggers an electric charge.**
- **c) There are two types of electric charges.**

6: What causes the human body to conduct electricity?
- **a) Water in the body's flesh.**
- **b) The body's water intake.**
- **c) Impurities in the body's water.**

7: ________ are materials that do not allow electricity to flow through them.
- **a) Insulators**
- **b) Conductors**
- **c) Semiconductors**

8: Feeling a shock from a metal door handle is an example of an __________.
- **a) electrical force**
- **b) insulator**
- **c) electrical discharge**

9: Two pithballs have the same amount of electrical charges, but are oppositely charged. What will happen to the pithballs?

10: To what other phenomenon can Coulomb's Law be applied?
- **a) The distance between the moon and the earth**
- **b) Gravity**
- **c) The mass of objects**

Assessment Questions Answer Key

1: Why was Benjamin Franklin's theory about positive and negative charges incorrect?
A: Franklin theorized that "negative" implied an absence of the property or substance that allowed charges to materialize, and that "positive" implied exactly the opposite. In fact, positive and negative are determined by the amount of negatively charged electrons and positively charged protons.
Feedback: An object with more protons than electrons has an overall positive charge; an object with more electrons than protons has a negative charge.

2: 6.25 x 10^{18} elementary charges is a measure of________________________.
- **a) a single electron**
- **b) a coulomb**
- **c) the force between charges**

A: b
Feedback: A coulomb is the combined charge of 6.25 x 10^{18} elementary charges. It is considered to be a larger and more practical unit of charge because measurements are not usually made one electron at a time.

3: The symbol "q" in Coulomb's Law equation represents the ________________.
- **a) mass of a charged object**
- **b) distance between charged objects**
- **c) charge of a charged object**

A: c
Feedback: In the equation, each symbol represents a critical variable. Q1 and Q2 represent the quantity of charge on object 1 and object 2.

4: What is significant about the symbol "k" in Coulomb's Law equation?
A: The "k" represents a proportionality; in this case, it is known as the Coulomb constant.
Feedback: The value of this constant is dependent upon the medium that the charged objects are immersed in.

5: What is true about electric charges?
- **a) Opposite charges repel each other.**
- **b) An atom's nucleus triggers an electric charge.**
- **c) There are two types of electric charges.**

A: c
Feedback: Charges are either positive or negative. The term "neutral" does not refer to a third type of charge, but to the presence in a region of positive and negative charges in equal amount. The sum of identical positive and negative quantities is zero. This is what it means to be electrically neutral.

6: What causes the human body to conduct electricity?
- **a) Water in the body's flesh.**
- **b) The body's water intake.**
- **c) Impurities in the body's water.**

A: c
Feedback: Pure water is an insulator. However, water with impurities causes the release of electrons from the impurities that enable water to conduct electricity.

7: ________ are materials that do not allow electricity to flow through them.
- **a) Insulators**
- **b) Conductors**
- **c) Semiconductors**

A: a
Feedback: Insulators are made from what are called reluctant atoms — atoms that do not readily lose electrons. These substances prevent the flow of electricity, and therefore do not allow the creation of electric charges.

8: Feeling a shock from a metal door handle is an example of an __________.
- **a) electrical force**
- **b) insulator**
- **c) electrical discharge**

A: c
Feedback: Human bodies are electrically charged and thus can lose that charge, or experience a discharge of electricity under certain conditions.

9: Two pithballs have the same amount of electrical charges, but are oppositely charged. What will happen to the pithballs?
A: The pithballs will come together.
Feedback: Positive and negative — or opposite — charges attract.

10: To what other phenomenon can Coulomb's Law be applied?
- **a) The distance between the moon and the earth**
- **b) Gravity**
- **c) The mass of objects**

A: b
Feedback: Gravitational force, like the force between electrical charges, is inversely proportional to distance squared.

Additional Resources

BOOKS

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

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

Electrostatics: Exploring, Controlling, and Using Static Electricity, by A.D. Moore. Laplacian Press, 2nd edition, 1997. ISBN: 1885540043

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; 2 edition, 2006.
ISBN: 0071474986

WEB SITES

The Franklin Institute: A Short History of Electrostatics
www.fi.edu/pieces/otoole/Statichistory.htm

BrainPOP
www.brainpop.com

The NSTA Learning Center: Charging into Electrostatics
http://learningcenter.nsta.org/products/symposia_seminars/NSDL/webseminar6.aspx

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

Miami Science Museum: The Atoms Family
www.miamisci.org/af/sln

IEEE
www.ieee.org

NDT Resource Center: Introduction to Electricity
www.ndt-ed.org/EducationResources/HighSchool/Electricity/electricityintro.htm

National Science Teachers Association
www.nsta.org

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

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

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

Einstein Made Relatively Easy
- **DVD #35602**
- **Preview clip online**
- **Correlates to educational standards**

Introducing EinSteinchen, an animated techno-Einstein who has a genius for explaining physics. In section one of this DVD, this likable know-it-all elucidates 12 essential topics in 90-second segments that are perfect for launching lectures or illustrating concepts. Section two departs from EinSteinchen's virtual world to show 12 cutting-edge applications or studies of Einsteinian physics in high-level mini-documentaries of two to five minutes in length. A Deutsche Welle Production. (60 minutes) © 2006

Section one's animated segments include the following: *Absolute and Relative • E=mc^2 • The Discovery of Slowness • As Fast as Light • Glowing Atoms—Stimulated Emissions • The Super-molecule—Bose-Einstein Condensation • The Spooky Long Distance Effect • Bent Space • Dancing Particles • Electricity from Light • The Invisible Force • Wormholes.*

Section two's mini-documentaries include the following: *Nuclear Medicine—A Formula and Its Results • Satellite Navigation • The Speed of Light, Part 1—Light Researchers • The Speed of Light, Part 2—Radar Satellite • The World's Fastest Flash • Juggling Ultra-cold Atoms • Cloned Atoms through Teleportation • Cosmic Telescopes • Racing Down Einstein's Paths • Organic Solar Cells • Time Travel through Wormholes—Nothing More Than a Dream? • The Search for a Theory of Everything.*

Electricity and Electronics

- **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

Atoms and Molecules

- **DVD/ VHS #29558**
- **Preview clip online**
- **Close captioned**
- **Correlates to Project 2061 Benchmarks for Science Literacy from the American Association for the Advancement of Science.**
- **"The concepts of atomic structure, atomic number, atomic mass, periodic properties and arrangement are covered quite well. It offers excellent descriptions of the Bohr Model and the Quantum Mechanical Model.... The information is accurate, well organized, and current.... This production would serve as an excellent review of or introduction to these concepts for group viewing."**

—School Library Journal

Here is a video that literally gets down to basics—the basics of everything. In this concise and logically formatted program, students discover the fundamental building blocks of the universe: the elements. Lively computer animation makes the atom and its constituent parts—the proton, neutron, and electron—easy to understand. The Bohr Model and the Quantum Mechanical Model of the atom are clearly differentiated. Working from these concepts, students can then make sense of the Periodic Table with its arrangement according to Atomic Mass. The program also explains the concept of the mole and the different chemical bonds within molecules and compounds. A valuable summary at the end of the video reinforces all the concepts. (16 minutes) © 2001

Electrons at Play: A Century of Electrifying Discoveries

- **DVD/ VHS #11324**
- **Preview clip online**
- **Correlates to educational standards**

This lively program presents the 1998 Faraday Lecture, which explains how the discovery of the electron by J. J. Thomson profoundly impacted both everyday life and scientific innovation. Combining stimulating on-stage experiments, computer graphics, interviews, and even a visit to CERN, the European Laboratory for Particle Physics, the program illustrates the principles of electrostatics and electromagnetism, examines the workings of the cathode ray tube and flat-screen TV, and inquires into the origin of the universe. A Wimshurst machine, a Tesla coil, a plasma globe, an electron microscope, and a particle accelerator are demonstrated. (55 minutes) © 1998

Magnetism and Static Electricity

- **DVD/ VHS #6849**
- **Preview clip online**
- **Correlates to educational standards**

Using a bar magnet and compass; a neodymium magnet, soft iron, and a dumbbell; a ferrite magnet crushed into small pieces; a magnetized and broken knife blade; nails and a plastic plate with layers of aluminum, copper, and iron in-between; an iron bar, enamel wire, and a battery; and an ebonite bar, a wool cloth, and a leaf electroscope, this program investigates the following concepts: magnetic field, poles, and lines of force; Curie temperature; electromagnets; static electricity; Thompson's water droplet experiment; like and unlike charges. (30 minutes) © 1997

Physics in Action

- **DVD/ VHS #1916**
- **Preview clip online**
- **Correlates to educational standards**

This 10-part series comprises an anthology of demonstrations and quantitative experiments taught in introductory physical science. The experiments selected are ones that are difficult or impossible to perform in most school laboratories. The quantitative experiments are designed to permit students to record data from the screen and perform their own calculations. The programs also contain illustrations of physics principles at work in industry, business, and at home. The series includes the following titles: Electrostatics • Electrostatics 2 • The Generation of Electricity • Commercial Generation and Transmission of Electricity • Electricity in the Home • Radioactivity • The Thermal Expansion of Metals • The Electromagnetic Spectrum • The Laws of Motion • The Laws of Motion Applied.
(20 minutes each)

The Electric Body

- **DVD/ VHS #4191**

Sparks flying when one brushes one's hair... hair standing on end... an electric shock when one touches a door handle or certain synthetic fabrics... twitching of the eyes and eyelid muscles during the dream phase... These are all indications that the human body is charged with electricity. Bioelectrical impulses underlie the entire complex of thinking and feeling. This program examines the basic nature of the bioelectrical processes in the human body, their role in the functioning of cells, and the multiplicity of simultaneous electrical processes. (28 minutes) © 1993