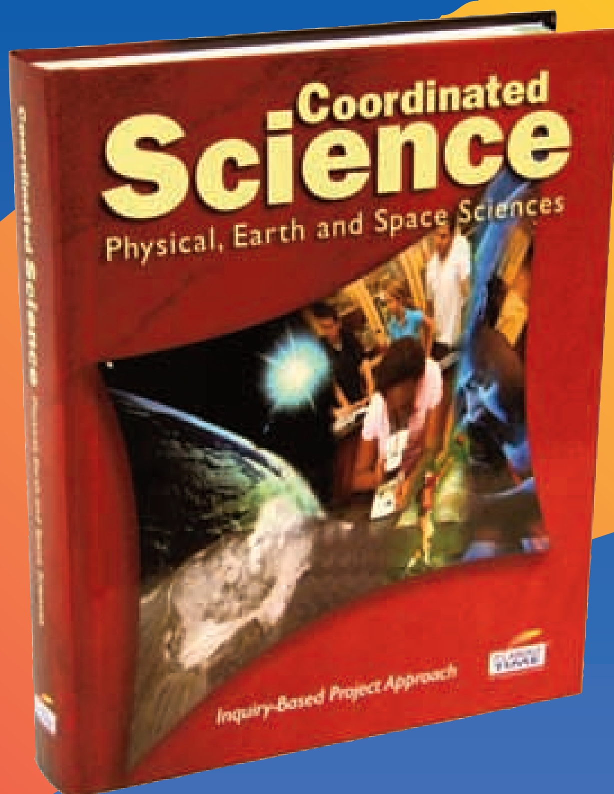
Coordinated Science
Physical, Earth & Space Sciences
Course Overview



- **coverage of principles required for meeting Physical, Earth, and Space Sciences state frameworks**
- **a proven guided-inquiry, project-based integrated science course that works with students of all learning levels**
- **an instructional approach that engages all students in the learning of science**

What Inquiry Should Be

IT'S ABOUT TIME®
HERFF JONES EDUCATION DIVISION

Coordinated Science Physical, Earth & Space Sciences: It's about increasing student achievement.

Coordinated Science™ is developed using an instructional strategy that combines guided-inquiry and whole class instruction with appropriate content. It's about increasing student achievement.

Coordinated Science is a research-based curriculum that has been field-tested in diverse classrooms for 3 to 5 years and has demonstrated increased student engagement and learning. It's about a proven approach.

Coordinated Science is a curriculum that weaves together all the activities and chapter content to build a strong grasp of the science concepts so that students can transfer their understanding to relevant real-world projects. It's about having more than just isolated activities and content.

Our Commitment to Research-Based Curricula.

Are all "research-based" programs equal? When we say research-based this is what we mean: Our developers created the chapters in *Coordinated Science* from the very conception on the best research on how students best learn and how teachers can best facilitate this process in the classroom.

Coordinated Science relies on the rigorous research of the National Science Foundation development process. *Coordinated Science* consequently promotes positive student attitudes toward science and positive perceptions of the student as learner. It engages students through the use of real-world contexts and provides a deeper understanding of the role of science and technology in the workplace.

First Year of the Curriculum Development Process — Content Specialists, Master Teachers.

Under the direction of a distinguished, active, and dynamic Advisory Board (that meets twice yearly over a three-to four-year period), the program's Principal Investigators select and then oversee teams of writers chosen from top university science education departments, content-based science departments, and specially selected high school teachers, and industry scientists to collaborate on the development of the first drafts of the curriculum materials. These lead authors, each a distinguished content specialist and/or educator from a leading university, also serve as part of the Review Committee to assess each other's works for pedagogical strategies and content accuracy. The curriculum is then reviewed and evaluated by other leading educational specialists for pedagogy, content, safety, equity, readability, cognitive effectiveness, and efficacy, and then the curriculum is revised again based on those results.

All new materials proceed through the following system for development and revision:

- Approved by Content Review Committee comprised of leading content experts
- Approved by the following consultants: science educators, master teachers, and cognitive scientists
- Micro-tested by the development group. A micro-test is a series of tests of a few students with careful observation and follow-up interviews by the developers

Second Year of the Curriculum Development Process — Content Specialists Pilot to ensure curriculum is correct and rigorous.

The curriculum is then ready to be pilot tested by a select group of high school teachers from across the country. After an extensive summer training course, these teachers spend the next year piloting the program in their classrooms.

- Pilot tested by master teachers in their classrooms
- Pilot materials, classes, teachers, and students are studied and evaluated based on an established evaluation and research design model

- Materials are also reviewed by leading content experts and science educators to evaluate if the materials appropriately prepare students for their later study in these subjects
- Materials are then revised based on the pilot feedback, experts' reviews and evaluation and research reports

Third Year of the Curriculum Development Process — Diverse Classrooms to Ensure Approach is Appropriate for All Students.

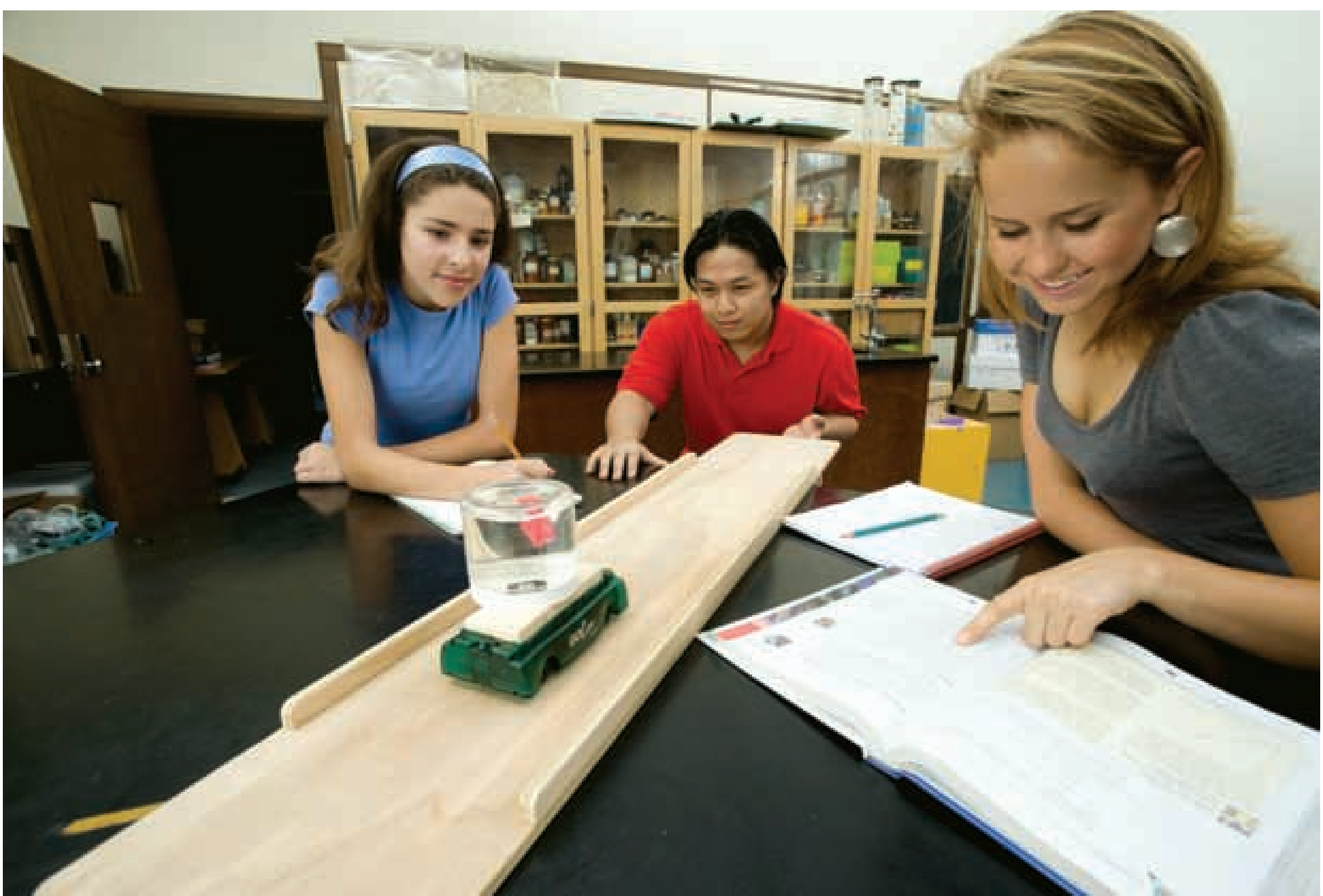
The curriculum is now ready to be field-tested by a broad range of high school teachers from across the country. After an extensive summer training course, these teachers spend the next year field-testing the materials in their classrooms.

Like the pilot test, the research/evaluation component of the revision process is designed to inform the next iteration and revision of the materials.

- Field-testing of the materials conducted in a wide range of classrooms by teachers with a wide range of experience and expertise
- Field-test materials, classes, teachers, and students are studied and evaluated based on the evaluation and research design model
- Materials are then revised again based on the field-test feedback, experts' reviews and evaluation and research reports

Fourth Year of the Development Process.

Additional consultant specialists in cognitive psychology, assessment, technology, science education and equity continue to be brought into the project to review the materials and secure its pedagogical approach and content basis. Finally, the product is turned over to the commercial publisher to mold into a commercial product.

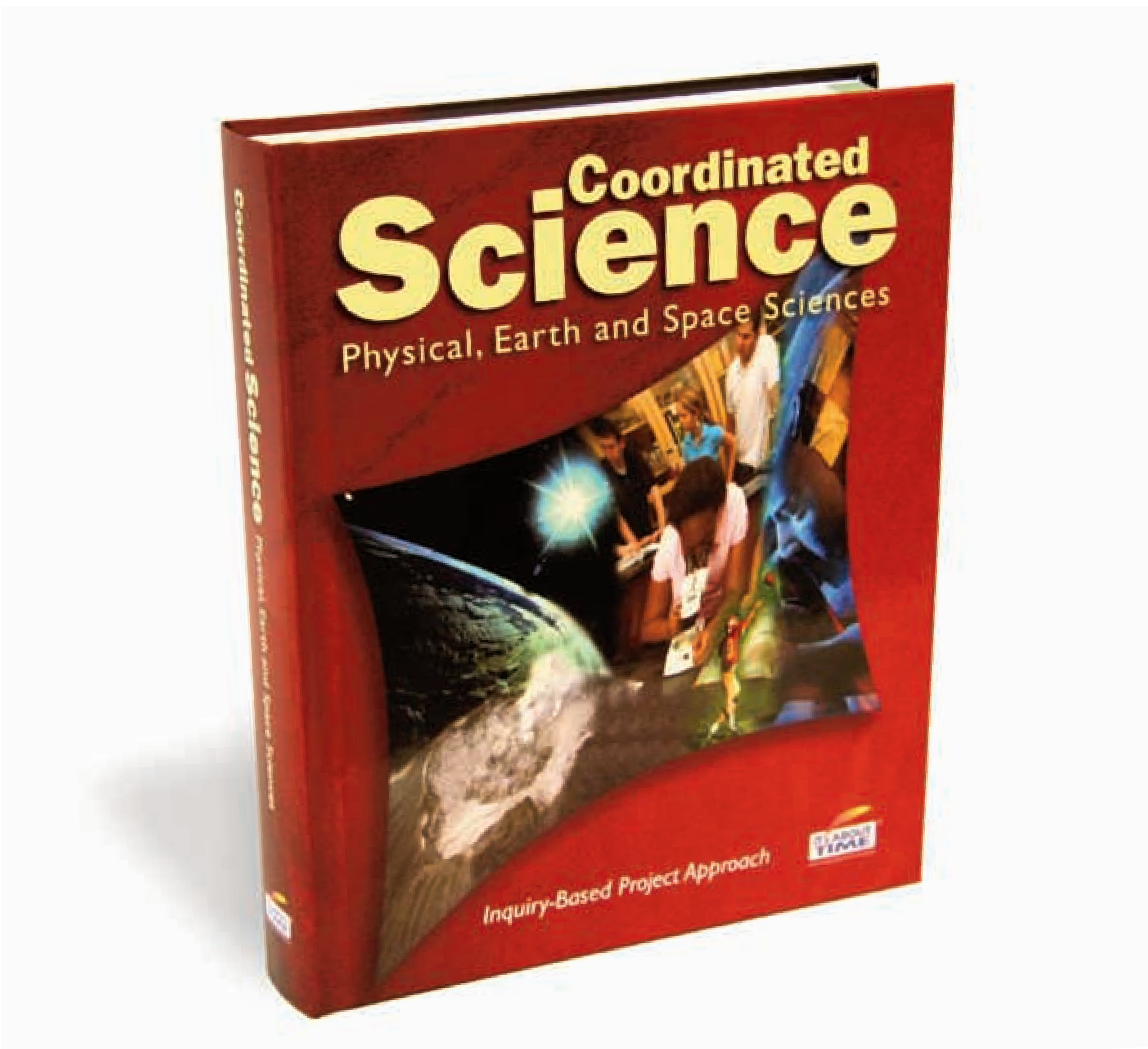


Coordinated Science Physical, Earth & Space Sciences: An innovative core curriculum assembled from our proven inquiry-based programs in each of the three basic content areas. Each program was originally supported by the National Science Foundation and developed by leading educators. ***Coordinated Science*** is a proven guided-inquiry, project-based course that works with students of all learning levels.

Active Physics (Unit 1) was originally developed by the American Association of Physics Teachers and the American Institute of Physics under the direction of Dr. Arthur Eisenkraft.

Active Chemistry (Unit 2) was also directed by Dr. Arthur Eisenkraft in association with the American Institute of Chemical Engineers.

EarthComm (Unit 3) was developed by the American Geological Institute (AGI) Each unit of this course has been designed and built...on the same research-based instructional strategy...and inquiry-based approach.



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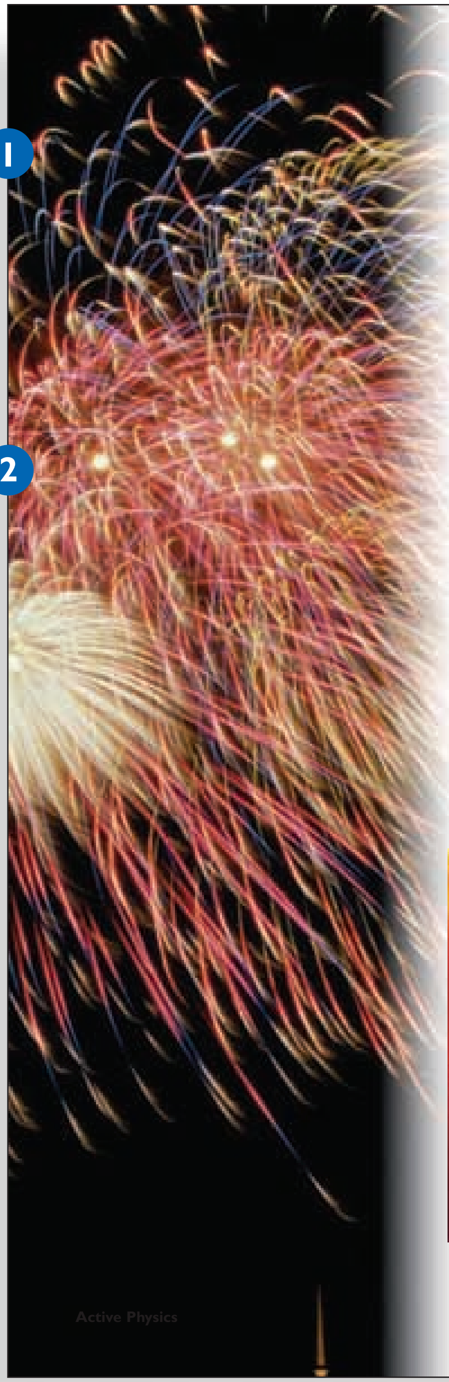

Scenario

Most entertainment today comes from the communication of sound and light signals. You look forward to television shows, movies, and rock concerts. The sound signals that entertain you come from voices or musical instruments. Light signals make the images you see on TV or in the movies. Specially designed light patterns add to the effect of a rock concert.

Challenge

You have been made part of a committee to design a two- to four-minute sound and light show to entertain other students your age. But unlike the professionals, you have neither the funds nor the technology available to rock stars or MTV™ productions. All the sounds you use must come from musical instruments or sound makers that you build yourself, or from human voices. Some of these sounds may be prerecorded and then played back during your show. If your teacher has a laser and is willing to allow you to use it, you may do so. All other light must come from conventional household lamps.

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1 *Scenario*

Each chapter begins with a realistic event or situation. Students might have actually experienced the event, or they can imagine participating in a similar situation at home, in school, or in their community. Chances are they probably never thought about the science involved in each case.

2 *Challenge*

This feature presents your students with a challenge that they can expect to complete by the end of the chapter. As they progress through the chapter they will accumulate all the knowledge needed to successfully complete the challenge.

3 Criteria

Work with your classmates to agree on the relative importance of the following assessment criteria. Each item in the list has a point value given after it, but your class must decide what kind of grading system to use.

1. The variety and number of physics concepts used to produce the light and sound effects: 30 points

   four or more concepts: 30 points

   three concepts: 25 points

   two concepts: 20 points

   one concept: 10 points

2. Your understanding of the physics concepts: 40 points

   Following your production, you will be asked to:

   a) Name the physics concepts that you used. 10 points
   b) Explain each concept. 10 points
   c) Give an example of something that each concept explains or an example of how each concept is used. 10 points
   d) Explain why each concept is important. 10 points

   As a class, you will have to decide if your answers will be in an oral report or a written report.

3. Entertainment value: 30 points

   Your class will need to decide on a way to assign points for creativity. Note that an entertaining and interesting show need not be loud or bright.

You will have a chance later in the chapter to again discuss these criteria. At that time, you may have more information on the concepts and how you might produce your show. You may want to then propose changes in the criteria and the point values.

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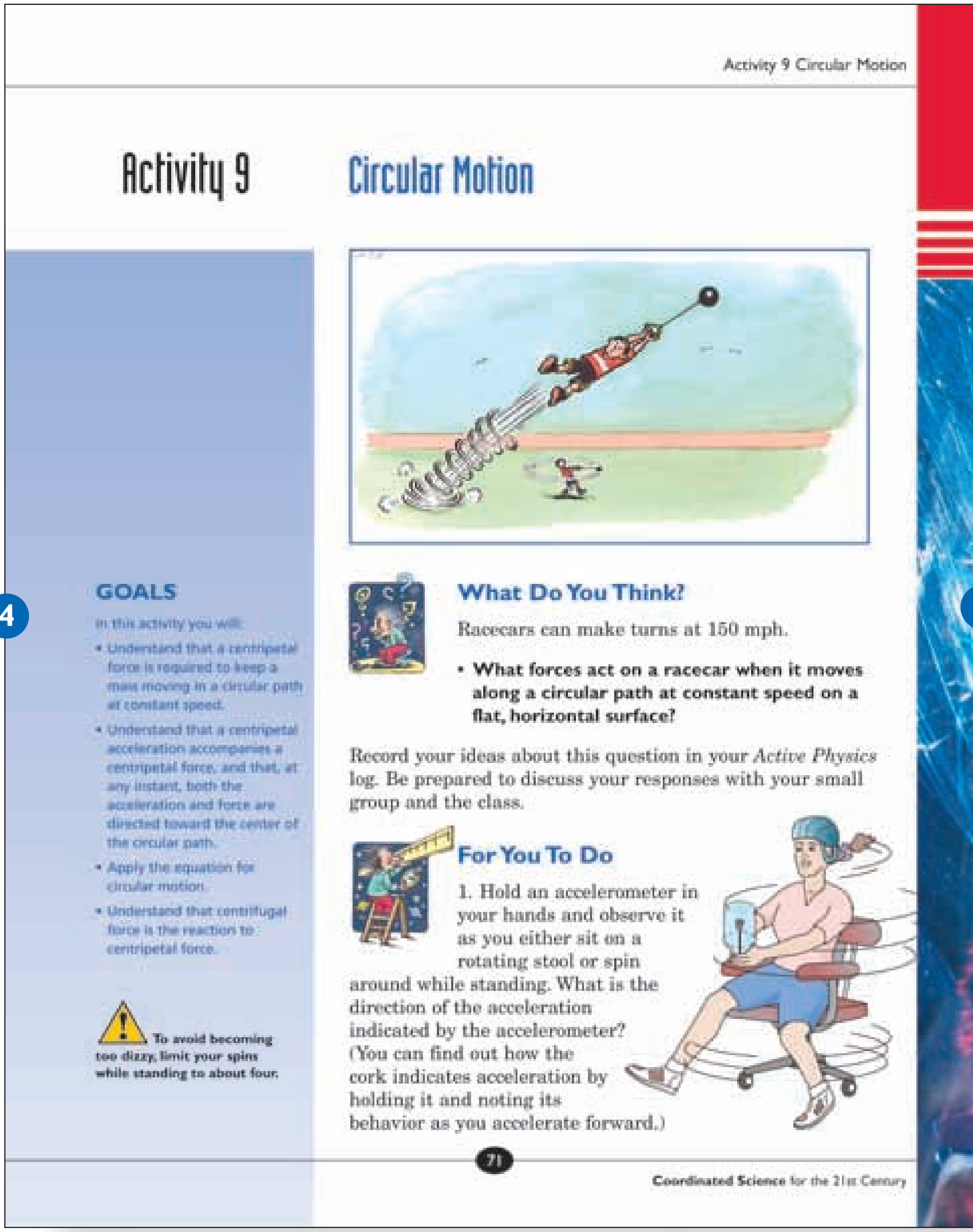
3 *Criteria*

Before the students begin the chapter and the challenge, the class, along with the teacher, will explore exactly how they will be graded. All will review the criteria and expectations for solving the challenge, and make decisions about how their work should be evaluated.


Activity 9 Circular Motion

Activity 9 Circular Motion

GOALS

In this activity you will:

- Understand that a centripetal force is required to keep a mass moving in a circular path at constant speed.
- Understand that a centripetal acceleration accompanies a centripetal force, and that, at any instant, both the acceleration and force are directed toward the center of the circular path.
- Apply the equation for circular motion.
- Understand that centrifugal force is the reaction to centripetal force.

To avoid becoming too dizzy, limit your spins while standing to about four.

What Do You Think?

Racecars can make turns at 150 mph.

- What forces act on a racecar when it moves along a circular path at constant speed on a flat, horizontal surface?

Record your ideas about this question in your *Active Physics* log. Be prepared to discuss your responses with your small group and the class.

For You To Do

1. Hold an accelerometer in your hands and observe it as you either sit on a rotating stool or spin around while standing. What is the direction of the acceleration indicated by the accelerometer? (You can find out how the cork indicates acceleration by holding it and noting its behavior as you accelerate forward.)

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Coordinated Science for the 21st Century

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5

4 Goals

At the beginning of each activity students are provided with a list of goals that they should be able to achieve by completing their inquiry.

5 What Do They Already Know?

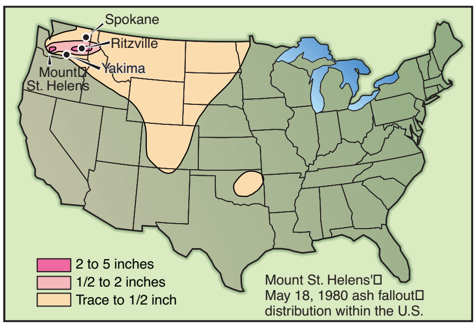
Before the students start each activity they will be asked one or two questions to consider. They will have a chance to discuss their ideas with their group and the class. Students are not expected to come up with the "right" answer, but to share their current understanding and reasoning.

Earth's Dynamic Geosphere Volcanoes

6

Investigate

1. Look at the map of the 1980 eruption of Mt. St. Helens. It shows the pattern of ash. Use the map to answer the following questions:



Distribution of ash from Mt. St. Helens eruption.

   a) How many states showed at least a trace of volcanic ash?
   b) In what direction did the ash move?
   c) Was Canada affected by ash from Mt. St. Helens? Why or why not?
   d) Would you consider this a small, medium, large, or gigantic eruption? Explain your choice.

2. Make a bar graph of the data shown in the table.
   a) Plot the name of each volcano on the horizontal axis.
   b) Plot the volume of volcanic eruption on the vertical axis. Arrange the volumes in order from least to greatest.

Volumes of Volcanic Eruptions

Volcano	Date	Volume (cubic kilometers)
Ilopango, El Salvador	300	40
Krakatoa, Indonesia	1883–84	2.4
Long Valley, California (Bishop Tuff)	740,000 years ago	500
Mazama, Oregon	4000 B.C.	75
Mt. Pelée, Martinique	1902	0.5
Mt. St. Helens, Washington	1980	1.25
Nevado del Ruiz, Colombia	1985	0.025
Pinatubo, Philippines	1991	10
Santorini, Greece	1450 B.C.	60
Tambora, Indonesia	1815	150
Valles, New Mexico	1.4 million years ago	300
Vesuvius, Italy	79	3
Yellowstone, Wyoming (Lava Creek Ash)	600,000 years ago	1000

Note: Volumes are approximate.

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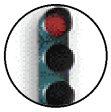
EarthComm

6 *Investigate*

In *Coordinated Science for the 21st Century* students learn by doing science. In their small groups, or as a class, students will take part in scientific inquiry by doing hands-on experiments, participating in fieldwork, or searching for answers using the Internet and reference materials.



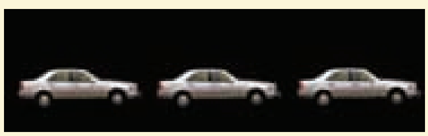
Safety

7 

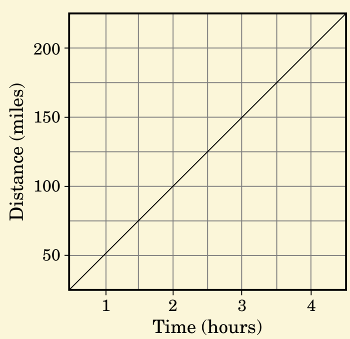
FOR YOU TO READ

Representing Motion

One way to show motion is with the use of strobe photos. A strobe photo is a multiple-exposure photo in which a moving object is photographed at regular time intervals. The sketches you used in **Steps 1**, **2**, and **3** in **For You To Do** are similar to strobe photos. Here is a strobe photo of a car traveling at the average speed of 50 mph.



Another way to represent motion is with graphs. The graph below shows a car traveling at the average speed of 50 mph.



Kilometers and Miles

Highway signs and speed limits in the USA are given in miles per hour, or mph. Almost every other country in the world uses kilometers to measure distances. A kilometer is a little less than two-thirds of a mile. Kilometers per hour (km/h) is used to measure highway driving speed. Shorter distances, such as for track events and experiments in a science class, are measured in meters per second, m/s.

You will use mph when working with driving speeds, but meters per second for data you collect in class. The good news is that you do not need to change measures between systems. It is important to be able to understand and compare measures.

To help you relate the speeds with which you are comfortable to the data you collect in class, the chart below gives *approximate* comparisons.

School zone	25 mph	40 km/h	11 m/s
Residential street	35 mph	55 km/h	16 m/s
Suburban interstate	55 mph	90 km/h	25 m/s
Rural interstate	75 mph	120 km/h	34 m/s

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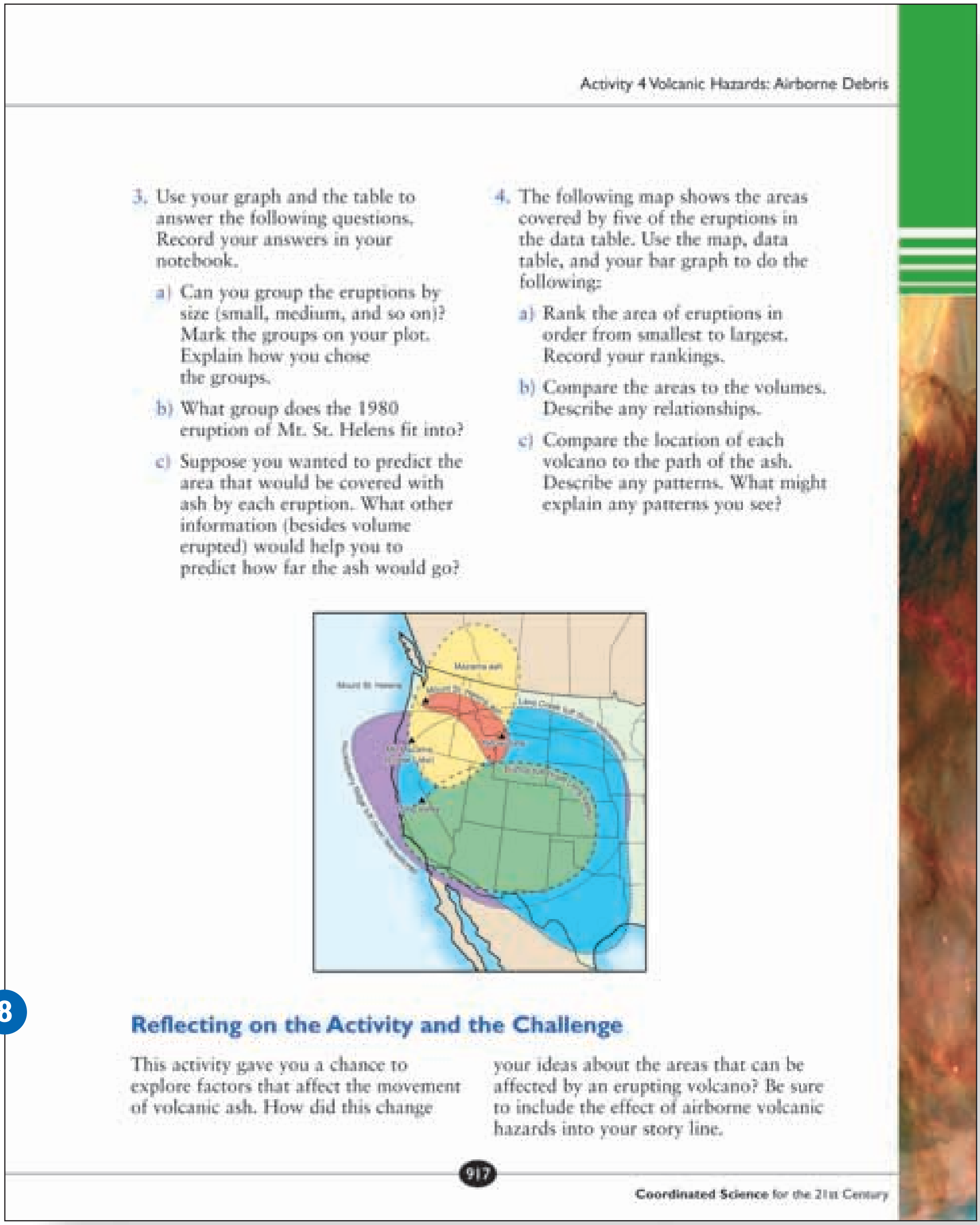
Active Physics

7 *Reading Sections*

These sections provide text, illustrations, and photographs that will give students a greater insight into the concepts they explored in the activity. Equations and formulas are provided with easy-to-understand explanations. **Science Words** that may be new or unfamiliar to them are defined and explained. In some chapters **Checking Up** questions are included to guide them in their reading.



Activity 4 Volcanic Hazards: Airborne Debris

3. Use your graph and the table to answer the following questions. Record your answers in your notebook.
   a) Can you group the eruptions by size (small, medium, and so on)? Mark the groups on your plot. Explain how you chose the groups.
   b) What group does the 1980 eruption of Mt. St. Helens fit into?
   c) Suppose you wanted to predict the area that would be covered with ash by each eruption. What other information (besides volume erupted) would help you to predict how far the ash would go?

4. The following map shows the areas covered by five of the eruptions in the data table. Use the map, data table, and your bar graph to do the following:
   a) Rank the area of eruptions in order from smallest to largest. Record your rankings.
   b) Compare the areas to the volumes. Describe any relationships.
   c) Compare the location of each volcano to the path of the ash. Describe any patterns. What might explain any patterns you see?

8

Reflecting on the Activity and the Challenge

This activity gave you a chance to explore factors that affect the movement of volcanic ash. How did this change your ideas about the areas that can be affected by an erupting volcano? Be sure to include the effect of airborne volcanic hazards into your story line.

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Coordinated Science for the 21st Century

8 *Reflecting on the Activity and the Challenge*

Each activity helps to prepare students to be successful in the challenge. This feature gives them a brief summary of the activity. It will help them relate the activity that they just completed to the challenge. It's another piece of the chapter jigsaw puzzle.

Reflecting on the Activity and the Challenge

Although many colorful chemical reactions involve the use of acids and bases with indicators, there is an entire group of chemical reactions that produce colorful results through the transfer of electrons. In this activity you became familiar with some of the simple concepts behind redox reactions, and you saw several examples of the color changes they can produce. You and/or your classmates may decide to include some redox reactions in the **Cool Chemistry Show.**

Chemistry to Go

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1. Aluminum metal can react to form an ion with a charge of +3. Does the aluminum atom gain or lose electrons to form the Al^{+3} ion?
2. A copper ion with a charge of +2 can react to form an atom of copper. Does the copper ion have to gain or lose electrons in this reaction?
3. The element iron can form two different ions. The iron (II) ion (Fe^{+2}) is commonly called a ferrous ion while the iron (III) ion (Fe^{+3}) is called a ferric ion. When ferrous ions undergo a chemical change to become ferric ions, what process has taken place, oxidation or reduction? Explain your answer.
4. In the reaction you did with zinc metal reacting with copper ions, which substance gains electrons? Which loses electrons?
5. What must take place for copper metal to be oxidized?
6. Galvanized iron nails are used to fasten materials that will be exposed to the outdoors. A galvanized nail is a regular iron nail that is coated with zinc.
   a) Why would a zinc coating be an advantage here? What do you think is the purpose of the zinc?
   b) What two reactants could you use to test this in the laboratory? What results would you expect if you were right about the purpose of the zinc?

10

Inquiring Further

The Statue of Liberty

In the 1980s the Statue of Liberty in New York harbor underwent extensive renovation. Research the involvement of oxidation-reduction reactions in this renovation. Identify what the problem was and its solution.

9 *Science to Go*

Questions in this feature ask students to use the key principles and concepts introduced in the activity. Students may also be presented with new situations in which they will be asked to apply what they have learned. They are excellent as a study guide, helping them to review and understand what is most important from the activity. Students will also be provided with suggestions for ways they can organize their work and get ready for the challenge.

10 *Inquiring Further*

This feature stretches your students' thinking. It provides suggestions for deepening their understanding of the concepts and skills development. Also, if they're looking for more challenging or in-depth problems, questions, and exercises, they'll find them right here.

Toys for Understanding

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Chapter 4 Assessment

Your task is to prepare a kit of materials and instructions that a toy company will manufacture. Children will use these kits to make a motor or generator, or a combination electric motor/generator. It will serve both as a toy and to illustrate how the electric motors in home appliances work or how electricity can be produced from an energy source such as wind, moving water, a falling weight, or some other external source.

Review and remind yourself of the grading criteria that you and your classmates agreed on at the beginning of the chapter. The following was a suggested set of criteria:

- **(30%) The motor/generator is made from inexpensive, common materials, and the working parts are exposed but with due consideration for safety.**
- **(40%) The instructions for the children clearly explain how to assemble and operate the motor/generator device, and explain how and why it works in terms of basic principles of physics.**
- **(30%) If used as a motor, the device will operate using a maximum of four 1.5-volt batteries (D cells), and will power a toy (such as a car, boat, crane, etc.) that will be fascinating to children.**

OR

- **(30%) If used as a generator, the device will demonstrate the production of electricity from an energy source such as wind, moving water, a falling weight, or some other external source and be fascinating to children.**

Physics You Learned 12

Motors

Generators

Galvanometers

Magnetic field from a current

Solenoids

Electromagnets

Induced currents

AC and DC generators

11 *Chapter Assessment*

How do your students measure up? Here is their opportunity to share what they have actually learned. Using the activities as a guide, they can now complete the challenge they were presented at the beginning of the chapter.

12 *Science You Learned*

This lists the science terms, principles, and skills they have just learned in the chapter.

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Chemistry at Work

Marc Pollack

President, Flix FX

"Everyone talks about 'Movie Magic,'" says Marc Pollack, president of the prestigious Hollywood special effects company Flix FX. "So I guess that makes me a magician." But Pollack is clearly more comedian than magician. The 'magic' he creates for movies like *Blackhawk Down*, *Men In Black* and *Cast Away*, in addition to scores of television commercials, museum installments and Las Vegas casinos, is the product not of mysterious hocus-pocus but rather fundamental principles of science. "One of the most important aspects of our work," he continues, "is to push the limits of how chemicals are designed to be used." Among other things, Pollack and his crew at Flix FX use vacuum-forming thermoplastics to make tin-based silicon molds for everything from prehistoric creatures to futuristic robots. Through a combination of trial and error experimentation and traditional research science, they've perfected the process. "Silicon is what we call an R.T.V.," Pollack explains. "That stands for room temperature vulcanization. So depending on the type and amount of catalyst we use, the mold will cure at different rates and with slightly differing properties." By manipulating the ratio of silicon to catalysts they can make strong, realistic molds in the most efficient way possible. "Increasing the amount of catalyst will speed up the curing process but too much catalyst will shorten the life of the mold," he says. "Every job is different so determining that balance is one of our many challenges."

Pollack, who is now a master in the art of using chemicals like silicon, polypropylene, urethane and urethane elastimers, is not a chemist by trade. He actually graduated from film school at SUNY Purchase in the hopes of becoming "the next Steven Spielberg." Then, through a twist of fate, he became a special effects nut and eventually founded Flix FX in 1990. "Now," Pollack says, "Spielberg may one day come to me."

Special effects — Pollack creates both mechanical and physical — is an industry in a constant state of transformation. "The industry is always trying new stuff and that's exciting," Pollack says. "For instance, someone just developed a great water-based breakaway glass for stunts called Smash Glass. It's similar to fiberglass without the dangerous elements associated with that material and can be made to break into either large chunks or tiny little pieces. I can't wait to get my hands on it and break it over someone's head. That's part of my job these days and I love it."

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Active Chemistry

13 *Science at Work*

Science is an integral part of many fascinating careers. This feature introduces some people working in different fields that involve the principles of science.

Chapter 1 – Physics in Action

Activity Summaries	Physics Principles
Activity 1: A Running Start and Frames of Reference Students measure the motion of a ball rolling down and up the sides of a bowl and find the ratio of the "running start" to the vertical distance. From this they are introduced to the concept of inertia.	• Acceleration • Gravity • Galileo's Principle of Inertia • Newton's First Law of Motion
Activity 2: Push or Pull – Adding Vectors Students construct, calibrate, and use a simple force meter to explore the variables involved in throwing a shot put. They then connect their observations and data to a study of the laws of motion.	• Newton's Second Law of Motion • Relationship of Mass and Force to Acceleration • Gravity
Activity 3: Center of Mass By finding the balancing points on objects with a variety of shapes, students are introduced to the effects of motion the athlete's center of mass has on the balance and performance.	• Center of Mass • Gravity
Activity 4: Defy Gravity Students learn to measure hang time and analyze vertical jumps of athletes using slow-motion videos. This introduces the concept that work when jumping is force applied against gravity.	• Gravity • Potential and Kinetic Energy • Work • Vertical Accelerated Motion
Activity 5: Run and Jump Thinking about the direction in which they apply force to move in a desired way introduces students to the concept that a force has an equal and opposite force. They test this concept, then apply it to a variety of motions observed in sports.	• Force Vectors • Weight and Gravity of Forces • Newton's Third Law of Motion
Activity 6: The Mu of the Shoe Students measure the amount of force necessary to slide athletic shoes on a variety of surfaces. From this and the weight of the shoe, they learn to calculate friction coefficients. They then consider the effects of friction on the athlete's performance.	• Gravity • Frictional Force • Normal Force • Coefficient of Sliding Friction
Activity 7: Concentrating on Collisions Students investigate the effects of a ball's velocity on its motion after a collision. They then apply these observations and what they now know about opposing forces in motion to describe collisions of balls and athletes in sporting events.	• Newton's Third Law of Motion • Mass • Velocity • Momentum
Activity 8: Conservation of Momentum Additional collisions between objects allow students to investigate what happens when the objects stay together or "stick" after the collision.	• Newton's Third Law of Motion • Momentum = Mass x Velocity • Law of Conservation of Momentum
Activity 9: Circular Motion Students use an accelerometer to test the direction of acceleration when spinning in a chair. From this, they investigate the forces involved in the movement of turning objects and athletes.	• Inertia • Centripetal Acceleration • Centripetal Force

Chapter 2 – Safety

Activity Summaries	Physics Principles
Activity 1: Response Time Using a response timer, students explore the time required for a driver to respond to a hazard. This activity introduces students to the process of beginning with their own ideas and predictions, then implementing an investigation that results in both qualitative and quantitative data.	• Series Circuits • Switches • Response Time
Activity 2: Speed and Following Distance Strobe, or multiple exposure photos of a moving vehicle are used to discuss speed and acceleration. Students then use a sonic ranger to measure how fast they walk and obtain a computer-generated graph of their speed. Information about speed is then connected to response time with a discussion of tailgating.	• Average Speed • Using Data as Basis for Predictions • Speed, Distance, and Time Relationships
Activity 3: Accidents Following an investigation about crashing cars against barriers, students use advertisements and consumer reports to learn about safety devices on automobiles. Each is analyzed to determine the type of collision-related injuries it prevents, and to identify if the device could in fact increase injuries in a unique setting.	• Physical Properties of Matter • Effect of Forces on Motion
Activity 4: Life (and Death) before Seat Belts Using a lump of clay on a motion cart to represent a person in a car, students explore “objects in motion stay in motion.” They then relate this to actual automobile collisions.	• Acceleration • Inertia
Activity 5: Life (and Fewer Deaths) after Seat Belts Students focus on the design and materials used in seat belt construction as they study force and pressure. They investigate how increasing surface area decreases the pressure exerted. They relate this to the challenge by finding ways to increase the area of impact in a collision.	• Inertia • Newton’s Laws of Motion • Force and Pressure • Newton as a Unit of Measure
Activity 6: Why Air Bags? A model of an air bag is used in an investigation of what happens on impact when objects of different mass are dropped from different heights. They observe the amount of damage in each case and relate this to the concept of “impulse” and how spreading out the time of the impulse reduces damage.	• Inertia • Force and Pressure • Impulse
Activity 7: Automatic Triggering Devices In this inquiry investigation, students design a device that will trigger an air bag to inflate. These simulations allow them to apply concepts of inertia and impulse as they test ideas that help them address the chapter challenge.	• Inertia • Force and Pressure • Impulse
Activity 8: The Rear-End Collision Students investigate the effect of rear-end collisions on passengers by using a model of the neck muscles and bones of the vertebral column. They then read to learn more about Newton’s Second Law of Motion and consider how they can apply this information in designing a safety device that prevents movement of the head in a collision.	• Collisions • Newton’s Second Law of Motion • Momentum
Activity 9: Cushioning Collisions (Computer Analysis) Using a force probe, students investigate the effectiveness of different types of systems designed to minimize the impact of collisions. The systems include sand canisters around bridge supports and padded car interiors. This investigation provides an opportunity to develop deeper understanding of the concepts of acceleration, velocity, and momentum.	• Inertia • Impulse • Momentum • Change in Momentum • Conservation of Momentum

Chapter 3 – Let Us Entertain You

Activity Summaries	Physics Principles
Activity 1: Making Waves Students begin the chapter by making waves with a Slinky,® observing pulses, periodic, standing, and compressional waves. From these observations, then measurements, they establish the relationships among wavelength, frequency, and speed of the wave.	• Wave Motion • Periodic, Standing, and Compressional Waves • Wavelength – Frequency, Speed
Activity 2: Sounds in Strings To connect waves to sound, students observe the vibration of a plucked string and compare how vibration and pitch vary when the tension of the string changes. They then explore the affect on vibrations and pitch when the length of the string is changed. Reading explains the physics concepts in the observed phenomena.	• Sound Waves • Wave Motion • Tension and Pitch • Frequency
Activity 3: Sounds from Vibrating Air Drinking straws and test tubes filled with water are used to model instruments that use columns of vibrating air to produce sounds. The relationship of pitch to length of the column of air provides another look at frequency and wavelength, helping students understand how sound is produced by compressional and standing waves.	• Sound Waves • Wave Motion • Compressional Waves • Frequency and Wavelength
Activity 4: Reflected Light In this activity, students begin looking at how light can be incorporated into the chapter challenge. They explore the result of changing the angle at which light rays are aimed at a mirror and learn to predict and control where images will be visible.	• Light Rays • Reflection of Light • Real Images – Focus, Focal Length
Activity 5: Curved Mirrors Shining a light beam on concave and convex mirrors increases student understanding of the variables that are involved in creating an image. They apply what they have learned to predict the path of a light beam reflected off a mirror.	• Reflection of Light • Real Images – Focus, Focal Length • Controlling Variables
Activity 6: Refraction of Light In this activity, a block of gelatin allows students to explore what happens when light goes from air into another substance. They observe and measure the angle of incidence and the angle of refraction as they learn about Snell's Law and how to mathematically predict where the beam of light can be observed.	• Refraction of Light • Snell's Law
Activity 7: Effect of Lenses on Light Shining a light through different lenses enables students to observe how focal length and the size of the image changes as the light source moves closer to, then farther away from a lens. They then consider how the variables in this phenomenon can enhance their sound and light show for the chapter challenge.	• Refraction of Light • Lenses and Image Formation • Focus, Focal Length
Activity 8: Color This final activity adds to the study of light with observations of shadows. By carefully tracing the light ray and noting the areas without any light and the areas of gray light, students begin to learn about diffusion of light. They extend their investigations to include the effect of shining different colored lights on objects.	• Light and Shadows • White Light • Color Addition

Chapter 4 – Toys for Understanding

Activity Summaries / Physics Principles

Activity 1: The Electricity and Magnetism Connection
Students investigate the relationship between electricity and magnetism by testing the effect of a magnetic field on current-bearing wire and on a compass.

- **Electricity**
- **Magnetism**
- **Magnetic Fields**

Activity 2: Electromagnets
Using the hand generator to construct an electromagnet is the first step in this continued investigation of the relationship between electricity and magnetism. Students test the strength and find polarity of electromagnets made with different core materials.

- **Electromagnets**
- **Solenoids**

Activity 3: Detect and Induce Currents
Students construct a Galvanometer as they learn that a compass can detect the presence of a magnetic field. They use the Galvanometer to create a current similar to the process used by Faraday and Henry, manually alternating the motion of a magnet.

- **Galvanometers**
- **Induced Currents**

Activity 4: AC & DC Currents
The use of human energy to produce electricity is replaced in this activity by a rotating coil motor. While using this motor, students test and describe the voltage in this induced current. They learn the difference between how AC and DC currents are generated. Students also learn to sketch output wave forms.

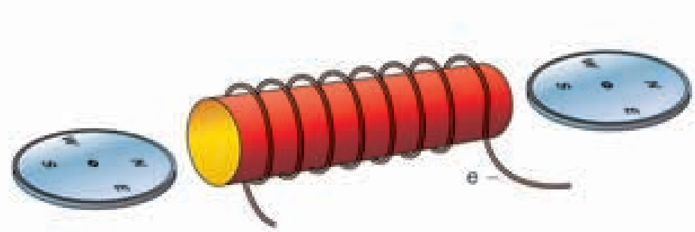
- **Energy Conversion**
- **AC and DC Currents**
- **Electrical Waves**

Activity 5: Building an Electric Motor
Students construct, operate, and explain the workings of a DC motor. This enables them to measure and express the efficiency of energy transfers. They also read to learn more about the discoveries that led to the generators and motors we use today to obtain useable power and electricity.

- **Electricity**
- **Magnetism**
- **Energy Transfer**

Activity 6: Building a Motor/Generator Toy
In this final activity, students apply what they have learned about the workings of an electromagnetic motor and how both AC and DC currents are generated. They must use given materials to design, construct, and demonstrate the physics of a motor or generator.

- **Energy Conversion**
- **Electricity**
- **Magnetism**
- **AC and DC Currents**



Chapter 5 – Patterns and Predictions

Activity Summaries	Physics Principles
Activity 1: Force Fields Observing, then measuring the properties of magnets introduces the study of force fields and helps students appreciate the dilemmas that can occur when describing something that is invisible.	• E Fields — Point Charge, Line of Charge, Plane of Charge • Magnetic Fields • Coulomb's Law
Activity 2: Newton's Law of Universal Gravitation In an activity in which they place a photocell on the light generated by a slide projector, students measure light intensity at various distances to uncover the inverse square law. They then apply this to Newton's Law of Universal Gravitation.	• Light Intensity • Newton's Law of Universal Gravitation • Inverse Square Relationship
Activity 3: Slinkies® and Waves In this activity, students explore wave motion with "people waves" then with Slinkies. Students then read to learn more about wavelength, frequency, amplitude, crests, and troughs. This experience is used as a model to explain the flow of energy.	• Nature of Science • Energy Transfer • Wave Motion and Periods • Wavelengths and Amplitude • Light as a Wave
Activity 4: Interference of Waves Using Slinkies to model wave motion, students explore and observe the phenomena of wave interference. They expand their understanding of waves by comparing this experiment to sine waves generated on graphing calculators, circular waves in a ripple tank, laser light beams, and sound waves from identical speakers.	• Energy Transfer • Sound • Light • Wave Motion • Wave Interference
Activity 5: A Moving Frame of Reference This activity introduces the concept of frames of reference by having students describe and compare observations of the same event made while standing still and while moving. They then read to learn more about how the laws of physics relate to these different descriptions of the same event.	• Frames of Reference • Speed • Relativity
Activity 6: Speedy Light In this activity, students explore the speed of light as related to the concept of relativity by considering how to know for certain whether two clocks, large distances apart, display exactly the same time. Reading more about Einstein's theories enables them to apply these concepts to the chapter challenge.	• Simultaneous Events • Speed of Light • Relativity • Frames of Reference
Activity 7: Special Relativity Simultaneous events and relativity set the stage for this final chapter activity in which students learn about muons. Muons, and Einstein's Theory of Special Relativity focus students on the need to consider the need for evidence from experiments to support the development of scientific theories.	• Special Relativity • Muons • Half-life
Activity 8: The Doppler Effect In this activity, students are introduced to the Doppler Effect in an experiment in which they toss an oscillator embedded in a Nerf ball. The change in pitch as the Nerf ball moves is related to how the Doppler Effect is used to measure distance to distant stars. This is then related to the development of the Big Bang Theory.	• Doppler Effect • Big Bang Theory • Measuring Distances in Space
Activity 9: Communication Through Space In this final activity, students are confronted with the extreme amount of time required for light waves to reach stars. After considering the impact of this time delay on communication with life on stars, students return to the chapter challenge and discuss what type of information is most important to send and receive.	• Speed of Sound • Speed of Electromagnetic Waves • Measuring Distances in Space

Chapter 6 – Designing the Universal Dwelling

Activity Summaries	Physics Principles
Activity 1: Factors in Designing the "Universal Dwelling" Examining characteristics of houses designed for a variety of geographic locations introduces students to the concept of form and function in a home. They then list features necessary for a universal dwelling.	• **Form and Function** • **Analyzing and Interpreting Data**
Activity 2: What is the "Right Size" for a Universal Dwelling? After researching and analyzing data on living space in sample homes, students plan the design of their universal dwelling and calculate the necessary dimensions of each room based on its function. They conclude by drawing a floor plan.	• **Analyzing and Interpreting Data** • **Models, Measurements, and Scale**
Activity 3: The Shape of the "Universal Dwelling" Students examine their floor plans, applying knowledge of area, perimeter, and volume to decide if the planned living space is maximized while building materials are minimized. They then refine their plans to reflect what was learned from investigating size as compared to form and function of rooms in other dwellings.	• **Applying Measurement and Data to Predictions**
Activity 4: Solar Heat Flow... This activity confronts students with implications of shape and size on occupants of the home. Students construct a model of the home, then use a heat lamp and temperature probe to investigate interior light and heat during a simulated day and night. This also introduces the use of passive solar designs for light and heat in the home.	• **Radiant Energy** • **Energy Transfer** • **Passive Solar Heating**
Activity 5: The Role of Insulation... Students expand their understanding of solar heat by exploring the affect of different types of insulation in an experiment with hot and cold water. They apply data collected to plan how to maintain a stable temperature inside the home. Students read to learn about transfer of radiant energy through conduction and convection.	• **Energy Transfer** • **Heat Conduction** • **Heating and Cooling Curves**
Activity 6: Investigating Insulation Placement... Students collect and compare temperature data during simulated 24-hour cycles for different types, thickness, and placement of insulation in the ceilings and walls of their model homes. Interpretation of this data combined with new understanding of heat loss and gain is used to further refine design of the home.	• **Energy Transfer** • **Heat Loss Through Conduction**
Activity 7: The Role of Windows... Light and ventilation are the focus of this activity as students plan and test placement, size, and materials of windows. As they continue experimenting with passive solar heating and lighting, they are challenged to again consider heat loss when an insulated wall is replaced with a window.	• **Energy Transfer** • **Heat Loss Through Conduction** • **Passive Solar Heating** • **Passive Solar Lighting**
Activity 8: Investigating Overhangs and Awnings Students investigate the affect of the angle of the Sun's rays in different geographic regions in a simulation with heat lamps and temperature probes. Overhangs and awnings are added to the house to compensate for increased interior temperature. Students then have the opportunity to further refine the design of their dwelling to maximize use of passive solar heating and lighting.	• **Energy Transfer** • **Passive Solar Heating** • **Passive Solar Lighting**
Activity 9: Too Hot, Too Cold, Just Right Students will be able to experimentally determine the final temperature when two liquids of different temperatures are mixed, determine the final temperature when a hot metal is added to cold water, and calculate the heat lost and the heat gained of two objects after they are placed in thermal contact. They will also determine if energy is conserved when two objects are placed in thermal contact and reach an equilibrium temperature, and explain the concept of entropy as it relates to objects placed in thermal contact.	• **Heating and Cooling Curves** • **Irreversibility of Heat** • **Specific Heat**

Chapter 7 – The Periodic Table

Activity Summaries	Chemistry Principles
Activity 1: Organizing a Store Students learn how to organize a store by categorizing the different items that are contained in the store and where new items are placed.	• **Periodicity**
Activity 2: Elements and Their Properties Students determine some of the physical and chemical properties of elements and start the process of arranging the chemicals into families.	• **Atoms** • **Chemical properties** • **Physical properties**
Activity 3: Atoms and Their Masses Why we believe in atoms is the first hurdle that the early scientists had to overcome. In this activity the students show why they believe in atoms and how the elements of different atoms interact with each other.	• **Single-Displacement Reaction** • **Atomic mass** • **Law of Definite Proportions** • **Quantitative analysis**
Activity 4: Are Atoms Indivisible? This activity shows the students that an atom consists of protons and electrons. It also suggests where these particles are located in the atom.	• **Cathode Rays** • **Properties of an electron** • **Proton** • **Nucleus**
Activity 5: The Chemical Behavior of Atoms This activity leads the students into the understanding of the energy of an electron and how it may be arranged about the nucleus of the atom. Spectroscopic analysis is used to determine the excited levels that an electron can occupy.	• **Element's Line Spectrum** • **Bohr's Atomic Model** • **Quantized energy levels** • **Light waves**
Activity 6: Atoms with More than One Electron This activity continues the investigation of the excitation of electrons in different atoms. The ionization energy of the elements are used to learn how the electrons are arranged and configured for each different atom.	• **Element's Line Spectrum** • **Ionization potential** • **Electron Configuration**
Activity 7: How Electrons Determine Chemical Behavior This activity shows that each family of the periodic table has its own unique electron configuration. It also shows what energy levels are occupied.	• **Noble gases stability** • **Chemical families**
Activity 8: How Atoms Interact With Each Other This activity explains why atoms combine in certain proportions by transferring electrons from one atom to another. The difference between ionic and covalent bonds is also explained.	• **Electron transfer** • **Ionic bonds** • **Covalent bonds** • **Chemical formulas**
Activity 9: What Determines and Limits an Atom's Mass? The mass of an atom is determined by the sum of its protons and neutrons. Since almost all elements have isotopes the mass listed in the periodic table is then called the average atomic mass. This activity also shows that the number of elements is limited to the stability of the nucleus. This nuclear stability is dependent upon the number of neutrons and protons contained in the nucleus.	• **Atomic mass** • **Isotopes** • **Protons** • **Neutrons** • **Radioactivity** • **Binding energy** • **Electric forces**

Chapter 8 – Movie Special Effects

Activity Summaries	Chemistry Principles
Activity 1: Elements and Compounds Students learn the basic concept of what matter is and how we can dissociate compounds back to elements. Also, simple tests are used to identify the properties of hydrogen and oxygen gas.	• Compounds • Electrolysis • Chemical reaction • Chemical elements • Chemical properties
Activity 2: States of Matter: Solid, Liquid, and Gas The students develop a heating curve of water as it goes through the three physical states of a solid, liquid, and gas. From the understanding of phase changes, the students develop animation to represent each phase.	• Heating curves • Kinetic energy • Potential energy • Physical states of matter • Molecular motion • Sublimation
Activity 3: Solutions, Suspensions, and Colloids Students learn that different materials can combine to make new materials when mixed together. They also learn how to classify a material as a solution, colloid, or suspension. Tyndall effect is used to help differentiate the different types of mixtures.	• Tyndall effect • Filtration • Homogeneous mixture • Heterogeneous mixture
Activity 4: Properties of Matter Students learn how to use modeling dough to illustrate macro structures at a smaller scale. They also compare the properties of emulsions to those of a composite. Finally, students learn how composites are used in industrial applications.	• Physical properties • Composites • Emulsions
Activity 5: Mass and Volume The students determine the density of liquids and solids. They also learn how to determine the density of irregularly shaped solids and how to determine the density of air. The use of significant figures in determining the density of different materials is emphasized.	• Density • Displacement • Measurements
Activity 6: Metals and Nonmetals Students observe physical and chemical properties of metals and nonmetals. From these observations they classify materials as metals or nonmetals. They also learn how different metals can be put together to make alloys.	• Metallic properties • Metalloids • Nonmetals • Alloys
Activity 7: Polymers Students make a cross-linked polymer. The slime that they produced is classified as a non-Newtonian fluid. They study the properties of this special material and compare it to the properties of solids and liquids.	• Polymers • Cross-linked polymers • Commercial uses of polymers
Activity 8: Identifying Matter Students discover that metal compounds have characteristic colored flames and that by combining dissimilar metal compounds they can produce visible flames with different colors. The principles of fireworks are reviewed as well as how these metals are used to produce the various colors observed in fireworks displays.	• Metal visible colored flame • Electron excitation
Activity 9: Organic Substances Students learn the various structures of hydrocarbons. They also learn how ethylene gas is used to ripen fruit. The activity includes a discussion of how the term "organic" is used differently by laypersons and scientists	• Hydrocarbon

Chapter 9 – Cool Chemistry Show

Activity Summaries	Chemistry Principles
Activity 1: Chemical and Physical Changes This activity explains the difference between chemical and physical changes. They are able to show what properties are necessary to have a chemical change.	• Chemical change • Physical change
Activity 2: More Chemical Changes This activity helps to identify the special properties of a chemical change or chemical reaction.	• Precipitate • Thermochemistry
Activity 3: Chemical Names and Formulas This activity focuses on the element's symbol and how they can combine with each other to make compounds. The students also learn how to write the correct formulas of these compounds.	• Elements • Chemical compounds • Chemical formulas
Activity 4: Chemical Equations This activity introduces the students to single-and double-displacement reactions. Also, some simple tests to identify the products that are formed.	• Chemical Equations • Single-Displacement reactions • Double-Displacement reactions • Chemical Synthesis
Activity 5: Chemical Energy This activity requires the students to determine what type of reactions produce heat. They will discover that both physical and chemical changes produce heat.	• Chemical Thermodynamics • Endothermic reactions • Exothermic reactions
Activity 6: Reaction Rates This activity reviews some of the properties that affect the rate of a chemical reaction. Concentration, temperature, nature of the compound, and the use of catalysts are examined in different chemical reactions.	• Reaction Rates • Kinetics • Concentration • Catalysts
Activity 7: Acids, Bases, and Indicators – Colorful Chemistry This activity discusses the properties of acids and bases. Students will also learn how to use an indicator to determine the acidity of a solution.	• Acids/Bases • Arrhenius Acids • Indicators • pH
Activity 8: Color Reactions that Involve the Transfer of Electrons This activity is used to determine the pH and also what the pH scale is. It also looks at different indicators and what pH range they change color.This activity involves oxidation and reduction reactions between metals. The activity of metals is used to determine which metals will react. Metal plating out and color changes of solutions are evidence of chemical reactions taking place.	• Buffered Solutions • Transfer of Electrons • Activity of Metals • Metal plating • Rust

Chapter 10 – Astronomy and Your Community

Activity Summaries	Earth Science Principles
Activity 1: The History and Scale of the Solar System To develop an understanding of the size of our Solar System, students make models of the Solar System using different scales.	• Astronomical distance and time (astronomical units, light-years, parsecs) • Nebular theory, birth of the planets • Relationship of our Solar System in the Milky Way Galaxy
Activity 2: The Earth–Moon System Students complete an exercise to understand what causes the different lunar phases. They observe the lunar phases for one month. Students examine data on tides and lunar phases to understand the relationship between the tides and phases of the Moon. They complete calculations to determine how the Moon has influenced the length of a year on Earth.	• Lunar phases • Formation of the Moon • Tides
Activity 3: Orbits and Effects Students draw a series of ellipses to understand the relationship between distance between foci and eccentricity of an ellipse. They study the eccentricity of the Earth's orbit around the Sun. They consider how the shape of the Earth's orbit is related to changes in climate through time.	• Eccentricity • Obliquity • Precession • Orbital inclination
Activity 4: Impact Events and The Earth System Students calculate the energy released when a hypothetical asteroid collides with Earth. They calculate the energy released during known impact events in the Earth's past. Students compare these calculations with the energy released through natural and human-made phenomena like earthquakes and bombs.	• Asteroids • Meteors • Impact events
Activity 5: The Sun and Its Effects on Your Community Students plot sunspot activity from 1899 to 1998 and determine the pattern of this activity. They examine data on strength of solar flares. They correlate this data with sunspot activity to understand that the two are related. Students then consider the effect of solar activity on Earth.	• Structure of the Sun • Sunspots • Solar flares • Earth's energy budget
Activity 6: The Electromagnetic Spectrum and Your Community Students use a spectroscope to determine how the visible spectrum looks in natural sunlight, fluorescent light, and incandescent light. They prepare a scale model of the electromagnetic spectrum to get a sense of the relative sizes of the different electromagnetic bands. Students then research space science missions to understand how astronomers use electromagnetic radiation to study objects and events in the Solar System.	• Electromagnetic radiation • Using electromagnetic radiation in astronomy • Frequency, wavelength
Activity 7: Our Community's Place Among the Stars Students complete an exercise to understand how brightness varies with distance. To help them understand how astronomers classify stars, they use luminosity and surface temperature to plot stars on a Hertzsprung-Russell diagram.	• Hertzsprung-Russell diagram • Classification of stars • Luminosity • Life cycles of stars

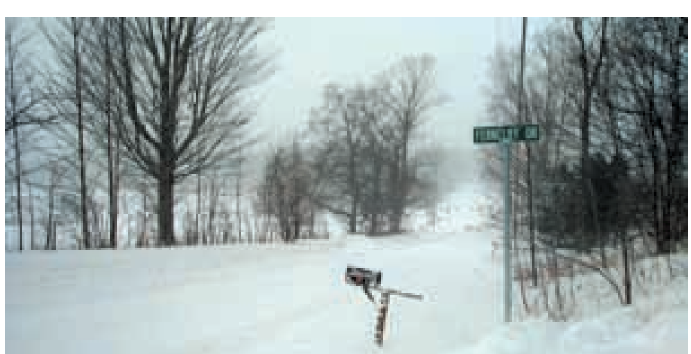
Chapter 11 – Climate Change and Your Community

Activity Summaries	Earth Science Principles

Activity 1: Present-Day Climate in Your Community
Students examine data on temperature and precipitation to describe the climate of their community. They look at a local topographic map to determine what physical features in their community might influence climate. Students then compare the climate of their community to that of a different community.
	• Climate, local and global
	• Weather
	• Factors affecting climate:
	  • latitude
	  • elevation
	  • geography

Activity 2: Paleoclimates
Students correlate changes in the appearance of tree rings to the Little Ice Age to understand the significance of growth rings in trees as evidence for climate change. They create a model of sediment layers to understand how fossil pollen can be used to understand climate change through time.
	• Paleoclimate
	• Evidence of climate change:
	  • fossil pollen
	  • ice cores
	  • deep-sea sediments
	  • glacial sediments
	  • tree rings

Activity 3: How Do Earth's Orbital Variations Affect Climate? Students complete a series of exercises on paper and then use a globe to understand the causes of seasons on Earth. They also use the globe to understand how the tilt of the Earth's axis causes the seasons. Students then draw a series of ellipses to understand the shape of the Earth's orbit. Finally, they complete an experiment to understand how energy from the Sun varies with distance.	• Axial tilt • Eccentricity • Obliquity • Precession • Milankovitch cycles
Activity 4: How Do Plate Tectonics and Ocean Currents Affect Global Climate? Students build models to understand how the positions of the continents have affected ocean circulation around Antarctica over the past 55 million years. They consider how changes in ocean circulation affect climate.	• Ocean circulation • Ocean currents and global climate • Plate tectonics and global climate • Pangea
Activity 5: How Do Carbon Dioxide Concentrations in the Atmosphere Affect Global Climate? Students examine atmospheric carbon dioxide concentrations over the last century and over the last 160,000 years. They compare the data to global temperatures to find the relationship between the two. Students then design and conduct an experiment to help them understand the greenhouse effect.	• Atmospheric carbon dioxide concentrations • Greenhouse gases and the greenhouse effect • Carbon budget
Activity 6: How Might Global Warming Affect Your Community? Students work in small groups to brainstorm about the effects of increased temperature on the community. They select one outcome of global warming and then, on paper, design an experiment to test their idea.	• Making predictions • Computer modeling • Effects of global warming



Chapter 12 – Energy Resources and Your Community

Activity Summaries	Earth Science Principles
Activity 1: Exploring Energy Resource Concepts Students cycle through a series of stations to investigate three processes of heat transfer: conduction, radiation, and convection. They answer questions based on a thought experiment to understand the conversion of mechanical energy into heat. Students learn about the Second Law of Thermodynamics and investigate how it is related to the generation of electricity.	• Heat transfer processes: convection, radiation, and conduction • Kinetic and potential energy • Power and work • Second Law of Thermodynamics
Activity 2: Electricity and Your Community Students compare the use of energy resources for electricity generation in the United States to those used in other countries. Students then identify the energy sources that are most commonly used for electricity generation in the United States and in their state. This helps them think about what current means of producing power their community relies on most, and which power sources are least important.	• Energy resources for electricity generation • Electric power versus electric energy • Methods of generating electric power • Renewable energy source
Activity 3: Energy from Coal Students examine coal samples to understand the physical properties of different types of coal. Students look at a map that shows the distribution of coal resources in the United States. They determine whether or not coal deposits are found in their community today, or if they could be found in their community in the future.	• Physical properties of coal • Distribution of coal deposits in the United States • Formation of coal • Fossil fuels
Activity 4: Coal and Your Community Students investigate the production and consumption of coal in the United States They use data on trends in coal production and consumption to extrapolate into the future. Students correlate a series of well logs to understand how geologists explore for coal. Finally, they look at possible methods to conserve coal resources.	• Trends in coal production and consumption • Coal exploration and mining • Well log correlation • Energy conservation
Activity 5: Environmental Impacts and Energy Consumption Students examine a map that shows the acidity of rainfall across the United States, and correlate the pattern of rainwater pH to the distribution of coal-producing regions. Students complete an experiment to understand how different types of rocks can neutralize the acidity of rainwater. They consider how this relates to environmental impacts of acid rain.	• Acid rain • Carbon cycle • CO^2 concentrations and the greenhouse effect • Advantages and disadvantages of energy resources
Activity 6: Petroleum and Your Community Students investigate oil production, imports, and consumption in the United States to recognize the dependence of today's society on oil as a resource. They use data on trends in oil production and consumption to extrapolate into the future. Students look at a map that shows the distribution of oil and gas deposits in the United States to determine whether oil and gas are found, refined, and/or distributed near their community. Finally, they go online to investigate production, consumption, and distribution of oil and natural gas in their state.	• Nature and origin of petroleum and natural gas • Production and consumption of oil and natural gas
Activity 7: Oil and Gas Production Students design investigations to explore porosity and permeability of rock bodies and to consider how these factors affect the volume and rate of production in oil and gas fields. Students use data to produce a cross section of a petroleum reservoir. They estimate the likelihood of finding oil and gas in various locations.	• Porosity and permeability • Petroleum recovery • Petroleum reserves
Activity 8: Renewable Energy Sources — Solar and Wind Students investigate the use of solar energy by constructing a solar water heater and determining its maximum energy output. They investigate the use of wind energy by constructing an anemometer to measure wind speeds and calculating how much power can be generated by wind.	• Forms of solar energy • Solar energy for heat and electricity • Wind power • Energy conservation

Chapter 13 – Volcanoes... And Your Community

Activity Summaries	Earth Science Principles
Activity 1: Where are the Volcanoes? Students begin the chapter by examining a map and searching for and describing patterns in the global distribution of volcanoes. They plot the latitude and longitude of the volcanoes closest to their community and make inferences about possible locations of future volcanic activity.	• **Volcanism** • **Mid-ocean ridge** • **Hot-spot volcanism** • **Mercator projection**
Activity 2: Volcanic Landforms Students construct models of volcanoes and contour maps of the models to learn how topographic maps depict elevations and features. Conceptual understanding of representations of the land surface is then connected to the relationship between magma composition and types of volcanic landform.	• **Topography** • **Magma composition and properties** • **Volcanic landforms**
Activity 3: Volcanic Hazards: Flows Using simple fluids and materials, students explore factors that affect volcanic flows (viscosity, slope, magma temperature, and channelization). They develop an understanding of the nature and hazards of lava flows, pyroclastic flows, and lahars. Students also explore the concept of a controlled experiment, and how knowledge of Earth science contributes to wise planning.	• **Experimental control** • **Viscosity** • **Types of volcanic flows** • **Flow hazards**
Activity 4: Volcanic Hazards: Airborne Debris In this activity, students interpret maps and data tables to develop a concept of the varying scale of volcanic eruptions and determine that volcanic ash affects a larger area than lava. They connect magma composition to volcanic explosivity to better understand why volcanoes vary in size, eruptive style, and potential hazard.	• **Volcanic Explosivity Index** • **Volcanic particle types** • **Airborne hazards**
Activity 5: Volcanoes and the Atmosphere Students design an experiment to determine the volume of gas dissolved in a carbonated beverage. They learn about the common gases dissolved in magma and released during volcanism. This enables students to understand the connections between the geosphere, atmosphere, hydrosphere, and biosphere.	• **Volcanic gases** • **Volcanoes and climate change** • **Experimental design**
Activity 6: Volcanic History of Your Community In this activity, students examine and classify rocks collected within their community and within volcanic regions. They also interpret local geologic maps to search for evidence of volcanism or past igneous activity. They learn about the nature and classification of igneous rocks, and how geologic maps provide evidence of past volcanism.	• **Common igneous rocks** • **Intrusive vs. extrusive** • **Geologic maps** • **Map interpretation**
Activity 7: Monitoring Active Volcanoes Interpreting an actual report from a volcano observatory provides the impetus for understanding the changes that volcanoes undergo prior to and during an eruption. Students apply their understanding by designing a monitoring instrument and preparing manuals that explain how the instrument is used.	• **Volcano monitoring** • **Monitoring systems**

Chapter 14 – Plate Tectonics... And Your Community

Activity Summaries	Earth Science Principles
Activity 1: Taking a Ride on a Lithospheric Plate Students use data from Global Positioning System (GPS) satellites to determine the direction and speed of motion of the North American plate. Based on their findings they then predict where their community will be located in the future.	• Lithospheric plate movement • Sea-floor spreading
Activity 2: Plate Boundaries and Plate Interactions Students build a model to simulate sea-floor spreading. Through a thought experiment, students learn how crust is created and destroyed at divergent plate boundaries. Students look at a world plate tectonic map to explore the different types of plate boundaries. They then describe the plate tectonic setting of their own community.	• Divergent plate boundaries • Convergent plate boundaries • Transform plate boundaries
Activity 3: What Drives the Plates? Students use a variety of liquids to investigate the effects of density on how a material moves and what effects temperature can have on the density of a material. Students then develop a method to determine the density of a variety of rocks. Students complete an experiment to determine the forces that cause the subduction of lithospheric plates.	• Earth's layered structure • Thermal convection as the driving force of plate tectonics • Subduction of plates
Activity 4: Effects of Plate Tectonics Students use maps to discover the relationship between plate tectonics and earthquakes and volcanoes. Students model the rise of magma through the Earth using honey and vegetable oil. Students then hypothesize about why volcanoes occur where they do. Students model subduction and accretion using cream cheese and cheese spread.	• Oceanic trenches • Volcanism at plate boundaries • Hot-spot volcanism • Continental accretion • Earthquakes and plate tectonics
Activity 5: The Changing Geography of Your Community Students create a series of maps showing how the position of the continents has changed over time and also how they may appear 250 million years into the future.	• Paleogeography • Development of the plate tectonic theory • Paleomagnetism

Chapter 15 – Earthquakes... And Your Community

Activity Summaries	Earth Science Principles
Activity 1: An Earthquake in Your Community Students use a model to learn how energy stored in rocks is released in the form of an earthquake. They then use Slinkys to explore the movement of earthquake waves through the Earth, and make inferences about the effects these waves may have on the Earth's surface.	• Earthquakes • Earthquake or seismic waves • Epicenter and focus
Activity 2: Detecting Earthquake Waves Students construct a simple seismometer and then learn how to interpret seismograms to determine arrival times of the two types of seismic waves. They can then use the Internet to learn how to determine the epicenter of an earthquake.	• Seismometer • Interpreting seismograms • Using travel-time curves
Activity 3: How Big Was It? Students rank the observed effects of a single earthquake to determine the earthquake's approximate origin. A web-based exercise then allows students to examine how scientists use an earthquake's amplitude to determine its magnitude.	• Earthquake intensity • Effect of local geology on earthquake intensity • Earthquake magnitude
Activity 4: Earthquake History of Your Community Students use maps to examine and describe the distribution of earthquakes at global, regional, and local scales. By examining earthquake data, along with the relationship between faults and earthquakes, students determine the potential risk for future earthquakes in their community.	• Earthquake patterns and plate tectonics • Faults • Earthquake risks
Activity 5: Lessening Earthquake Damage Students construct a map of earthquake intensities based on recorded observations to determine the approximate origin of the earthquake, and investigate how the effects felt vary in relation to the epicenter. Students then look at the geologic changes and destruction associated with earthquakes around the world, and finally assess the earthquake risks of their own community and how to prepare themselves during an earthquake.	• Isoseismal map • Earthquake hazards • Tsunamis • Earthquake preparedness
Activity 6: Designing "Earthquake-Proof" Structures Students build models to investigate factors that make buildings stable or unstable during earthquakes. They interpret photos to gain insights into damage caused by real earthquakes. They also use a model to understand how wave frequency influences vibrations of structures. They think about how the buildings in their community would respond in an earthquake.	• Duration of shaking • Direction of motion • Influence of underlying materials on behavior of structures • Resonance

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84 Business Park Drive, Armonk, NY 10504
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