Thinkin' Science™ Series

ZAP!™

S C H O O L   V E R S I O N

EDMARK®

Ignite the Curious Mind™

Quick Start

Installation

- **Windows 95/98 Users:**
  With AutoPlay enabled
  Insert the CD. Follow the installation instructions on your computer screen. To start the program after installation, reinsert the CD and click PLAY! from the Startup screen.
  With AutoPlay disabled
  Please see the installation instructions on page 5.

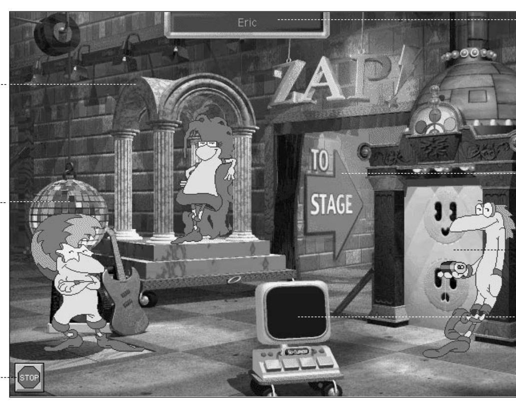
- **Windows 3.1 Users:**
  Insert the CD. Choose Run from the File menu in Program Manager and type **d:\setup** (where **d** represents your CD-ROM drive). Follow the installation instructions on your computer screen. After installation, the *Zap!* icon can be found in the Edmark program group. Insert the CD and double-click the icon to start the program.

- **Macintosh:**
  Installation is not needed. Simply insert the CD and double-click the *Zap!* icon. (There is an optional installation for best program performance; see page 7.)

For more detailed instructions, please see pages 4-5 (Windows) or pages 6-7 (Macintosh).

Navigating in Zap!

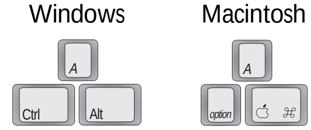
Click a *Zap!* star—Blaze, Surge, or Riff—to visit one of three exciting Learning Environments: the Laser Lab, the ElectroLoft, or the SoundWave Studio.



From a Learning Environment, click:

to choose a science topic or difficulty level.

to return to Backstage.



Customize the program for the user.

Welcome to Zap!™

In *Zap!*, students are Guest Directors for a concert by the *Zap!* Stars—Blaze, Riff, and Surge! With the Stars leading the way, students conduct scientific experiments and solve exciting science challenges. *Zap!* covers many of the major physical science topics in third, fourth, fifth, and sixth grade curriculums.

Students visit the three Learning Environments in *Zap!*—Laser Lab, SoundWave Studio, and ElectroLoft—and use powerful tools to explore the fundamental science concepts of light, sound, and electricity. During this journey of scientific discovery, students collect components and controls they can use to rehearse and perform a concert.

Children are naturally interested in science, and *Zap!* gives them many opportunities to act on this natural curiosity. *Zap!* excites students' interest in science and instructs them in the basics of the scientific method: hypothesis, experimentation, observation, and deduction. Each Learning Environment begins in a Question & Answer Mode that provides guided learning. The Stars give helpful feedback to guide your students to solutions. In addition, each Learning Environment includes an Explore Mode, so your students can experience self-directed learning. Students can also explore the Sci-Clopedia, an open-ended research and reference tool.

Zap! offers hundreds of fascinating science challenges. As each student learns and succeeds, Edmark's unique Grow Slides advance automatically, offering more challenging problems. You can also manually set a Learning Environment's Grow Slide to provide practice in a specific topic area.

Our goal is to place the very best educational software in the hands of your students, providing the consistent quality that teachers expect from Edmark. During the development of this program, we have listened to teachers, parents, and children. We would like the opportunity to listen to you, as well. Please drop us a line or visit our web site (www.edmark.com), tell us about your needs, and join us in helping children learn and succeed.

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What's in This Guide?

Introductory Information (pages 3–8)

- *Steps to Start* information
- System requirements, installation, and setup instructions

Program Information (pages 9–46)

- Information on each of the three Learning Environments in *Zap!*, including:
  - *Overview*, giving a summary of the Learning Environment and the opportunities it provides
  - *Question & Answer Mode*, explaining how a character leads the way and is looking for a correct response. The character also offers help and fun rewards.
  - *Explore Mode*, explaining how your students can learn by exploring, experimenting, and creating in the activity
- *Sci-Clopedia* and *World Book Bonus Science Reference*, with information on the two student-friendly science reference tools
- *Concert,* explaining how students can use the science of light, sound, and electricity to create a fun multimedia show
- *Adult Options* and *Dear Parents*, describing how to set program options, Grow Slide settings, and science topics for your students, and how to view the Dear Parents video
- Information on running the program from *KidDesk*

Introducing Zap! to Your Students (pages 47–56)

- Suggestions for orienting students to the program to ensure they benefit fully from its use
- Reproducible map to help students navigate the program
- Reproducible *Guided Tours* to help students independently and productively use the Explore Mode of each Learning Environment
- Information on using the program with students who have special needs

Classroom Activities and Reproducible Worksheets (pages 57–113)

- Introduction to the classroom activities
- List of cross-curricular activities
- Teacher's notes, containing suggested "at the computer" and "away from the computer" activities. These activities strengthen the learning opportunities found in *Zap!* and can be integrated with many curricular areas.
- Reproducible student activity sheets to use as worksheets, overhead transparencies, and so on
- Answer keys for the student activity sheets

Technical Support (pages 114–118)

- Troubleshooting information
- Information on contacting Edmark Customer Service and Technical Support
- Warranty information

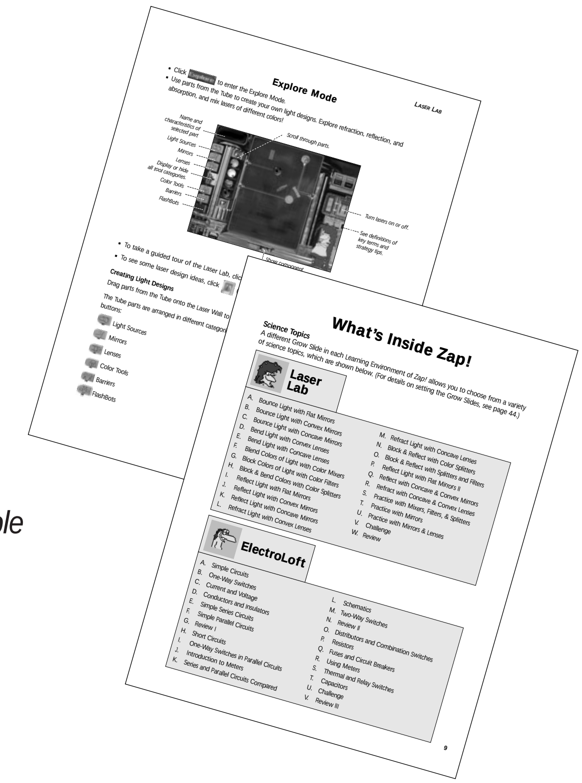
Steps to Start

1. Check to be sure Zap! is installed (Windows users only).

- If the software has not been installed, see *Setup Instructions* (page 5).

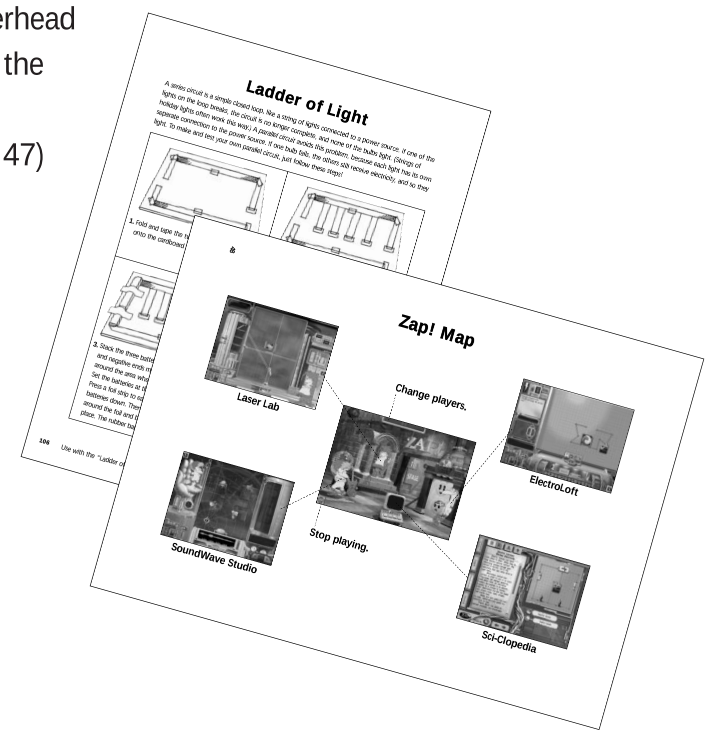
2. Read the Teacher's Guide and become familiar with the program.

- *What's Inside Zap!* (pages 9–13) will give you a brief overview. Before you introduce the program to your students, read *Using Zap!* (pages 14–46) and try each activity at the computer.
- Use *Adult Options* (see pages 43–45) to customize the program for your students. You can adjust the Grow Slides, select science topics, turn printing on or off, and more.
- Decide if you want to introduce the activities to your students one at a time, or let them explore at their own pace.
- Browse through the *Classroom Activities and Reproducible Activity Sheets* section (starting on page 57) to find suggestions for using the program with your students as well as numerous activities to extend the learning opportunities presented by the program.



3. Introduce Zap! to your students.

- Reproduce (for each student) or make an overhead transparency of the *Zap! Map* (page 48) and the Guided Tours (pages 49–55).
- See *Introducing Zap! to Your Students* (page 47) for more suggestions.



System Requirements

Windows®

- Windows 3.1 or Windows 95/98
- 486, Pentium® or better (66 MHz or faster recommended)
- Hard drive with 5 MB free
- 8 MB memory (RAM)
- Super VGA graphics, 640x480, 256 or more colors
- Double-speed (2X) or faster CD-ROM drive
- Windows-compatible sound card

Optional:

- **Windows-compatible printer**
- **Microphone**
- **Browser** (for World Book Bonus Science Reference)
- **Edmark TouchWindow®**—A touch screen that attaches to your monitor and provides direct, easy input for young students or students with special needs. The TouchWindow is available directly from Edmark Corporation. To order, call (800) 320-8377.

Please...

- Register today so you can receive new product announcements, upgrade news, money-saving offers and friendly, toll-free technical support. It's easy to register. Just mail your registration card or register online during installation (modem required). If you prefer to register by phone, call (800) 691-2988, 24 hours a day, 7 days a week.

- Read the rest of this guide so your students can use *Zap!* to its full potential.

Setup Instructions

The installer places a small amount of necessary information on your hard drive to make it easy to run *Zap!*

Windows 95/98:

Insert the *Zap!* CD, then follow these steps.

If AutoPlay is enabled

1. Installation starts automatically.

2. Follow the on-screen instructions to complete the installation.

3. After installation, reinsert the CD to run *Zap!* The Startup Screen appears. Click the Play or Dear Parents button.

If AutoPlay is disabled

1. Choose *Run* from the Start menu and type **d:\setup** (where **d** represents your CD-ROM drive).

2. Follow the on-screen instructions to install the program.

3. After installation, the *Zap!* and *Dear Parents* icons can be found on the Start | Programs | Edmark | Zap! menu. To run *Zap!,* insert the CD and use the Start menu.

Windows 3.1:

1. Insert the *Zap!* CD into your CD-ROM drive.

2. Choose *Run* from the File menu in Program Manager and type **d:\setup** (where **d** represents your CD-ROM drive).

3. Follow the on-screen instructions to install the program.

4. After installation, the *Zap!* and *Dear Parents* icons can be found in the Edmark program group. To run *Zap!,* insert the CD and double-click the *Zap!* icon.

- **To run *Zap!* from *KidDesk*, see page 45.**
- **For more information about *Dear Parents*, see page 46.**

System Requirements

Macintosh®

- System 7.0.1 or higher
- 68040 or PowerPC®
- 8 MB memory (RAM); 16 MB recommended for PowerPC
- 13" monitor or larger, 256 or more colors
- Double-speed (2X) or faster CD-ROM drive

Optional:

- **Macintosh-compatible printer**
- **Microphone**
- **Browser** (for World Book™ Bonus Science Reference)
- **Edmark TouchWindow**—A touch screen that attaches to your monitor and provides direct, easy input for young students or students with special needs. The TouchWindow is available directly from Edmark Corporation. To order, call (800) 320-8377.

Please...

- Register today so you can receive new product announcements, upgrade news, money-saving offers and friendly, toll-free technical support. It's easy to register. Just mail in your registration card or register online by double-clicking the *Register Online* icon (modem required). If you prefer to register by phone, call (800) 691-2988, 24 hours a day, 7 days a week.
- Read the rest of this guide so your students can use *Zap!* to its full potential.

Setup Instructions

There are two options for setting up *Zap!* Standard-performance setup requires 2 MB free hard drive space. The *Optional Install* setup requires 15 MB free hard drive space, and copies some program files onto your hard drive for best performance.

Standard Performance

1. Insert the CD-ROM and double-click the *Zap!* icon to run the program.

2. To run *Dear Parents*, insert the CD-ROM and double-click the *Dear Parents* icon in the *Zap!* folder.

Optional Install

1. Insert the CD-ROM and double-click the *Optional Install* icon.

2. Follow the on-screen instructions to install program files to your hard drive.

3. When installation is complete, open the *Zap!* folder on your hard drive and double-click the *Zap!* icon.

4. To run *Dear Parents*, insert the CD-ROM and double-click the *Dear Parents* icon in the *Zap!* folder.

- **To run *Zap!* from *KidDesk,* see page 45.**
- **For more information about *Dear Parents,* see page 46.**

A Reminder to Register

When you register your copy of *Zap!* with us, you become a member of the Edmark Education Team—a group of parents, educators, and software professionals committed to helping children learn. As a member of the Education Team, you automatically receive:

- New product announcements and upgrade news
- Money-saving offers
- Friendly, toll-free technical support

To Register:

1. Simply fill out the enclosed, postage-paid Registration Card and drop it in the mail.

OR

2. Register online during installation (Windows) or by double-clicking the *Register Online* icon (Macintosh). Online registration is toll-free; a modem is required.

OR

3. Give us a call, toll-free: ***(800)691-2988***

24 hours a day, 7 days a week

Visit Edmark on the Web!

www.edmark.com

- Download free software.
- Learn about Edmark's full line of software for preschool to 10th grade students.
- Sign up for *Edmark E-News*—a free newsletter with fun activities, special offers, and more.
- Find answers to frequently asked technical support questions.
- Leave questions and comments for us.

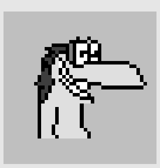
What's Inside Zap!

Science Topics

A different Grow Slide in each Learning Environment of *Zap!* allows you to choose from a variety of science topics, which are shown below. (For details on setting the Grow Slides, see page 44.)

Laser Lab

A. Bounce Light with Flat Mirrors
B. Bounce Light with Convex Mirrors
C. Bounce Light with Concave Mirrors
D. Bend Light with Convex Lenses
E. Bend Light with Concave Lenses
F. Blend Colors of Light with Color Mixers
G. Block Colors of Light with Color Filters
H. Block & Bend Colors with Color Splitters
I. Reflect Light with Flat Mirrors
J. Reflect Light with Convex Mirrors
K. Reflect Light with Concave Mirrors
L. Refract Light with Convex Lenses
M. Refract Light with Concave Lenses
N. Block & Reflect with Color Splitters
O. Block & Reflect with Splitters and Filters
P. Reflect Light with Flat Mirrors II
Q. Reflect with Concave & Convex Mirrors
R. Refract with Concave & Convex Lenses
S. Practice with Mixers, Filters, & Splitters
T. Practice with Mirrors
U. Practice with Mirrors & Lenses
V. Challenge
W. Review



ElectroLoft

A. Simple Circuits
B. One-Way Switches
C. Current and Voltage
D. Conductors and Insulators
E. Simple Series Circuits
F. Simple Parallel Circuits
G. Review I
H. Short Circuits
I. One-Way Switches in Parallel Circuits
J. Introduction to Meters
K. Series and Parallel Circuits Compared
L. Schematics
M. Two-Way Switches
N. Review II
O. Distributors and Combination Switches
P. Resistors
Q. Fuses and Circuit Breakers
R. Using Meters
S. Thermal and Relay Switches
T. Capacitors
U. Challenge
V. Review III

SoundWave Studio

A. Introduction
B. Identify Location of Sound by Pitch
C. Identify Location of Sound by Amplitude
D. Identify Frequency of Sound
E. Identify Amplitude of Sound
F. Identify Sound by Frequency or Amplitude
G. Review I
H. Change Frequency of Sound Heard
I. Change Frequency of Waveform Viewed
J. Identify Frequency of Waveform Viewed
K. Change Amplitude of Sound Heard
L. Change Amplitude of Waveform Heard
M. Identify Amplitude of Waveform Heard
N. Identify Sound by Freq. or Amp.—Waveform
O. Identify Location of Sound. — Freq. & Amp.
P. Identify Frequency and Amplitude I
Q. Identify Frequency and Amplitude II
R. Review II
S. Change Freq. & Amp. of Sound Heard
T. Change Freq. & Amp. of Waveform
U. Identify Freq. & Amp. of Waveform
V. Identify Sound by Freq. & Amp.
W. Identify Sound by Waveform Viewed
X. Challenge
Y. Review III

Backstage

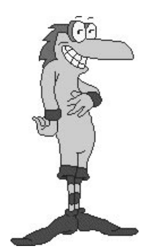
From Backstage, you can access each of *Zap's* three Learning Environments: the Laser Lab, the ElectroLoft, and the SoundWave Studio.

You can also open the Sci-Clopedia or go to the Stage to rehearse or perform the Concert.

Zap! Stars

Meet the Zap! Stars—Blaze, Surge, and Riff! They're your hosts in each of *Zap's* exciting Learning Environments.

Blaze "enlightens" you about light and color in the Laser Lab.



Surge is in "charge" of circuit building and repair in the ElectroLoft.

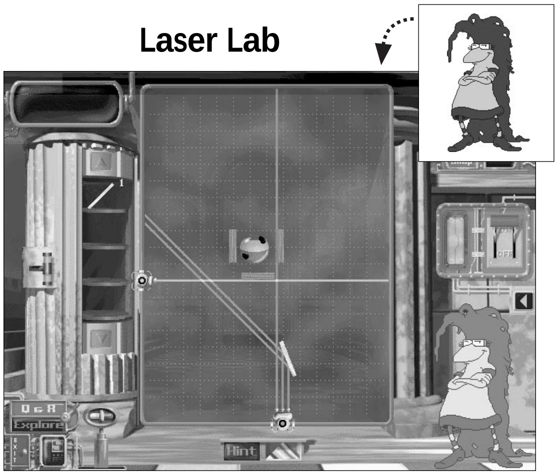
Riff "sounds off" about frequency and amplitude in the SoundWave Studio.

The Stars can be a little rambunctious, but they sure know their science! They give you tips on how to solve problems and offer you helpful feedback while you work.

Learning Environments

Each Learning Environment contains hundreds of exciting science challenges. From Backstage, click the Learning Environment you want to explore.

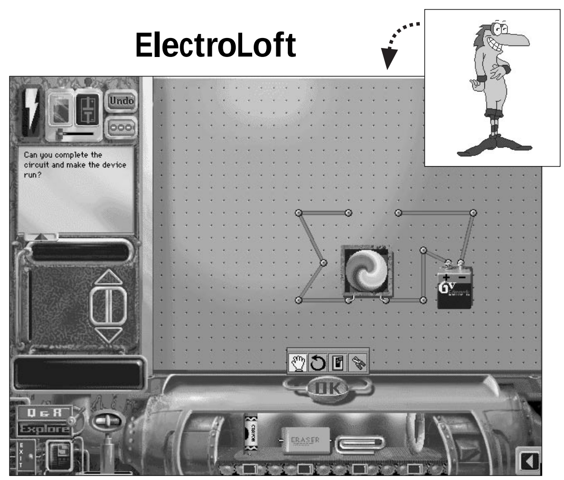
Laser Lab



Help Blaze energize the Flashbots by manipulating "lasers"—beams of light that can be reflected, refracted, and absorbed! Experiment with beams of different colors, and mix or unmix colored beams to get new colors!

ElectroLoft

In the ElectroLoft, you'll learn how to build electric circuits to control lights, bells, fans, and other fun devices. Then apply your knowledge of circuits, batteries, switches, current, voltage, and resistance to fix the Stars' broken appliances!



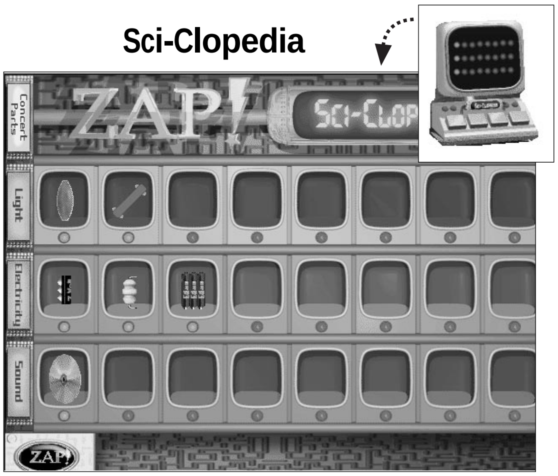
SoundWave Studio

The SoundWave Studio is a great place to learn about sounds and their waveforms. With the Wave Editor, you can see and change the frequency, amplitude, and wavelength of all kinds of sound waves. You can also record your own sounds and use the Wave Editor to examine their waveforms.

Sci-Clopedia and Concert

Young scientists can use the Sci-Clopedia to find out about science topics in *Zap!* As Guest Directors of the Concert, students can show off their knowledge of light, sound, and electricity.

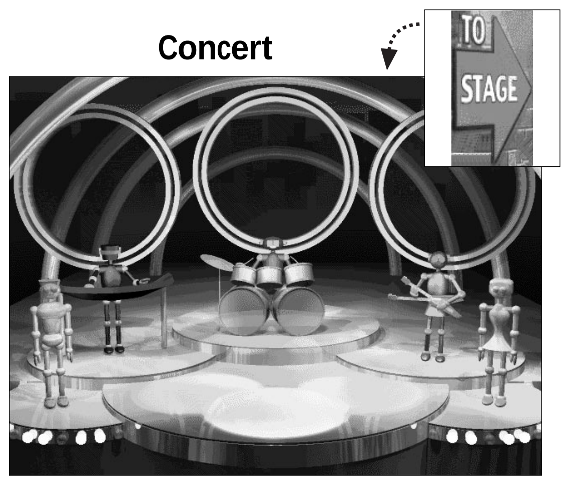
Sci-Clopedia



The Sci-Clopedia is full of interesting entries about light, sound, and electricity. You can explore the colorful illustrations and animations, and write your scientific observations and ideas for experiments in the Notebook.

You're the Guest Director of the Concert! Solve science challenges to collect parts for the light, sound, and electrical controls at the Wonder Dome. Once you've collected all the parts, the *Zap*! Stars take the stage for the grand finale!

Concert



Using *Zap!*

It's easy to explore all of the science challenges in *Zap!* From Backstage, click one of the *Zap!* Stars to enter a Learning Environment:

Laser Lab

ElectroLoft

SoundWave Studio

Question & Answer and Explore Modes

The Laser Lab, ElectroLoft, and SoundWave Studio each have two modes: the Question & Answer Mode (find the answers to a Star's questions) and the Explore Mode (explore, experiment, and create). All Learning Environments open in the Question & Answer Mode.

To switch modes in a Learning Environment, click the button (

or 

) for the mode you want to use.

To return to Backstage from a Learning Environment, click 

.

Sci-Clopedia

From Backstage, click  to explore the Sci-Clopedia.

From the Laser Lab, ElectroLoft, or SoundWave Studio, click 

to see the related section of the Sci-Clopedia.

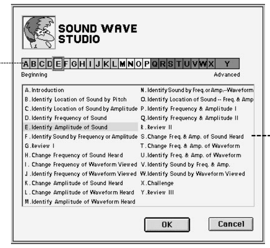
Adult Options

To enter Adult Options, Windows users hold down the Ctrl and Alt keys and press the "A" key. Macintosh users hold down the Command ⌘ and Option keys and press the "A" key. Adult Options (see pages 43–45) allow you to customize *Zap!* to suit an individual student.

Grow Slides

As a student successfully answers questions, the slider on the Learning Environment's Grow Slide automatically advances and more difficult questions are offered. (You can also adjust the Grow Slide manually.) There is a different Grow Slide for each Learning Environment.

Drag slider to adjust difficulty level.



Click topic to select it.

From a Learning Environment:

Click the Grow Slide button and then drag the slider to adjust the difficulty level, or click a specific science topic.

From Adult Options:

View the Grow Slides to monitor a student's progress. You can also manually adjust the difficulty level of an activity to suit a student or choose to focus on a topic you are studying in class. If you prefer, you can turn off a student's access to the Grow Slides. (This removes the Grow Slide buttons from the activities.)

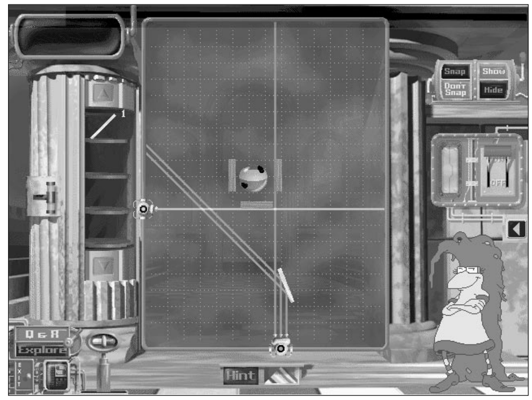
Saving and Opening Zap! Designs

In the Laser Lab, SoundWave Studio, and ElectroLoft, students can create, save, and open their own designs for future use or to share with friends.

From the Explore Mode in the Laser Lab, SoundWave Studio, or ElectroLoft, follow these steps:

- Click (above the Tour button) to pull out the sliding tab, and then click .
- Drag the thumbnail picture of your design into an empty rectangle on the grid. Type a name for your design in the space provided, then click "OK" to save your design.
- To delete a previously saved design, drag the thumbnail picture of it into the trash can .
- To open a previously saved design, click . Click the thumbnail picture of the design you want to open, then click "OK."
- *Zap!* files are automatically saved in the Edmark "Zap" folder on your hard drive. To save a *Zap!* design to an alternate location (such as a floppy disk, network, or external hard drive), click Export. Select the folder name and location, then type a file name in the space provided.
- To open a *Zap!* design that you saved to a location of your choice, click Import. Select the file you want to open, then click "Open." The file appears in Explore Mode

Laser Lab Overview



Help Blaze hatch her FlashBot friends so they can fix the light controls for the Concert. Arrange mirrors, lenses, filters, color mixers, and color splitters on the Laser Wall to direct light beams to the eggs and hatch the FlashBots!

Learning Opportunities

- Develop problem-solving, experimentation, and prediction skills
- Discover that light travels only in a straight line
- Experiment with the properties of light, including reflection, refraction, absorption and color mixing
- Experiment with the properties of optical instruments, including lenses, mirrors, filters, and prisms

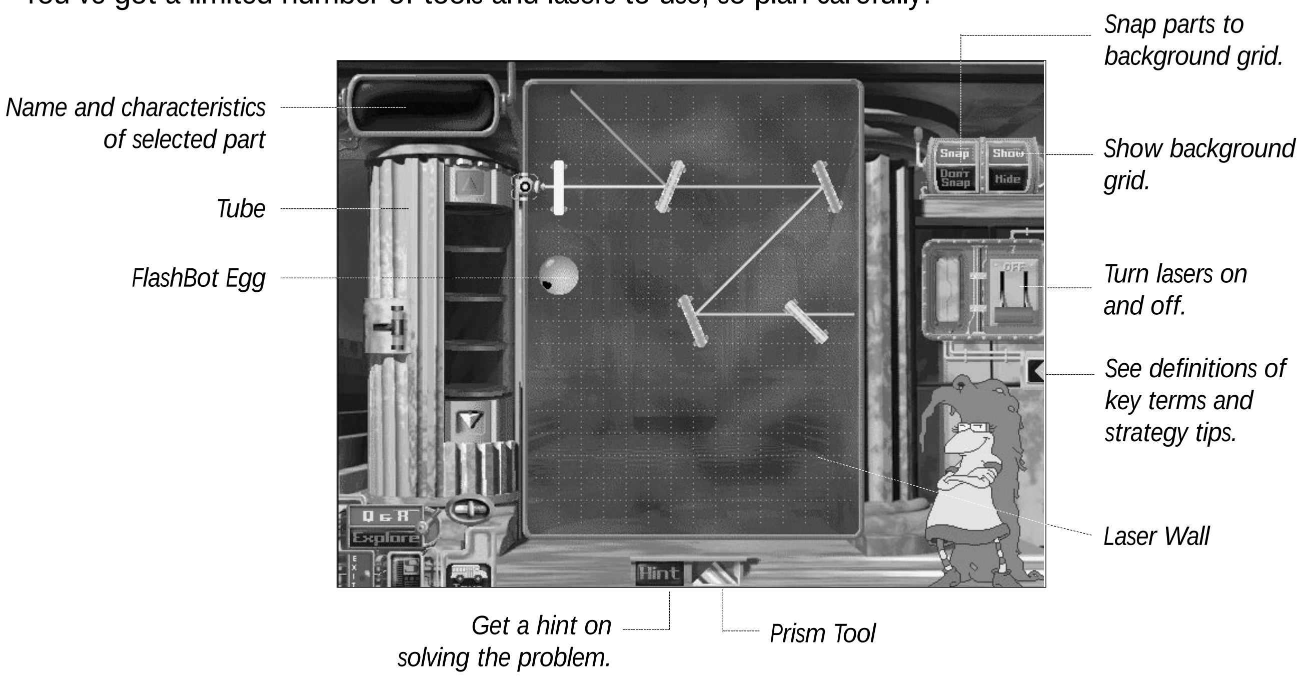
About Kids

Students often enjoy conducting their own experiments and drawing conclusions based on the results. In the Laser Lab, students can experiment with optical tools—lasers, mirrors, lenses, barriers, filters, and prisms. As they “play” with these tools, they are studying the science of light. For example, by reflecting lasers off mirrors, students learn that light travels in a straight line and that it reflects off a mirror at the same angle at which it strikes the mirror.

Computer simulations offer a unique opportunity to experiment with the behavior of light—in an environment that’s designed just for kids. By directly manipulating mirrors, lenses, and barriers, students use their own “hands-on” experiences to discover the basic properties of light.

Question & Answer Mode

- From Backstage, click  to visit the Laser Lab.
- Blaze gives you parts and lasers—beams of light—and asks you to help her energize the FlashBots. You've got a limited number of tools and lasers to use, so plan carefully!



Solving Light Problems

Blaze presents you with optical parts (lenses, mirrors, filters, and barriers) and asks you to energize one or more of her FlashBots.

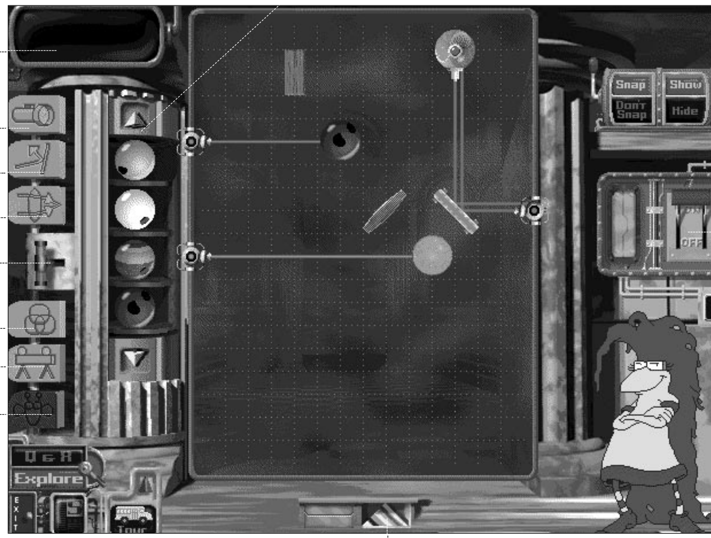
Arrange the parts so that the correct lasers reflect or refract off the parts to hit the FlashBot Eggs and energize them.

- There are two rules for energizing Eggs:
  - The color of the laser used must match the color of the Egg. (Blue lasers can energize only Blue Eggs.)
  - The number of lasers must match the number of spots on the Egg. (Eggs with two spots require two lasers to be energized.)
- To place a part, drag it from the Tube onto the Laser Wall. (Some problems begin with parts already positioned on the Laser Wall.) Light sources must be attached to the edge of the Laser Wall.
- To rotate a part, hold the cursor over the end of the part. When the cursor becomes a circular arrow , drag the part in the direction you want to rotate it.

- To remove a part, drag it off the Laser Wall. (Parts positioned for you at the start of a problem can be rotated, but cannot be moved.)
- To automatically snap parts to the grid on the Laser Wall, click . Snapping a part to the grid centers the part on the nearest grid intersection point of the Laser Wall. (Exact part placement is necessary to solve some problems in the Laser Lab.)
- To see the different colors that make up each laser on the Laser Wall, click the Prism and then hold the cursor over a laser. The Prism splits the laser into its component colors. Click anywhere to release the Prism.
- As you move parts around on the Laser Wall, you can see the lasers reflect and refract. If you want to work with the lasers turned off, click . You must turn the lasers on to test your answer.
  - If you energize all the Eggs with the correct number of beams, the Flashbots hatch and Blaze gives you a new problem.
  - If you are having trouble energizing all the Eggs, you can click for helpful illustrations of each part's properties, or click Hint to listen to a hint. (At higher levels of the Grow Slide, click Hint to see Blaze step you through one possible solution to the problem.)
- Click to clear the Laser Wall and start over.
- To change the difficulty level of the problems or to select a different light topic, click .
- To find out more about light in the Sci-Clopedia, click . (For details on using the Sci-Clopedia, see pages 34–37.)
- To enter the Explore Mode, click Explore .
- To return to Backstage, click .

Explore Mode

- Click Explore to enter the Explore Mode.
- Use parts from the Tube to create your own light designs. Explore refraction, reflection, and absorption, and mix lasers of different colors!



- To take a guided tour of the Laser Lab, click Tour.
- To see some laser design ideas, click (above the Tour button) and then click Ideas.

Creating Light Designs

Drag parts from the Tube onto the Laser Wall to build light designs.

The Tube parts are arranged in different categories. To select a category, click one of the following buttons:

Light Sources

Mirrors

Lenses

Color Tools

Barriers

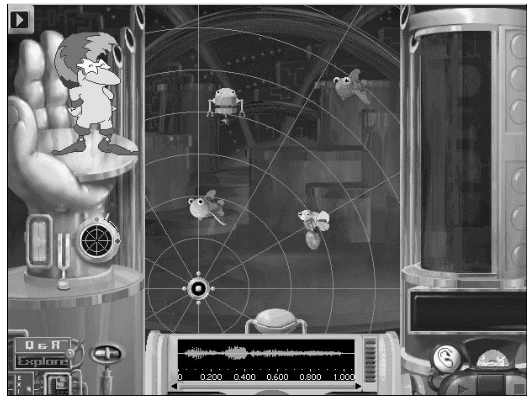
FlashBots

- Click to scroll through the parts available in the category you select. To see a part's name and characteristics displayed in the Monitor, hold the cursor over the part.
- Drag parts onto the Laser Wall to build your light design. Light sources must be attached to the *edge* of the Laser Wall.
- For more details on how to select, place, rotate, and remove parts, see *Question & Answer Mode*, page 17.
- When you are finished arranging parts on the Laser Wall, click to turn on the lasers and see your design "light up!" You can adjust the parts until you have the design exactly as you want it.
- To print your design, click and then click .
- To learn more about light in the Sci-Clopedia, click .
- Click to return to the Question & Answer Mode or click to return to Backstage.

Saving and Opening Light Designs

See *Saving and Opening Zap! Designs*, page 15.

SoundWave Studio Overview



Riff has a problem. The BoogieBots can help rebuild the sound controls for the Concert, but only if they hear the sounds they like to dance to. As you explore the properties of sound and sound waves, you'll discover how to help each BoogieBot groove to the music!

Learning Opportunities

- Develop problem-solving, musical-listening, and logical-thinking skills
- Discover that sound travels outward in all directions
- Observe and compare sounds to develop discrimination ability
- Manipulate sound waves and experiment with the properties of sound
- Analyze the frequency (pitch) and amplitude (loudness) of sound waveforms
- Compare waveform shapes of a variety of sound sources, including musical instruments, animals, humans, and synthesized sounds

About Kids

Students are familiar with many different sounds—from a dog's bark to a ship's foghorn to an opera singer's high note—and are usually able to describe them in a common-sense way (as "loud" or "soft," "high" or "low"). However, they may not understand how sound is made or transmitted, or how these common-sense terms relate to the scientific properties of sound: frequency and amplitude.

The SoundWave Studio provides a powerful visual model of the transmission of sound—vibrations travelling in waves outward from the source of the vibrations—and offers students tools to analyze and manipulate sound waveforms. As students play and listen to a wide variety of sounds, they see the sounds' waveform representations displayed in the Wave Editor. The picture of the waveform allows students to match how a sound "sounds" with how it "looks" and helps them understand the abstract and (usually) invisible properties of sound waves.

Question & Answer Mode

- From Backstage, click  to visit the SoundWave Studio.
- Riff asks you to help him locate and create the sound waveforms that make the BoogieBots break into dance! Use the Wave Editor to look at and manipulate the sounds.

See definitions of key terms and strategy tips.

Display background grid.

Tuning Fork

Tube

BoogieBot

Name and characteristics of selected CD or BoogieBot

CD Player

Use Wave Editor.

Play CD sound.

Stop CD sound.

Solving Sound Problems

Riff presents you with four types of problems in the SoundWave Studio. As you solve sound problems, be sure you listen carefully to each sound and observe the properties of its waveform. Also, look at the properties of each BoogieBot to determine the frequency and amplitude each Bot dances to.

Note: In some sound problems, the ear is disconnected from the CD Player, and you cannot hear the sound. Study the sound's waveform, displayed in the Wave Editor, to solve the problem.

Click  to see a close-up view of the waveform.

The color and brightness of the rings travelling from the speaker indicate the CD sound's frequency and amplitude:

Blue rings are high frequency sounds.
Red rings are low frequency sounds.
Bright rings are loud sounds.
Dim rings are soft sounds.

Tuning Fork

The Tuning Fork has a “middle tone” sound (mid-range frequency and mid-range amplitude). To determine the frequency and amplitude of a CD sound, click the Tuning Fork and listen to the sound, then play a CD sound. Low amplitude CD sounds are softer than the Tuning Fork’s tone; high amplitude sounds are louder. Low frequency sounds are lower-pitched than the Fork’s tone; high frequency sounds are higher-pitched.

BoogieBot Frequency and Amplitude

The color and type of each BoogieBot indicates the frequency and amplitude of the sounds that make the Bot dance. To see the frequency and amplitude of sounds that a particular Bot responds to, hold the cursor over the Bot. The frequency and amplitude that make the Bot dance are displayed on the Monitor.

The color of a BoogieBot represents the frequency it responds to:

Bot Color	Frequency
Blue	high
Red	low
Purple	any

The type of a BoogieBot represents the amplitude it responds to:

Bot Type	Amplitude
BugBot	high
SpaceBot	low
FishBot	any

Here are the four types of problems presented in the SoundWave Studio:

- **Determine which BoogieBots will dance to a given CD sound.**
  - Listen to the CD sound and determine its frequency and amplitude. Select the BoogieBots on the Dance Floor that dance to that sound. (Hint: for more accurate estimation, click  to see the Boogiebots’ exact positions on a circular grid.) When you have selected the BoogieBot(s) you want, click “OK” to submit your answer.
- **Find and play a CD Sound of a certain frequency or amplitude to make a given BoogieBot dance.**
  - Drag a CD from the Tube into the CD Player (see page 26). Click  to play the CD and see its sound wave displayed in the Wave Editor. When the correct CD is in the player, click “OK” to submit your answer.
- **Choose a speaker that will make a given BoogieBot dance.**
  - Look at the properties of each BoogieBot on the Dance Floor. Look at the properties of the given CD sound. Then select the speaker that will make a given BoogieBot dance. Click “OK” to submit your answer.

- **Change a CD Sound to achieve a specific result.**
  - Click  to open the Wave Editor. Play the CD Sound to see its waveform displayed in the Wave Editor. Click and drag the Frequency and Amplitude dials to change the sound wave. When you have the wave you want, click "OK" to submit your answer.

- To change the difficulty level of the problems or to select a different sound topic, click .
- To find out more about sound in the Sci-Clopedia, click .
- To enter Explore Mode, click 
.
- To return to Backstage, click 
.

Explore Mode

- Click Explore to enter the Explore Mode.
- Experiment with the Wave Editor to modify existing CD sounds. You can also record your own sounds and then modify them!

- To take a guided tour of the SoundWave Studio, click Tour .
- To see some sound design ideas, click (above the Tour button) and then click Ideas .

Setting Up the Dance Floor

The SoundWave Studio is a great place to design your own sound show! Try arranging the dance floor in the following way:

- Drag BoogieBots onto the Dance Floor. Use different types of Bots to add variety to your show. Drag a BoogieBot off the Dance Floor to remove it.
- Drag the speaker to the position from which you want to transmit sound.
- Drag the ear to the place where you want to hear the sound.

To select a sound from the Tube, click one of the following buttons:

BoogieBots

Music Tunes

Musical Instruments

Animal Sounds

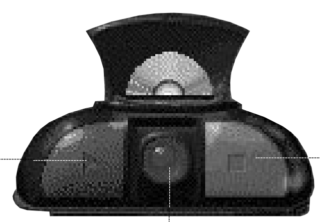
Human Sounds

Other Sounds

Drag the selected sound into the CD Player, then click and watch the BoogieBots dance! (For a table of the frequency and amplitude each Bot type dances to, see *BoogieBot Frequency and Amplitude*, page 23.)

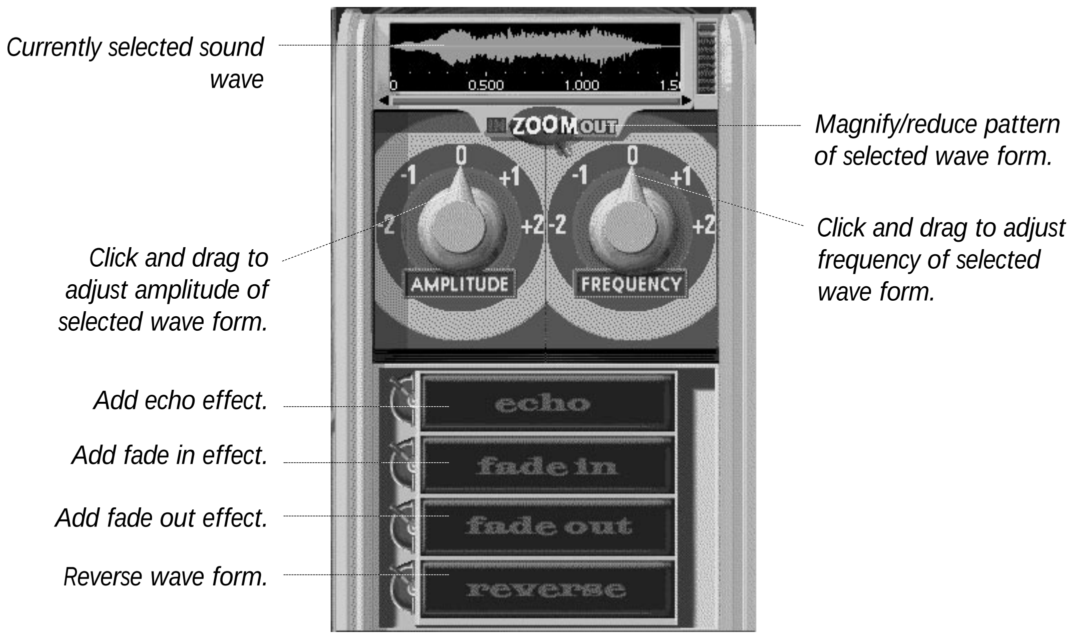
CD Player Controls

The CD Player plays all the sounds in the SoundWave Studio. Each time you drag a CD into the CD Player, the waveform of the sound is displayed in the Wave Editor. To use the CD Player, click:



Wave Editor Controls

You can use the Wave Editor to modify existing CD sounds and your own recorded sounds. To use the sound editing controls, click . Then click:

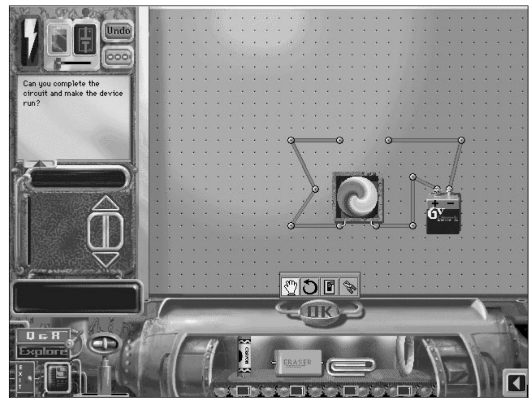


- To find out more about sound in the Sci-Clopedia, click .
- Click to return to the Question & Answer Mode or click to return to Backstage.

Saving and Opening Your Sound Designs

See *Saving and Opening Zap! Designs*, page 15.

ElectroLoft Overview



Welcome to Surge's repair shop, the ElectroLoft! Help Surge examine simple series and parallel circuits to find out what's wrong with them, and then fix them. As you work with batteries, lights, wires, switches, and other electrical components, you'll learn about and measure current, voltage, and resistance.

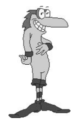
Learning Opportunities

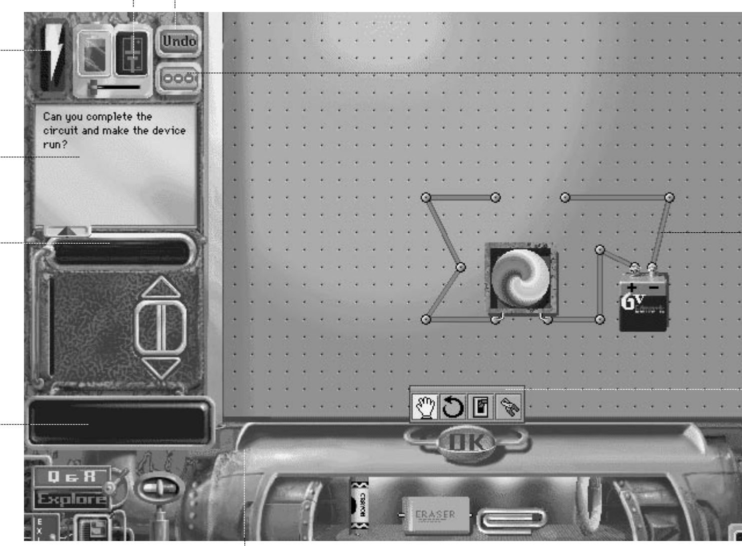
- Develop troubleshooting, problem-solving, and analytical skills
- Experiment with simple circuits
- Discover the practical relationship between current, voltage, and resistance
- Discover the practical relationship between conductance and resistance
- Experiment hands-on with simple series and parallel circuits
- Experiment hands-on with electrical components such as batteries, switches, resistors, and capacitors

About Kids

Electricity is an integral part of modern life, but most children have fairly limited chances to experiment with it in the home or classroom. The ElectroLoft enables your students to learn about and safely experiment with simulated components of basic circuits (wire, batteries, light bulbs, switches) and more advanced circuits (insulators, conductors, resistors, capacitors, and fuses). By building a wide array of circuits, students can take a considerable step beyond the battery and light bulb experiments you may be doing in class. As students troubleshoot and fix broken electrical circuits and appliances, they follow the basic process of scientific inquiry: pinpoint a faulty part or circuit, decide what needs to be replaced or added, design a new circuit, and then test it. Solving problems in the ElectroLoft can help students learn to think like scientists.

Question & Answer Mode

- From Backstage, click  to visit the ElectroLoft.
- Surge presents you with circuits and broken appliances. Diagnose the problem with each circuit, then use the tools to change circuits and replace broken or missing parts. Be sure to test your work!



Solving Electricity Problems

Surge presents you with three basic types of problems in the ElectroLoft: Fix or Build, Multiple Choice, and Combination. (To see the order in which these problems appear on the Grow Slide, click .)

For details on how to select, place, rotate, and remove parts, see *Explore Mode*, pages 31–33.

Fix or Build

In "fix or build" problems, you are asked to look at a picture or written description of a circuit, and then fix or build a matching circuit.

- **Fix or build a circuit based on a picture or written description.**
  - Study the picture or written description of the circuit carefully. Drag parts from the Tube onto the workspace and snap them in place to build a circuit that matches the one in the picture or written description. When you are done, click "OK" to submit your answer.

Multiple Choice

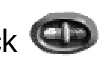
In "multiple choice" problems, you are asked to look at a group of circuits and choose the circuit that will either light a bulb or match a circuit displayed on the workspace.

- **Choose the circuit plan that will light the bulb.**
  - Study the circuit pictures and select the one that will light the displayed bulb. (You can build circuits to test your ideas.) Click "OK" to submit your answer.
- **Choose the circuit that matches the one displayed on the workspace.**
  - Study the circuits and select the one that matches the circuit displayed on the workspace. Test the selected circuit to make sure it works the same as the one displayed. Click "OK" to submit your answer.

Combination

In "combination" problems, you are asked to choose the correct circuit from a group of circuits and to build one or more circuits to match the plan(s).

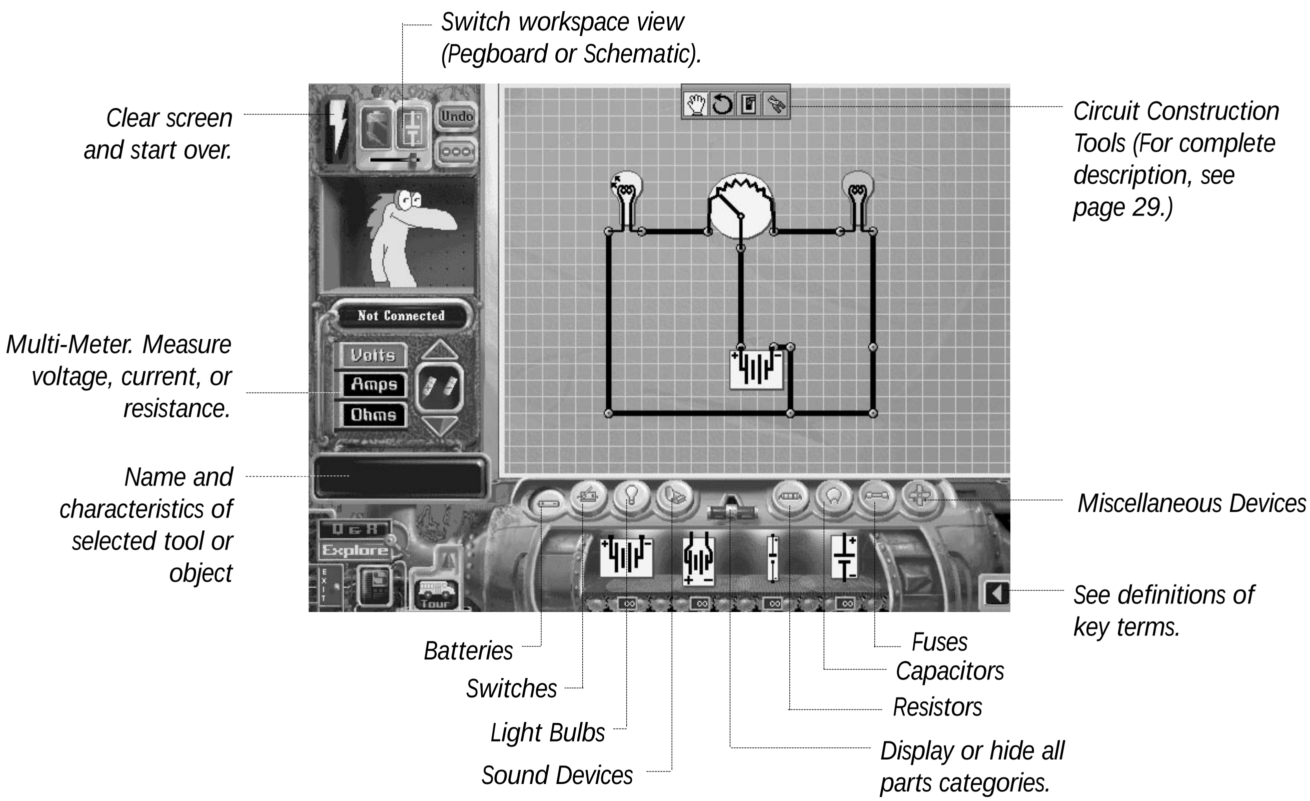
- **Choose the circuit plan that will light the bulb, then build the circuit.**
  - Select the correct circuit plan, then drag parts from the Tube onto the workspace to build the circuit. Click "OK" to submit your answer.
- **Build circuits to match each picture, then choose the circuit that will light the bulb.**
  - Drag parts from the Tube onto the workspace to build each of the three pictured circuits. (Build circuits one at a time. Click picture tabs to switch circuits.) Once you have built all pictured circuits, select the circuit that will light the bulb. Click "OK" to submit your answer.

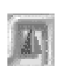
- To change the difficulty level of the problems or to select a different electricity topic, click .
- To find out more about electricity in the Sci-Clopedia, click .
- To enter the Explore Mode, click .

- To return to Backstage, click .

Explore Mode

- Click  to enter the Explore Mode.
- Use the ElectroLoft's parts and tools to build your own electrical circuits! Use the Multi-Meter to measure the voltage, current, and resistance of the circuits.



- To take a guided tour of the ElectroLoft, click .
- To see some circuit design ideas, click  (above the Tour button) and then click .

Workspace Views (Pegboard and Schematic)

There are two available views of the workspace: the Pegboard view (shown on page 29) and the Schematic view (shown above). The Pegboard view shows parts as they appear from the outside, while the Schematic view shows a symbol for each part (similar to diagrams used by electrical engineers). Click  to toggle between views.

Building Circuits

Drag parts from the Tube onto the workspace, then connect them with wire to build your own circuit.

Click a button to choose parts from one of the following categories:

Batteries

Switches

Light Bulbs

Sound Devices

Resistors

Capacitors

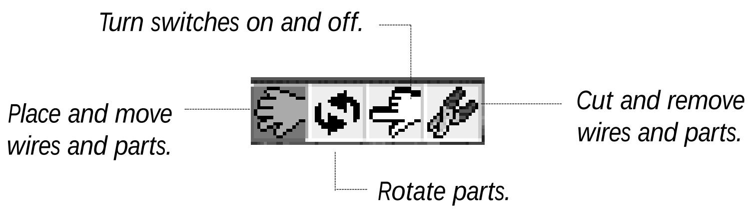
Fuses

Click to scroll through the parts available in the category you selected. To see a part's name and characteristics displayed in the Monitor, hold the cursor over the part.

Click a part to select it, then drag it onto the Workspace to make a circuit design.

Circuit Construction Tools

Use these tools to move, remove, and rotate parts, cut wire, and activate switches. You can move the toolbar to any part of the screen.



Click the tool you want to use, then click (or click and drag) the part or wire you want to place, change, or cut.

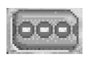
Tips for Building Circuits

You can use the following keystrokes to copy and paste parts on the workspace.

- To copy a part on the workspace, hold down the Ctrl key (Windows users) or the Option key (Mac users) and click the part. Drag the copy wherever you want on the workspace, then release the mouse button to place it.
- To move several parts from one area of the workspace to another, click the Ctrl key (Windows users) or the Option key (Mac users) and click a spot on the workspace. Drag the mouse to select the area you want to move, then release the mouse button. Drag the selected area to a new position on the workspace, then release it.

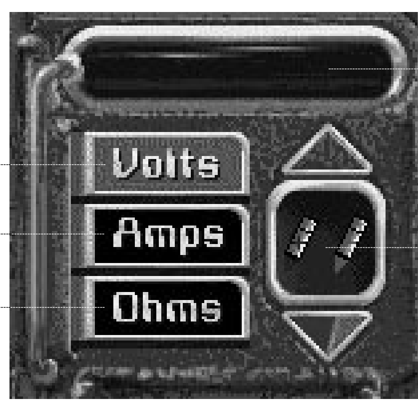
As you experiment in the ElectroLoft, you may find that light bulbs and other devices blow up or fail to light in some circuits. This is probably due to one of the following reasons:

- A circuit is incomplete. (Wire does not connect all parts of the circuit to one another.)
- One or more switches are not turned on.
- The circuit has too much or too little electrical current.
- A part has too much or too little resistance.

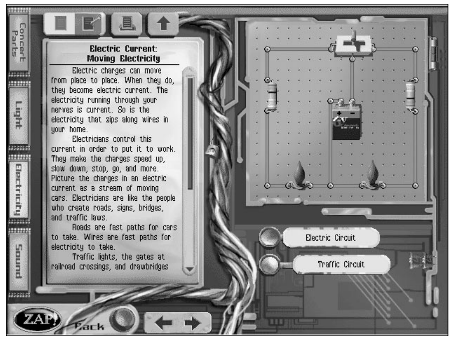
Once you have built your circuit, click  to see where current is (or is not) flowing.

Measuring with the Multi-Meter

You can use the Multi-Meter to measure voltage, current, or resistance in circuits on the workspace.



Sci-Clopedia Overview



The Sci-Clopedia is a multimedia reference tool full of information about basic concepts in light, sound, and electricity. Read the topics that interest you, try out the interactive experiments, and write down your own important observations in the Notebook.

Learning Opportunities

- Use basic multimedia reference tools
- Read about fundamental concepts of light, sound, and electricity
- Conduct simple experiments with interactive multimedia
- Record your scientific observations in writing

About Kids

Accurate and reliable reference materials are an invaluable part of scientific research. After all, no one can know everything! The entries in the Sci-Clopedia feature information about light, sound, and electricity topics. These entries include illustrations, animations, and interactive exhibits that bring the scientific concepts and principles to life. Students can write observations, discoveries, and questions for future experiments in the Sci-Clopedia's Notebook, just as a scientist uses a lab notebook. Writing about the circuits they built in the ElectroLoft or the kinds of sounds they recorded in the SoundWave Studio gives students valuable practice communicating their knowledge about science.

Explore Mode

To open the Sci-Clopedia, click:

-  from Backstage. (The Sci-Clopedia opens to the Main page.)
-  from the Laser Lab, SoundWave Studio, or ElectroLoft. (The Sci-Clopedia opens to the corresponding Sci-Clopedia section.)

From the Sci-Clopedia main page, you can view the parts you have collected for the Concert or open a section on light, electricity, or sound.

Read about light.

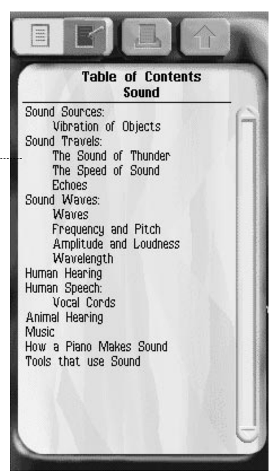
Read about electricity.

Read about sound.

Close the Sci-Clopedia.

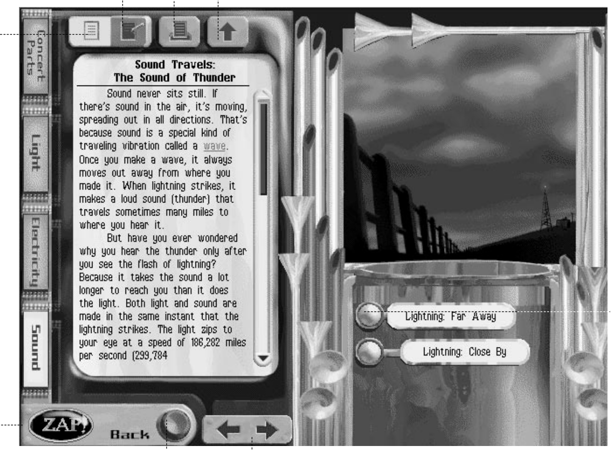
Concert parts you've collected

- Click a tab to see the table of contents for the section you want to explore. For example, to read about thunder, click the "Sound" tab and then click the entry entitled "The Sound of Thunder."



Click an entry to read it. The entry opens on the right.

- From an entry, you can scroll through the other entries in the section, view the illustrations and animations, and write your own ideas and observations in the Notebook.



Using the Notebook

As you explore the Sci-Clopedia, you can jot down what you have learned about light, sound, and electricity in the Notebook. Click to open the Notebook.

You might want to type in:

- Observations you've made about light, sound, and electricity while playing with *Zap!*
- Questions you have about light, sound, and electricity.
- Science topics you would like to explore in more depth.
- Questions about one of the Sci-Clopedia's interactive experiments.

Your notes are automatically saved under your name and are available the next time you use *Zap!*

- Click to close the Sci-Clopedia.

If you are especially interested in a specific Sci-Clopedia topic, you may want to find out more about it by consulting the *World Book Bonus Science Reference*. (See page 42.)

Concert Overview

As you solve challenges in the Laser Lab, the SoundWave Studio, and the ElectroLoft, you collect light, sound, and electrical components and controls that can be used to direct the Concert. The *Zap!* band and DanceBots are always available for rehearsal, but the Stars won't show up until you've restored all the concert components and are ready for the performance!

Learning Opportunities

- Strengthen visual and musical creativity
- Develop sequential programming skills
- Experiment with light, sound, and electrical staging controls
- Apply acquired scientific knowledge about lenses, filters, voltage, resistance, current, and the properties of sound

About Kids

As they learn more about light, sound, and electricity in the *Zap!* activities, students acquire components that control the Concert's lights, music, and movement. Students can apply their new knowledge of light-mixing (gained in the Laser Lab) to create spotlights of different colors. The knowledge gained from building circuits in the ElectroLoft can be used to make the DanceBots "boogie" faster or slower. Selecting the spotlights, music, and electrical controls for the Concert also allows students to express themselves creatively and practice organizing a sequence of commands.

Explore Mode

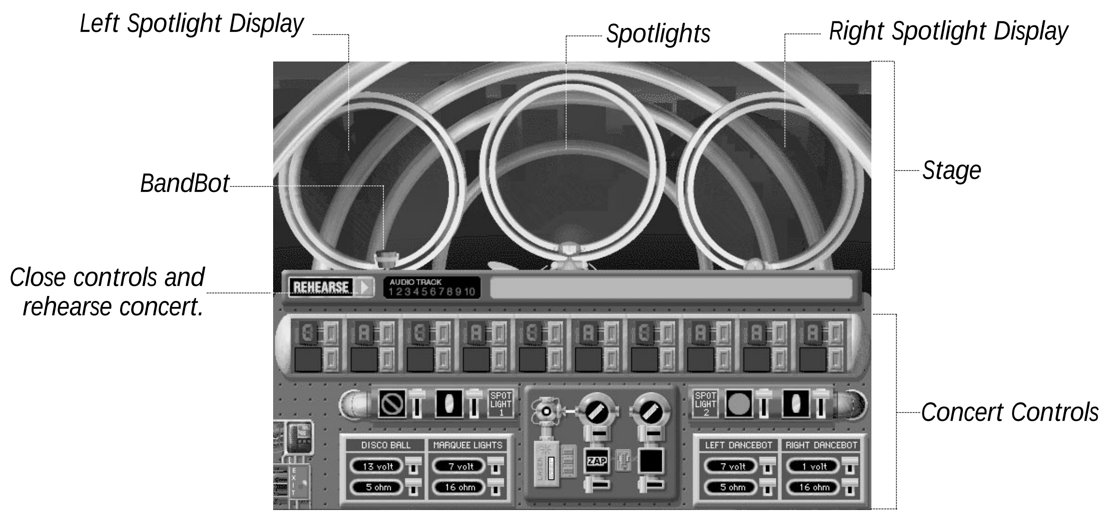
- From Backstage, click to rehearse or perform the Concert.
- From the Laser Lab, ElectroLoft, or SoundWave Studio, click and then click to rehearse or perform the Concert.

The first time you visit the Concert, you may have just a few controls available (depending on how many science challenges you've solved). As you solve science challenges in *Zap!*, you collect parts that help you control light, sound, and electrical features for the Concert. The Zap! Stars let you know when you've collected a new part.

Note: You can see all parts at all times, whether you've collected them or not. However, parts that you haven't yet collected remain inactive.

Rehearsal

You can rehearse the Concert at any time. The more parts you have, the more you can do with the Concert. To see a current inventory of your parts, click and then click Concert Parts.

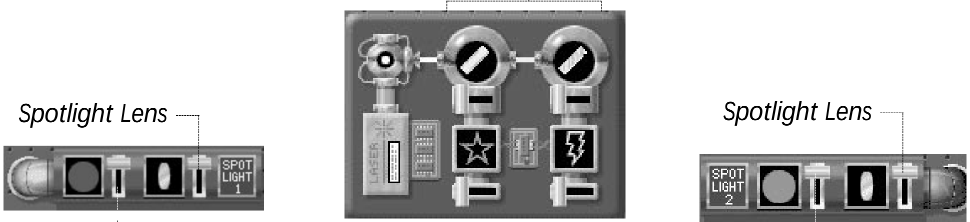


Concert Controls

As special Guest Director of the Zap! Concert, you can use light, sound, and electrical controls to choreograph a great show.

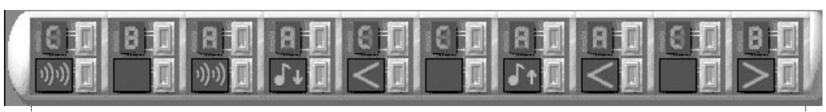
Light

There are two kinds of light controls: spotlights and lasers. Use the spotlight controls to change the lens and color of each spotlight. Use the laser controls to change the color and pattern of the laser display.



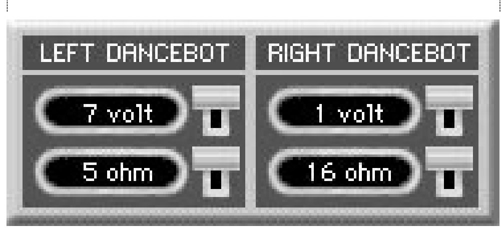
Sound

Use the top row of control buttons to select the type of music you want. Use the bottom row of control buttons to change the sound effects of the music you select.



Electrical

There are two types of electrical controls: voltage and resistance. Use these controls to change the amount of voltage and resistance used in the circuits of the disco ball, marquee lights, and DanceBots.



- When you are finished adjusting the controls, click  to rehearse the Concert. Click this button again to pause the rehearsal and adjust the controls.

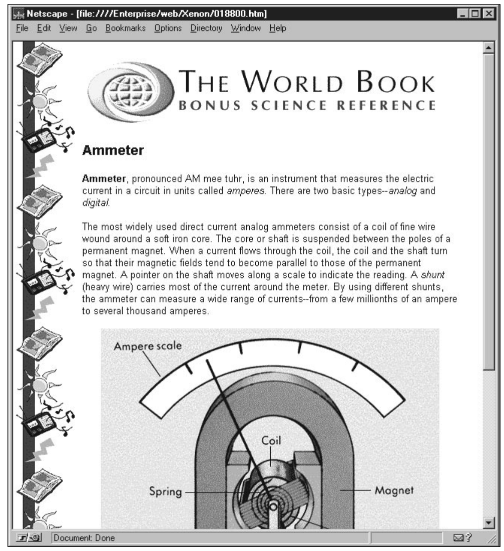
Zap! Concert

When you have collected all the parts, you can use ALL of the light, sound, and electrical controls to direct a mind-boggling show—starring Blaze, Surge, and Riff!

- To return Backstage, click .

World Book Bonus Science Reference

The World Book Bonus Science Reference features 222 articles on light, sound, and electricity from the World Book Multimedia Encyclopedia. In addition to exploring the information found in the *Zap!* Sci-Clopedia, students can use a web browser to explore the World Book material and learn more about their favorite science topics.



Note: To access the World Book Bonus Science Reference, you must have a web browser (for example, Netscape 3.0 or Internet Explorer 3.0 or higher) installed on your computer.

For Windows Users

Windows 95/98:

If AutoPlay is enabled

After installation of *Zap!* (see Setup Instructions, page 5), insert the CD and click the Worldbook Bonus Science button on the Startup Screen to begin.

If AutoPlay is disabled

After installation of *Zap!* (see Setup Instructions, page 5), select Worldbook Bonus Science from the Start | Programs | Edmark | Zap! menu to begin.

Windows 3.1:

After installation of *Zap!* (see Setup Instructions, page 5), double-click the World Book icon to begin. The Worldbook Bonus Science icon can be found in the Edmark program group.

For Macintosh Users

Insert the CD-ROM and double-click the Worldbook Bonus Science folder. To browse the reference section using Netscape, click the World Book (Navigator) icon. To browse it with Internet Explorer, click the World Book (Explorer) icon.

You do not need to have access to the Internet to benefit from the World Book Bonus Science Reference. You only need a browser. For more information about browsing the World Book Bonus Science Reference, Macintosh users can read the “Browser” section of the *Zap!* Read Me file. (Insert the CD-ROM and double-click the *Zap! Read Me* icon.)

Adult Options

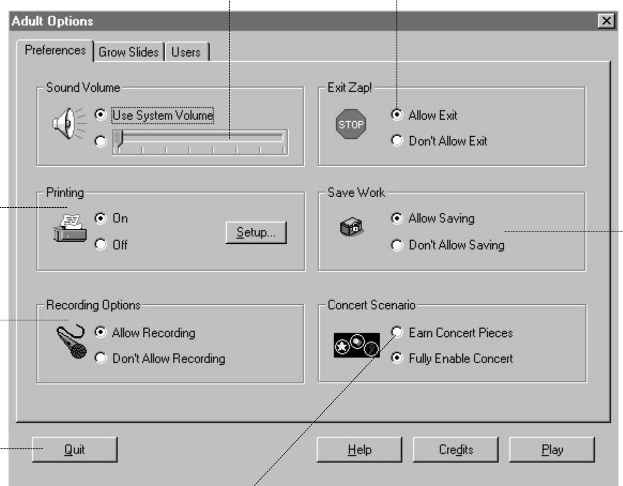
Use Adult Options to change preference settings for *Zap!*, control the Grow Slide settings, and modify the User List.

To enter Adult Options, Windows users hold down the **Ctrl** and **Alt** keys while pressing the **A** key. Macintosh users hold down the **Command ⌘** and **Option** keys while pressing the **A** key.

Preferences

Use the system volume or set the volume manually with the slider.

If exit is allowed, the Stop Sign appears on the Main Menu. If exit is not allowed, the Stop Sign does not appear, but users can still exit by pressing Alt-F4 (Windows) or Command ⌘-Q (Mac).



Select printing format or turn printing off.

Allow users to save their light, electricity, and sound designs, or check “Don’t Allow Saving” to hide the Save buttons in all Learning Environments.

Allow users to record sounds in SoundWave Studio.

Quit Zap!

Require users to solve science problems to earn Concert pieces, or check “Fully Enable Concert” to allow users access to all Concert controls at all times.

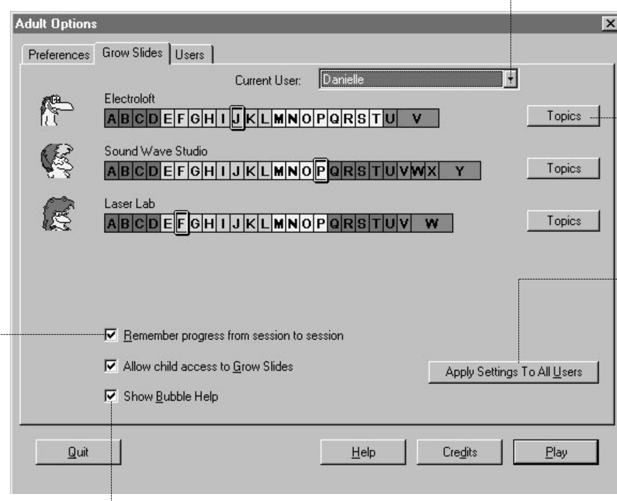
Concert Scenario

To allow your students access to all the Concert controls at all times, check “Fully Enable Concert.” If you want your students to solve problems in order to earn Concert controls, check “Earn Concert Pieces.”

Grow Slides

Click the “Grow Slides” tab in Adult Options to adjust the Grow Slide settings and options. Adjustable Grow Slides allow you to monitor a student’s progress or set an activity to focus on a particular topic. As a student successfully solves problems, the slider automatically advances to more difficult problems.

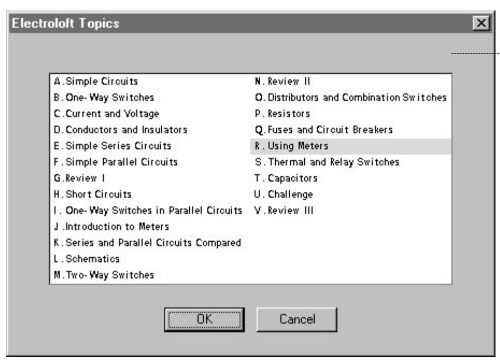
Grow Slide settings for this student. The drop-down menu bar lists all currently signed-in users.



When “Remember Progress ...” is checked, play begins at the difficulty level attained at the end of the previous session of play.

Clicking this button changes all students’ settings to the currently displayed settings.

When “Show Bubble Help” is checked, a Bubble Help box appears when the cursor pauses over a button.



Click “Topics” to see a list for this Learning Environment. You can choose to target a specific science topic.

- Select “Remember progress from session to session” if you want *Zap!* to save a student’s progress in each activity when he or she exits the program. If this box is unchecked, *Zap!* will always begin at the settings that are currently displayed on the Grow Slides. (To change the settings, you will need to open the Grow Slides and change them manually.)
- Select “Allow child access to Grow Slides” if you want this student to be able to adjust the topic or the level of difficulty. If this box is unchecked, the Grow Slide buttons do not appear within the activities.

Users

Click the "Users" tab.

- To remove a name from the User List, select the name and click Remove. (You cannot remove the current user or the "Guest" user.)
- To rename a user, select the name and click Rename.
- To add a name to the User List, click Add and type the name. If the "Allow New Users to Add Themselves" box is checked, students can add their names to the User List. Uncheck this box if you do not want students to add their own names.

KidDesk® Aware

KidDesk Family Edition, a separate program published by Edmark, gives students a place of their own on the computer—a personalized desktop that provides hard disk security, letting students use the computer independently and run only those programs you select for their use.

KidDesk Internet Safe offers the same hard disk security and personalized desktops as *KidDesk Family Edition*, while also providing a "safety first," child-friendly Web browser that helps protect students from inappropriate content on the Internet.

If *Zap!* is launched from *KidDesk*, the *KidDesk* user is signed in automatically and the User List does not appear. To switch users, return to *KidDesk* and open a different desk.

The Stop Sign Backstage is replaced by the *KidDesk* icon. Clicking the icon returns the user to *KidDesk*.

Dear Parents

Donna Stanger, award-winning software designer and former teacher with twenty years of classroom experience, shares her thoughts about science learning and each of the Learning Environments in *Zap!*

For Windows Users

Windows 95 or later:

If AutoPlay is enabled

After installation of *Zap!* (see Setup Instructions, page 5), click the Dear Parents  button on the Startup Screen to begin.

If AutoPlay is disabled

After installation of *Zap!* (see Setup Instructions, page 5), select Dear Parents from the Start | Programs | Edmark | Zap! menu to begin.

Other Versions of Windows:

After installation of *Zap!* (see Setup Instructions, page 5), double-click the Dear Parents icon to begin. The Dear Parents  icon can be found in the Edmark program group.

For Macintosh Users

Insert the CD-ROM and double-click the Dear Parents  icon to begin.

Introducing Zap! to Your Students

Zap! is easy to use, but your introduction can help students get the most out of their learning experience. First, you may want to spend an hour or so exploring the software yourself, using pages 9–42 of this guide. Playing with *Zap!* is fun, and it familiarizes you with the program features, so you can better orient and assist your students.

At this time, you can also use the Adult Options (see pages 43–45) to enter your students' names and set the Grow Slides. Or, you can let students do this themselves later, as they begin using the program.

Zap! Map

The map on page 48 shows the basic features of the program. You may want to:

- Duplicate the map on plain paper and post a copy by each computer for students to use as they explore the software independently.
- Duplicate the map on an overhead projector transparency and use it while you introduce the program to the class.

Free and Guided Exploration

Most students are eager to explore all of the activities the first time they use the program. You may want to allow students to do this for their first session. Then, on subsequent sessions, you can focus on specific science topics. (For a list of available science topics, see pages 9–10. To learn how to set a topic, see page 44.)

So Let's Begin!

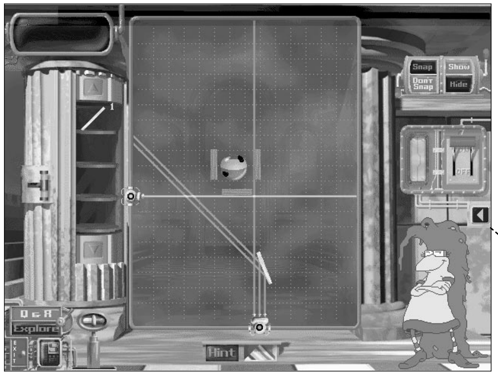
Once you are comfortable with the software, demonstrate it to your students. If possible, use a large-screen monitor or projection device. Show students how to add or choose their names Backstage, how to enter and exit the Learning Environments, and how to open and use the Sci-Clopedia. (If you need a review of these steps yourself, please see pages 14–15 of this guide.)

The Guided Tours on pages 49–55 can help students learn to use the Explore Mode of each Learning Environment. You may want to:

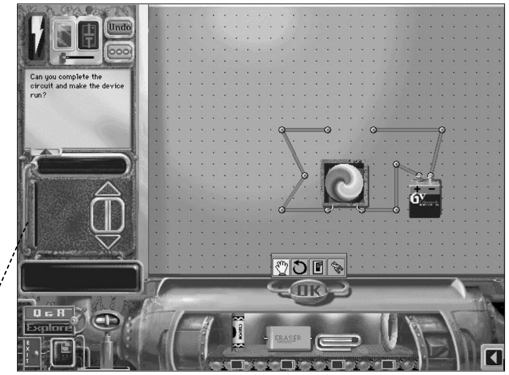
- Reproduce the tours and post them by the computer for students to use independently.
- Reproduce the tours on overhead projector transparencies and follow them as a class.

As students explore the different areas of the program, you can reinforce what they're learning with the corresponding classroom activities and reproducible worksheets, beginning on page 57.

Zap! Map

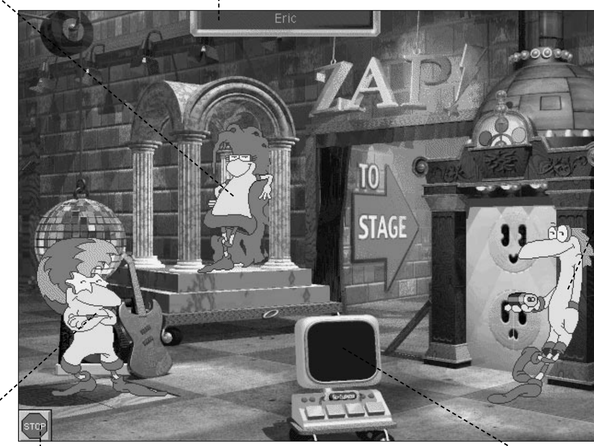


Laser Lab

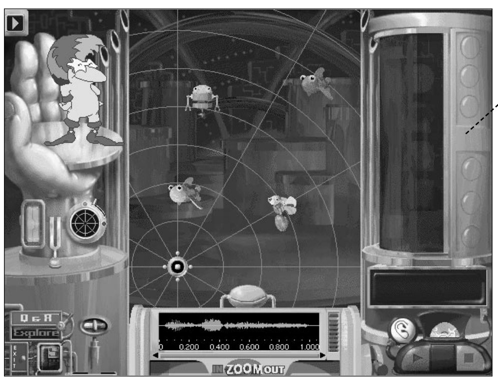


ElectroLoft

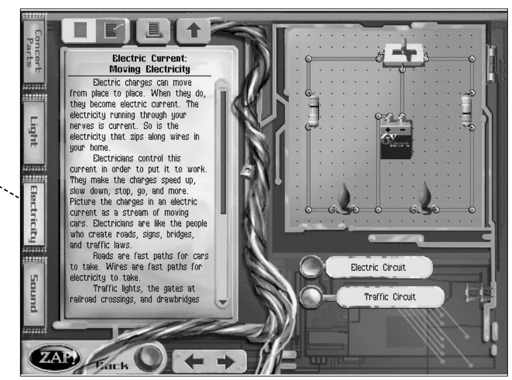
Change players.



Stop playing.



SoundWave Studio



Sci-Clopedia

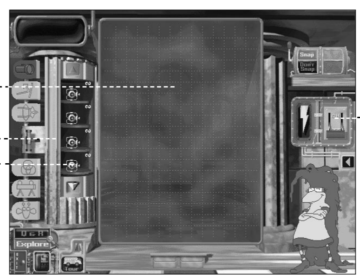
Guided Tour—
Laser Lab

1. From Backstage, click .

2. Click to enter Explore Mode. Click to hear Blaze give a brief tour of the Laser Lab. (You can click the screen again if you want to stop the tour.)

Building Light Designs

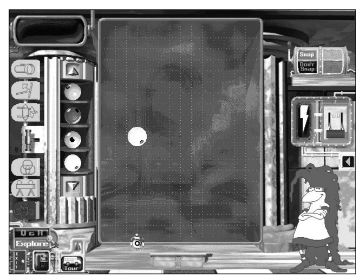
3. In Explore Mode, you can use laser beams and parts from the Tube to create cool light designs and hatch FlashBots!



4. Look at the Light Sources in the Tube. Hold the cursor over each Source and read the name and description in the Monitor (on top of the Tube). Stop when you see this description: White single beam light.

5. Drag the white Light Source onto the workspace and attach it to the bottom left edge of the Laser Wall. (Light Sources can only be attached to the edges of the Laser Wall.)

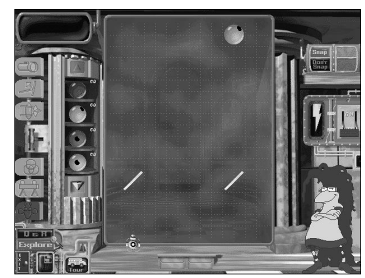
6. Now you're ready to hatch a FlashBot Egg! Click (on the left of the Tube) to see the eggs in the Tube. Click   to see the different eggs. The color of an egg tells you what color lasers will hatch it; the spots on the egg tell you how many lasers you need to hit the egg with to hatch it. Drag a white egg with one spot onto the Laser Wall and place it straight above the Light Source:



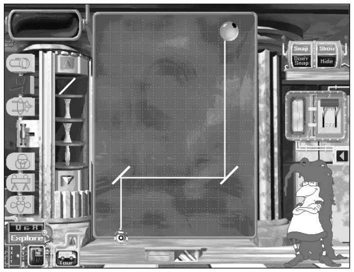
7. Click to turn on the laser. Watch it hit the egg and hatch the FlashBot!

8. Now let's try something a little bit harder. Drag a green egg with one spot onto the workspace and put it in the top right-hand corner of the Laser Wall. Can you aim the white laser so it hits the green egg, without moving the light source?

9. You can if you use mirrors! Click (on the left of the Tube) to see the Mirrors. Drag a flat mirror onto the Laser Wall and put it right above the Light Source. Drag another flat mirror to the right of the first one, and line it up straight across from the first mirror and directly below the green egg. The Laser Wall should look something like this:



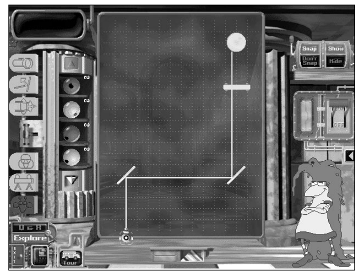
10. Click to turn on the laser. The wall should look something like this:



11. You can see that the laser hits the egg but does not hatch it. This is because a green egg can be hatched only by a green light beam—not a white one.

12. Do you know that white light is made up of *all* colors? You can use the Prism tool to see the colors with your own eyes. Click (at the bottom of the screen) and then hold the Prism over the white laser beam. The Prism shows you each color in the white laser beam. Click anywhere on the screen to release the Prism, and then click to turn off the laser.

13. To hatch the egg, you need to "filter out" the green light from the white light beam. Let's try using a Color Filter. Click to see the Color Tools. Drag the green Color Filter onto the Laser Wall. Put it halfway between the egg and the mirror on the right side of the Laser Wall. Hold the cursor over the end of the filter until it turns into the rotate icon. Spin the filter until it is in a straight horizontal line. Turn on the laser.



14. Look what happens to the laser beam as it passes through the filter. The green color filter stops all colors of light except for green light. The green light passes through, hits the egg, and hatches the FlashBot!

Explore Some More

15. Now that you've made a laser design and hatched some FlashBots, try creating new designs of your own.

16. If you need help coming up with some light design ideas, click (above the Tour button) and then click. Try changing one of these designs! (Don't worry, the original will still be saved.) Click to turn the lasers off or on. To see only the lasers, click to hide all the parts. Click to show the parts again.

Save Your Light Design

17. To save your light design, click (above the Tour button) and then click. Drag the picture of your design into an empty rectangle. Type a name under your design, then click "OK" to save it.

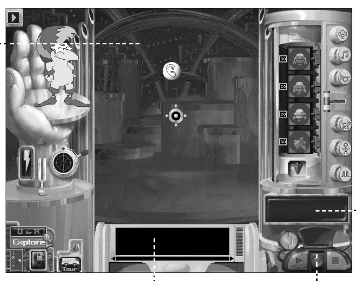
18. To open a saved light design, click. Click the picture of the design you want to open, then click "OK."

19. To clear all parts and lasers off the workspace and start over, click. (You must turn the lasers off to see this button.)

Guided Tour—
SoundWave Studio

1. From Backstage, click .

2. Click to enter Explore Mode. Click to hear Riff give a brief tour of the SoundWave Studio. (You can click the screen again if you want to stop the tour.)



Building Sound Designs

3. In Explore Mode, you can use CD sounds from the Tube to create cool sound designs and make the DanceBots boogie. Use the Wave Editor to change sounds!

4. Drag the Ear Tool around on the Dance Floor. Place it in the bottom right-hand corner of the Dance Floor, far away from the Speaker .

5. Click to see the Musical Instruments CD sounds in the Tube. Hold the cursor over each CD and read the name of the sound in the Monitor at the bottom of the Tube. Stop when you see the name "Guitar."

6. Drag the "Guitar" CD sound into the CD Player .

7. Click to hear the sound played and watch its waves move across the Dance Floor. When do you hear the sound?

8. Move the Ear Tool closer to the Speaker and click again. Do you hear the sound sooner or later than before? Notice that when you move the ear closer to the source of the sound, you can hear the sound sooner.

9. Now let's try to use a CD sound to make a BoogieBot dance! Click to see the BoogieBots in the Tube.

10. Click the arrows to see different BoogieBots. Hold the cursor over each Bot as you look at the Monitor. The Monitor will tell you the *amplitude* (loudness or softness) and *frequency* (high or low pitch) of the sounds that make this Bot dance.

11. Drag the red FishBot onto the Dance Floor and place it at the top edge of the Dance Floor. Put the Ear Tool between the Bot and the Speaker.

12. Click to see the Music Tunes CD sounds in the Tube. Drag the "Funk Bass Line" CD into the CD Player.

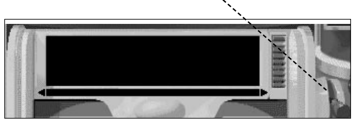
13. Click to play the CD sound. Watch the waves travel outward from the Speaker and make the Bot dance! The "Funk Bass Line" CD sound is a low amplitude, low frequency sound. The red FishBot dances to "Any Amplitude, Low Frequency" sounds. If you like, play a few more CD sounds and see if the Bot dances.

14. Drag some different Bots onto the Dance Floor. Experiment with different sounds, too. Do all the Bots dance to the same tunes? Why or why not?

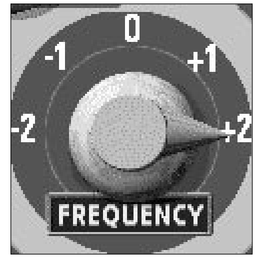
15. For "help cards" on different kinds of sounds and reminders about which BoogieBots dance to which sounds, click (in the top left corner of the screen).

Change a Sound with the Wave Editor

16. Click the handle on the right of the Wave Editor.



17. The Wave Editor opens. Drag the handle on the Frequency Control until the dial is pointing to "+2".



18. Now click on the CD player. How did the sound change?
Try experimenting with the Frequency and Amplitude controls to see how they affect the sound. You may want to try other CD sounds, too! (Just drag them from the Tube into the Player.)

19. When you are finished with the Wave Editor, click the handle again to close it.

Explore Some More

20. Now that you've experimented with sounds and made some music for the BoogieBots, you can explore on your own. You might want to try to make a group of Bots dance at once, or take a CD sound and use the Wave Editor to change it. (If you have a microphone plugged into your computer, you can also record your own sounds.)

21. To erase everything and start over, click .

22. If you'd like to see some sound ideas, click (above the Tour button) and then click to cycle through different designs. Click to play a CD sound.

Save Your Sound Design

23. To save your sound design, click (above the Tour button) and then click . Drag the picture of your design into an empty rectangle. Type a name under your design, then click "OK."

24. To open a sound design, click (above the Tour button) and then click . Click the picture of the design you want to open, then click "OK."

Solve Problems

25. Click to return to the Question & Answer Mode, where Riff asks you to solve sound problems and make the BoogieBots dance. You can use what you've just learned to help you solve them.

Guided Tour—
ElectroLoft

1. From Backstage, click .

2. Click to enter the Explore Mode. Click to hear Surge give a brief tour of the ElectroLoft. (You can click the screen again if you want to stop the tour.)

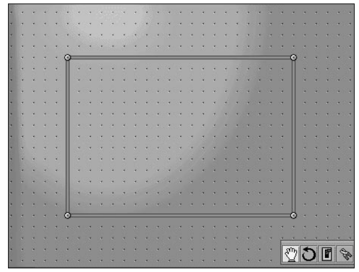
Build a Circuit

3. In Explore Mode, you can create electrical circuits using the Circuit Construction Tools .

4. To begin, click a spot in the top left corner of the workspace and drag the wire across the screen in a straight line. Let go of the mouse button to drop the wire. Keep adding wire until you have made a large rectangle on the workspace.

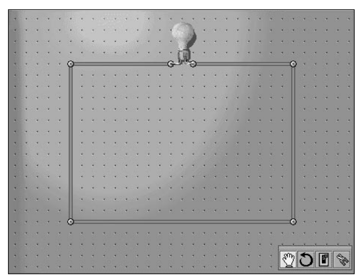
5. You can use the Cut tool anytime you like to remove a piece of wire. Try it! To replace the cut wire, click and then place new wire on the workspace.

When you are done making your rectangle, it might look something like this:



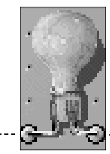
6. Now, click to look at different Light Bulbs in the Tube . Hold the cursor over each bulb in turn and read its name and description in the Monitor White Light Bulb: 5 Ohms, 30 Watts .

7. Select a 30 watt bulb and drag it onto the workspace in the middle of the top wire.



If the bulb won't fit, you can rotate it and hang it upside down by following these steps:

A. Click the Rotate Tool in the Toolbar
and then hold the cursor over one of the bulb's two *electrodes.*

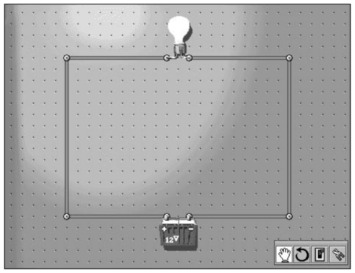
Left electrode

Right electrode

B. Once the cursor turns into the rotate icon , drag the bulb until both electrodes are touching the wire.

8. You may have noticed that no matter where you put the bulb on the wire, it does not light. Do you know why?

9. The answer is that you need a battery in the circuit to provide power to light the bulb! To choose a battery, click the Hand tool , then click (above the Tube) to see the Batteries. Hold the cursor over each battery and read the name and description displayed in the Monitor. Stop when you see the name "Car Battery: 12 volts."

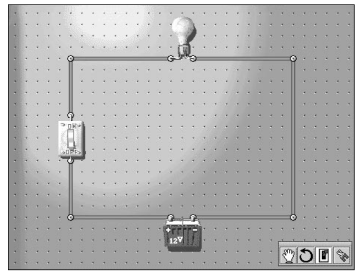
10. Drag the 12 volt battery from the Tube onto the workspace. Place it in the middle of the bottom wire, like so:



11. What happens? The light bulb should light up. If the bulb does not light, check to make sure that the wire is connected to each electrode on the bulb and to each electrode on the battery.

12. In this circuit, the bulb will always stay lit. Light bulbs in your house, though, can be turned on and off. To make a circuit like the ones in your house, you need to use a switch.

13. Click to see the switches in the Tube. Hold the cursor over each switch and read its name in the Monitor. Drag the Wall Switch onto the workspace and attach both electrodes to the wire on the left side of the rectangle.



14. Now the bulb is not lit. To light it, you need to "hit the switch!"

15. Click the Switch tool in the Toolbar and then click the switch to the "ON" position. The electrical current flows through the circuit, lighting the bulb.

16. Click the switch to set it to the "OFF" position. This "breaks" the circuit and stops the electrical current from flowing from the battery and into the light bulb. Click the switch again to turn the light back on.

Congratulations! You have just built a model of how the lights in your house and classroom work.

17. Click to see current flow through the circuit.

18. Now you may want to experiment a little on your own. Turn the switch off, and then click to see the Other Devices in the Tube. Click the arrows on the left and right of the Tube to see the different parts you can use.

19. Try adding different devices to the circuit. One neat device to try out is the Color Spinner. Drag the Spinner onto the workspace and attach it to your circuit. Click the Switch tool and then turn the switch "ON." What happens?

20. Add more bulbs or other devices to your circuit. What happens? Add more batteries to your circuit. What happens? Experiment and find out!

21. If you want to erase everything and start over, click.

Save Your Circuit

22. To save your circuit, click (above the Tour button) and then click . Drag the picture of your circuit into an empty rectangle on the grid. Type a name below your design, then click "OK."

23. To open a circuit, click (above the Tour button) and then click . Click the picture of the circuit you want to open and then click "OK."

Explore Some More

24. Now that you know how to design a circuit, try creating a few of your own!

25. If you'd like more tips, click (on the right of the Tube) to read the help cards.

26. If you want to see some circuit design ideas, click (above the Tour button) and then click .
Keep clicking to see different designs. Some of the designs need to be turned on so you can see them in action! Click and then click the switch on the circuit.

Solve Problems

27. Click to return to the Question & Answer Mode, where Surge asks you to troubleshoot circuit problems. You can use what you've just learned to help you solve them.

Students with Special Needs

Like all Edmark programs, *Zap!* includes built-in features that make it an extremely effective learning tool for a wide variety of students. *Zap!* can be used in general, inclusive, and self-contained classrooms, for enrichment and tutorial purposes.

TouchWindow Access

Zap! is fully compatible with the TouchWindow, a portable touch-sensitive screen that attaches to the computer monitor, allowing direct and natural touch input.

Unique Features

Below are descriptions of a few of the features that make *Zap!* extremely effective for students with special needs.

The strong, curriculum-based science content for grades 3-6 allows students to:

- Learn a variety of basic science principles with age-appropriate, technologically exciting activities.
- Progress at their own pace and skill level for specific science topics.
- Focus on science concepts that may be difficult by providing direction and support in enjoyable, interactive activities.
- Access identified learning tasks within all areas of the program.

Flexible settings, Grow Slides, and concrete and abstract learning opportunities allow students to:

- Repeat and review difficult areas.
- Move to more challenging topics as they experience success.
- Experience directed learning through a Question & Answer Mode with cueing, prompts, and guidance.
- Experience self-directed learning through an Explore Mode that allows students to experiment with science tools.
- Consult auditory support for many questions and explanations.

Hands-on, virtual science tools allow students to:

- Safely experiment with tools and concepts they might otherwise be unable to access.
- Complete science experiments at their own pace.

Classroom Activities and Reproducible Activity Sheets

The classroom activities on the following pages, grouped according to the corresponding *Zap!* software Learning Environments, help reinforce science skills and learning opportunities. These activities can be used throughout the school day, in different curriculum areas. There are many ways to use *Zap!* and the classroom extension activities. Use the ideas given here to stimulate your own imagination as you plan experiences for your students. *Zap!* and the activities in this guide are designed for grades three through six. This section includes:

- **Away from the computer activities** that can be used before each software activity or as follow-up experiences. Pick and choose the most appropriate activities for your class. **Note:** Because some activities require the use of small or sharp objects, supervision is advised.
- **At the computer activities** that can be used to add variety to the computer experiences. Some of these activities are designed for pairs or small groups of children, encouraging students to work cooperatively at the computer.
- **Reproducible activity sheets** to use for student work, transparencies, etc. Specific suggestions are offered on the following pages.
- **Answer keys** for the student activity sheets.

Science Across the Curriculum

All of the activities included in this guide reinforce science learning, as well as problem-solving and thinking skills. Some activities cross into other curriculum areas. If you are interested in integrating science with another subject area, use the list below to help you choose an appropriate activity.

Math

Calculating Current (page 92)

Social Studies

Electric Personalities (page 86)

Visual Art

Magic Mirrors (page 58)
Color Subtraction (page 59)
DeLIGHTful Creations (page 63)

Music

Strike Up the Band (page 73)
Bottle Bells and Water Whistles (page 74)

Health

Get in Focus (page 61)
Tuning Into Your Insides (page 76)

Technology

Build a Better Phone (page 75)

Laser Lab

Magic Mirrors

Background

The suffix *-scope* means “an instrument for viewing.” *Kalos eidos* means “beautiful form” in Greek, so a kaleidoscope is an instrument for viewing pretty shapes! These fun viewers are made of adjacent mirrors, which symmetrically reflect the objects inside the kaleidoscope as it’s rotated. When you look in the kaleidoscope, you see small objects reflected in three mirrors. Each reflection is in turn reflected, creating beautiful geometric designs.

Although it is difficult to trace the images in a kaleidoscope, the idea of multiple reflections is easy to show with two parallel mirrors facing each other. Ask students how many images they can see.

Procedure

Provide each group with a copy of the Magic Mirrors student activity sheet and the materials listed to the right. (**Note:** You may be able to find small mirrors in a crafts store. You can also create safe and inexpensive rectangular mirrors by snapping 4" x 6" plastic locker mirrors in half lengthwise, after scoring both sides with a nail and ruler.)

- **Primary Emphasis**
  Study reflection of light by mirrors
- **Subject Areas**
  Science and Visual Art
- **Materials Needed**
  Magic Mirrors student activity sheet (page 64); three small rectangular mirrors; duct tape; poster board; scissors; sharpened pencil; beads, sequins, confetti, seeds, or other small objects; tracing paper; rubber band
- **Grouping**
  Small groups

Help students assemble and use their kaleidoscopes. To see the effect, students need to look at the mirrors, not the objects at the end. Encourage students to change the contents of their kaleidoscopes by removing the tracing-paper end and refilling it. Ask students to make observations about how the different objects appear in the kaleidoscope. Which objects are easier to identify?

Safety Tips. To avoid an eye hazard:

- Tape any rough mirror edges with duct tape before distributing the mirrors to students.
- Make sure none of the objects inside the kaleidoscopes are small enough to fall out through the eyeholes.
- Make sure students hold the kaleidoscopes with the objects toward the floor and the eyeholes facing **up**.

Language Arts Extension

Challenge student groups to list as many words as they can that contain the suffix *-scope* (*telescope, microscope,* and *periscope* are just a few) and try to infer their meanings from the prefixes.

Color Subtraction

Background

White light is made up of all the colors of the rainbow. (Each color is a different wavelength of light.) But when white light falls on a colored surface, some wavelengths are absorbed (or subtracted), while the remaining wavelengths are reflected to our eyes. The color we see is a mix of only those wavelengths that reach our eyes. The missing wavelengths have been subtracted from the white light. We call this process *subtractive color mixing*. Red paint, for example, subtracts green and blue light, and reflects red. White paint, on the other hand, reflects all the colors without subtracting any. The subtractive primary colors of pigments (or paints) are *cyan, magenta*, and *yellow*.

- **Primary Emphasis**
  Understand that all colors are made up of the rainbow colors of light and that mixing paint colors involves subtractive color mixing
- **Subject Areas**
  Science and Visual Art
- **Materials Needed**
  Scissors; large cone-shaped coffee filters; 12-oz. plastic cups (one for each student); water; craft sticks; water-based "washable," non-permanent markers (permanent markers will not work); tape
- **Grouping**
  Class

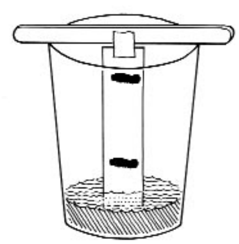
Procedure

Students will observe the different mixtures of pigments that give felt-tip markers their colors.

1. Cut 4" x 1" strips of coffee filter paper out of the cone filters. Pour a half inch of water into each cup.

2. Give each student a cup with water, a strip of filter paper, a craft stick, a marker, and a piece of tape.

3. Ask students to use their markers to draw a horizontal line about an inch from one end of the filter paper. It should be a dark line, made with four or five strokes of the marker. Have them make a second line, in the same color, one inch from the other end, to serve as a reference.



4. Students tape one end of the paper strip to the middle of the craft stick. Carefully lower the paper strips into the cups. The filter paper strip must touch the water, but both marker lines should stay above water.

5. When moisture approaches the higher color line (but before the higher line gets wet), lift out the strips and discard the water. Then set the strips back in the glasses and allow them to dry.

6. Ask students to observe which colors are found in each marker. Did any of the markers contain more than one color of pigment? Which had the most colors? Which had only one? What combinations of pigments made which colors? What conclusions can students draw about pigment color mixing?

Art Extension

Ask students to reproduce the color of a specific object by mixing only magenta, yellow, and cyan watercolor paints.

Looking Up

Background

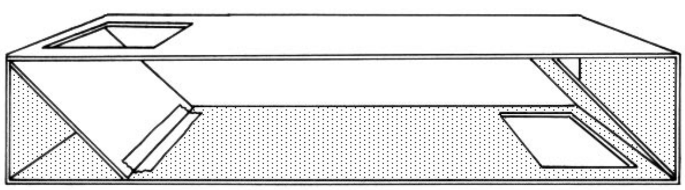
A periscope is an optical instrument that uses mirrors to bounce light from an object down a long tube to a viewer. A simple periscope, such as the one students will build here, has two parallel mirrors that face each other and are set at a 45º angle to the axis of the tube.

Procedure

Provide each group with the materials listed on the right. (**Note:** You may be able to find small mirrors in a crafts store. You can also create a safe and inexpensive pair of mirrors by snapping a 4"x 6" plastic locker mirror in half, after scoring both sides across the middle with a nail and ruler. If the mirror edges are sharp, tape them for safety before distributing mirrors to students.)

Provide assistance as needed while students follow the instructions on the activity sheets to build their periscopes. Encourage students to adjust the angle of their mirrors if they aren't seeing what they believe they should. (That's why using easily removable transparent tape is a good idea.) A great way for students to try out their periscopes is to kneel behind a desk or table and see what's happening on the other side.

- **Primary Emphasis**
  Study reflection by observing how mirrors bounce light through a periscope
- **Subject Area**
  Science
- **Materials Needed**
  Looking Up (page 65) and Periscope Pattern (page 66) student activity sheets; two small, same-sized mirrors for each group; cardboard or matboard; pencil; scissors; transparent tape; packing or duct tape; flashlight
- **Grouping**
  Small groups



The open sides on this periscope design make it easy to observe the path of reflected light. Invite students to shine a flashlight beam through the periscope and follow the path of light from the flashlight to a spot on the wall.

Extension

Challenge students to make a periscope that allows them to see around corners! (Follow the same basic design, but this time cut out squares on opposite ends of the same side and tilt the mirrors toward each other.)

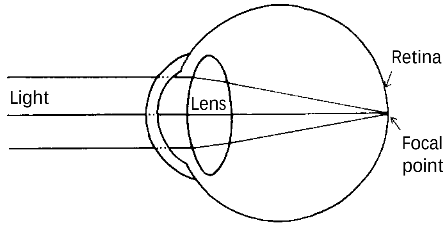
Social Studies Extension

Invite students to research the invention and development of submarine periscopes, which use a more complex system of prisms and telescoping lenses.

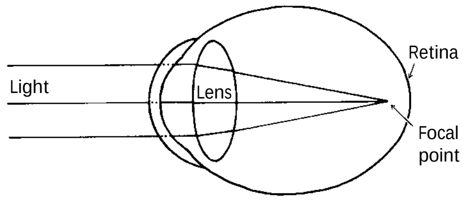
Get in Focus

Background

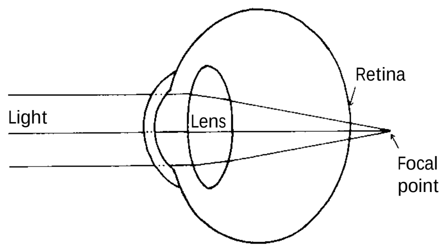
The human eye contains a convex lens. Light passing through this lens is focused into an image on the back of the eye. There, a thin layer of light-sensitive cells, called the *retina*, sends information about the focused light to the brain, where this information is processed as an image and we "see."



Normal Eye



Nearsighted Eye



Farsighted Eye

As we look at things, muscles attached to the eye's lens tighten or relax, causing the lens to get thinner or thicker. This allows us to focus on objects that are near or far.

The spot where refracted (or bent) light passing through a lens converges to a sharp focus is called the *focal point*. In eyes with normal vision, the lens and muscles work together to insure that the focal point falls on the retina. In a *near-sighted eye*, however, the eye is too long, the lens too thick, or the curve of the lens too deeply convex. This causes the light to focus (reach its focal point) *before* the retina, leaving the image blurry and out of focus. A *concave* lens (in glasses or contacts) placed in front of the eye's lens can correct the focal point.

In a *far-sighted* eye, the eye is too short, the lens too thin, or its curve too shallow. This causes the light to focus (reach its focal point) *after* the retina, also leaving the image out of focus. Wearing a *convex* lens in front of a far-sighted eye's lens can correct its focal point.

- **Primary Emphases**
  Study the refraction of light by convex and concave lenses and explore focal points; study how the lens in the human eye works and how lenses in eyeglasses correct near-sightedness and far-sightedness
- **Subject Areas**
  Science and Health
- **Materials Needed**
  Zap! software; Get in Focus student activity sheets (pages 67–68)
- **Grouping**
  Individual atudents or cooperative pairs

Procedure

In this activity, students use the tools in the Laser Lab to model and correct the common vision problems of near-sightedness and far-sightedness.

Photocopy the Get in Focus student activity sheet and provide one copy to each student. Ask students to follow the directions on the sheet. When the activity is complete, you may want to discuss the results as a class.

Tip: Before students begin this activity, ask them to complete the Guided Tour to the Laser Lab (pages 49–50). This will familiarize students with the lab's tools and terms.

(continued)

Math Extension

Have students take a survey of their classmates' vision—no glasses, near-sighted, or far-sighted—and graph the results as a bar chart. Students can also survey the school's teachers and staff about their vision and compare adult to child vision.

Social Studies and Language Arts Extension

Ben Franklin invented bifocals in the late 18th century. Invite students to read more about his invention and to write a historical-fiction-style story or play about it.

Mix it Up

Background

You see color when light of a particular wavelength hits color receptors on the retina of your eye. Your retina has three kinds of color receptors. One kind responds the most to red light, another kind to green, and a third to blue. For this reason, almost any color of light can be made by adding together some of each of the additive primary colors of light—red, green, and blue. If all the wavelengths are added, you see white. When colors result from combining different wavelengths of light, it's called *additive color mixing*.

(Colors of light mix differently from paint colors. When paints are mixed, they subtract colors, in a process called *subtractive color mixing*. When many colors of paint are mixed together, we see black. See *Color Subtraction*, page 59.)

- **Primary Emphasis**
  Understand that all colors are made up of the rainbow colors of light and that colors of light can be combined to make other colors
- **Subject Area**
  Science
- **Materials Needed**
  Zap! software; Mix It Up student activity sheets (pages 69–70)
- **Grouping**
  Individual students or cooperative pairs

Procedure

Students can mix and split light colors, predicting and confirming the outcome and combinations using the *Zap!* software. Photocopy the Mix It Up activity sheet and place one copy at each computer. Ask students to follow the directions to complete their activity sheets.

Tip: Before students begin this activity, ask them to complete the Guided Tour to the Laser Lab (pages 49–50). This will familiarize students with the lab's tools and terms.

DeLIGHTful Creations

Procedure

Duplicate the DeLIGHTful Creations activity sheet and place one copy by each computer. The instructions on the sheet challenge students to create fun shapes using particular tools. In the process, students will experiment with refracting and reflecting lights.

Tip: Before students begin this activity, ask them to complete the Guided tour to the Laser Lab (pages 49–50). This will familiarize students with the lab's tools and terms.

Extension

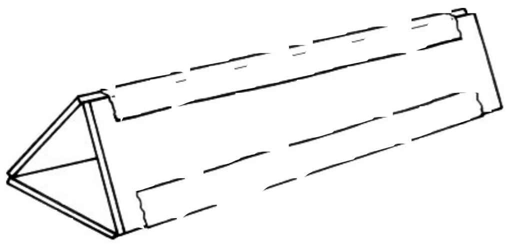
Invite students to make their own Laser Lab creations, print them in Hide mode, and challenge their classmates to recreate them.

- **Primary Emphasis**
  Experiment with refracting and reflecting light
- **Subject Areas**
  Science and Visual Art
- **Materials Needed**
  Zap! software; DeLIGHTful Creations student activity sheet (page 71)
- **Grouping**
  Individual students or cooperative pairs

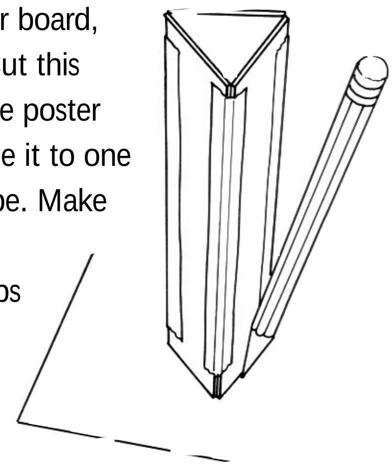
Magic Mirrors

Follow these directions to make a kaleidoscope and get an amazing view!

1. Use strips of duct tape to attach the three mirrors into a tubular triangle like this. The mirrored sides are on the inside. The mirrors' edges should touch each other.

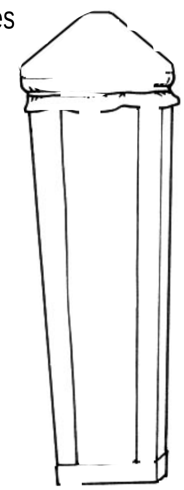


2. Set the mirror tube on end, place it on a piece of poster board, and trace it. Cut this shape from the poster board and tape it to one end of the tube. Make sure the tape covers any gaps or crevices.

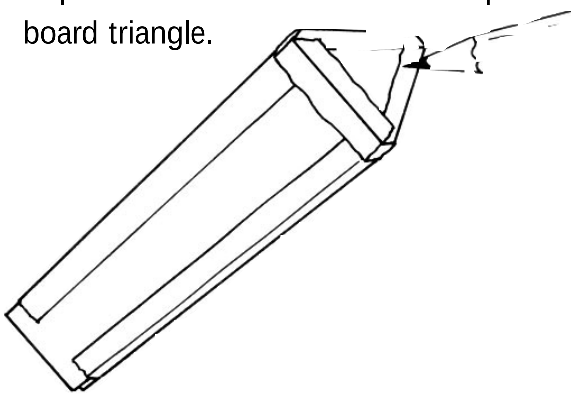


3. Turn the kaleidoscope over. Drop in about a tablespoon of beads, sequins, confetti, cut-up ribbon, shiny string, seeds, or anything else you think would be neat to see.

4. Cut a circle about 4 inches across from a sheet of tracing paper. Lay the circle over the open end of the kaleidoscope. Use a rubber band to hold it in place. Smooth out the tracing paper by pulling the ends down.



5. Turn the kaleidoscope over so that the poster board end is up. Use a sharp pencil to poke a hole in the center of the poster board triangle.



6. Your kaleidoscope is ready to use! Shake the kaleidoscope's insides down to the tracing-paper end. Hold the kaleidoscope with the tracing-paper end facing **down** and the eyehole facing up. Look down into the eyehole. To see the effect, you need to look at the mirrors.

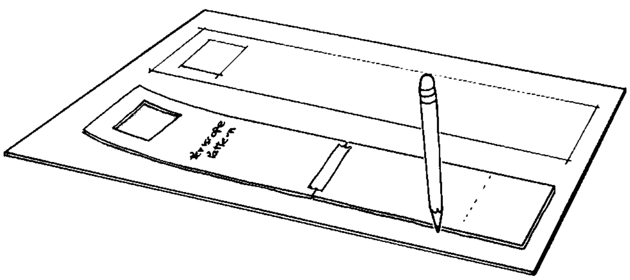
Never hold the kaleidoscope with the tracing-paper end up! Some of the small objects could fall out and hurt your eye.

 Use with the "Magic Mirrors" activity (page 58).

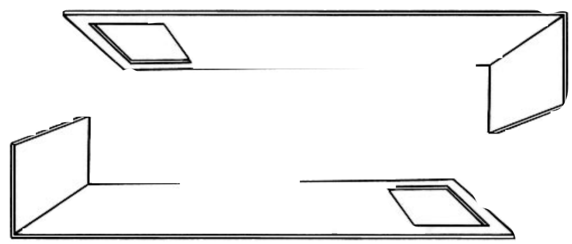
Looking Up

Here's a fun periscope to make. Once it's built you can use it to look over walls and other things in your way!

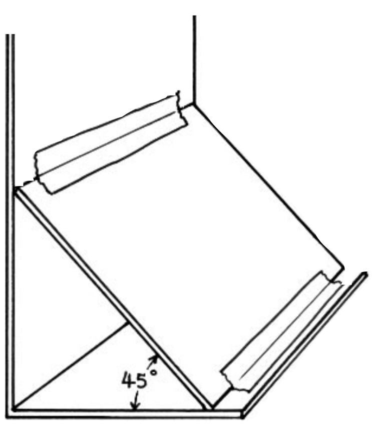
1. Cut out the Periscope Pattern and tape it together to make one long piece. Then trace the pattern **twice** onto cardboard and cut both copies out.



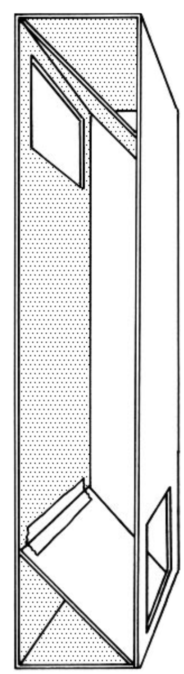
2. Cut out the squares on the cardboard. Mark the fold line, using the original pattern as a guide, and fold on the line. You should now have two pieces that look like this:



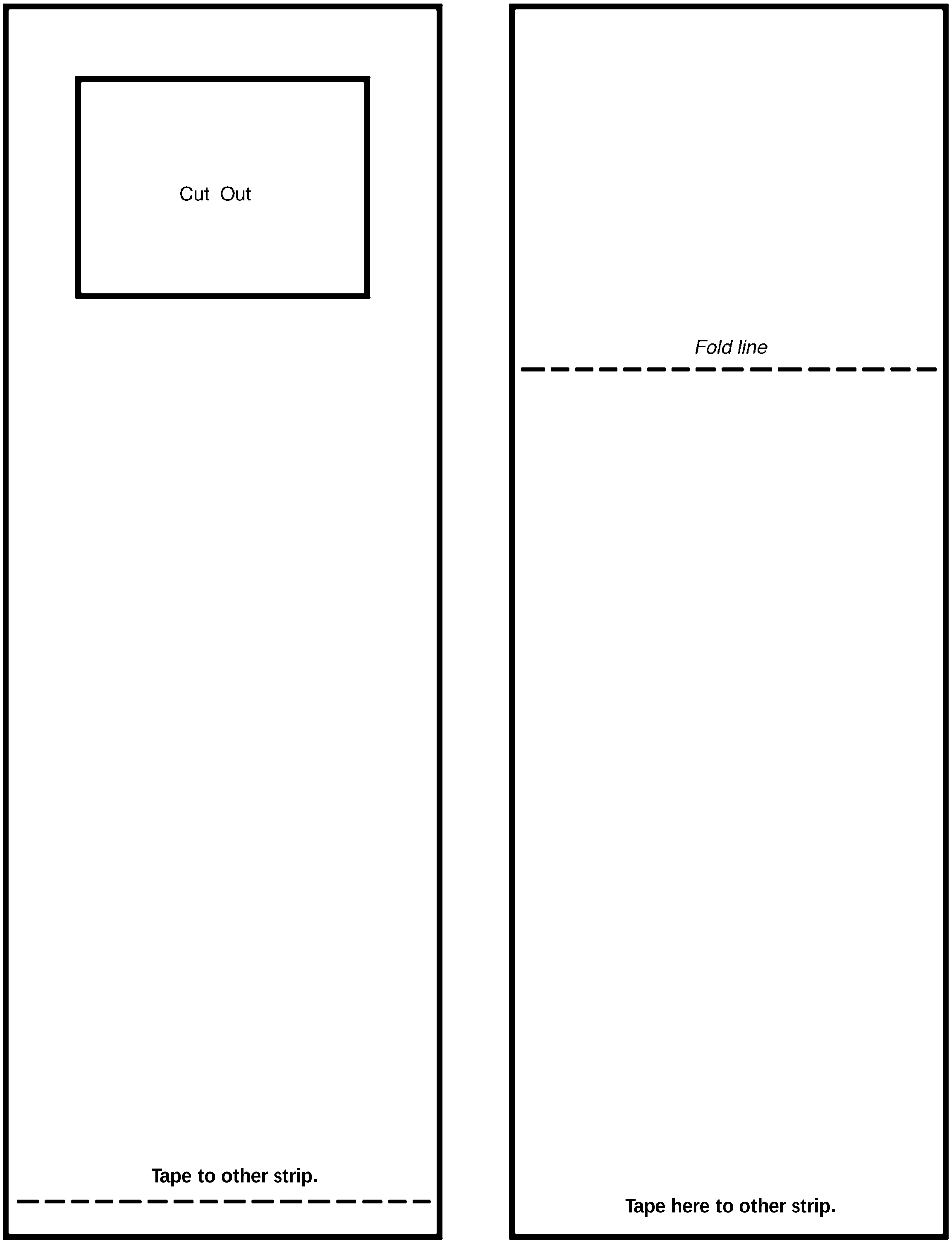
3. Use clear tape to attach a mirror to each folded corner. The side of the mirror and the side of the cardboard should form a 45º angle. (Try setting the folded corner up against a book or wall while you are doing this, to help keep it square.)



4. Tape the two pieces of your periscope together at each end, using strong tape. Now you have a periscope! Try using it to see over something.



Periscope Pattern

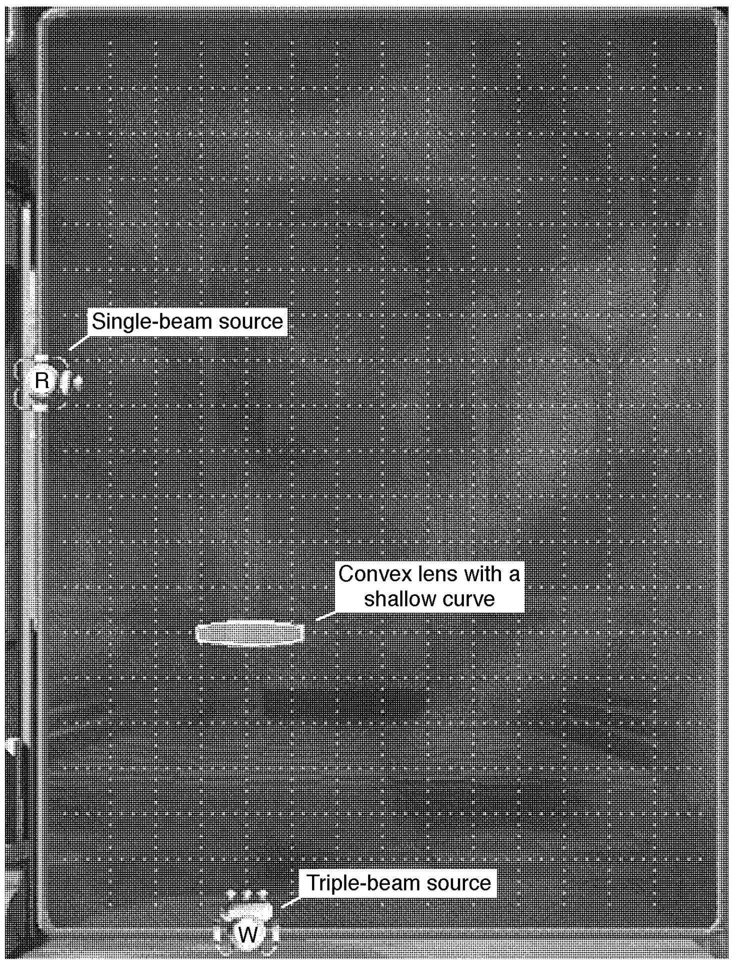


Get in Focus

1. Click  from Backstage. Then click  to enter the Explore Mode of the Laser Lab. Make sure you are in  mode, too.

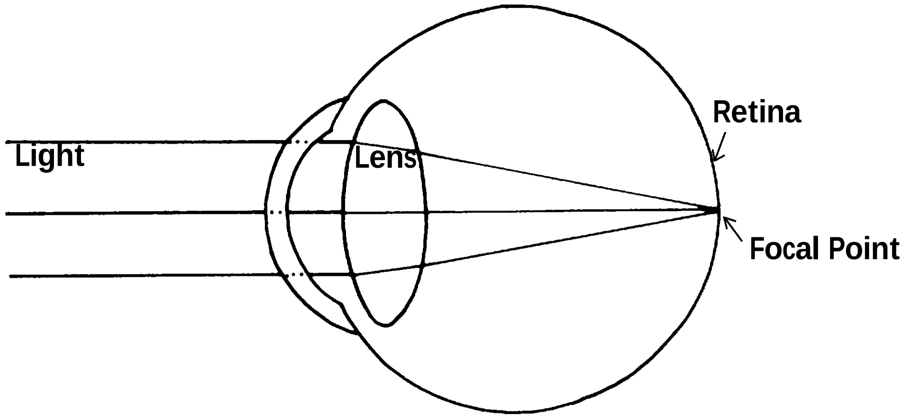
2. Take the following objects from the Tube (on the left of your screen) and place them on the workspace to match the picture below: one triple-beam white light source; one single-beam red light source; and one convex lens with a shallow curve. (The light sources will only stick to the edge of the workspace.)

Tip: To see the name of an object on the screen, place your mouse over the object and hold it there until you see the name.



3. Switch on the lasers by clicking . Use your pencil to draw the light's path on the picture above.

4. This is how your eye works to let you see things! The white light source is like the light bouncing off the object you're seeing. The red line is like your retina, where information about the image is registered and sent to your brain. The shallow convex lens is like the lens of your eye. Light passing though the lens is bent and comes together at a point, the focal point. This is where the image is in focus. For what you see to appear in focus, the lens must bend the light into a focal point that hits the retina. Label the “retina” and “lens” in the picture on the other page and circle the focal point.



Normal Eye

5. Turn off the lasers by clicking . Now take out the following objects from the Tube: one triple-beam white light source and one convex lens with a deep curve.

6. Set up the light source and lens next to the first “eye” to make a second “eye.” Then turn on the lasers. Does the light focus on the “retina”?________________
Is the focal point before or beyond the retina? ________________

7. This “eye” sees things out of focus. It‘s near-sighted, because the focal point falls short of the retina. People who are near-sighted need to wear contact lenses or eyeglasses. These lenses correct the focal point. Find a lens in the Tube to correct the near-sighted eye. You‘ll need to place the lens between the light source and the “eye’s” lens (just as glasses go between a person‘s eyes and everything that person sees)! What kind of lens works to correct the problem? ________________

8. Turn off the lasers. Take out the following from the Tube: one triple-beam white light source and one convex lens with a shallow curve. Use these to make another “eye.” But this time, place the eye‘s lens three large grid lines closer to the red beam line (retina). Turn on the lasers. Does the light focus on the “retina”? ________________
Is the focal point before or beyond the retina? ________________

9. This “eye” also sees things out of focus. It‘s far-sighted, because the focal point falls past the retina. People who are far-sighted also wear contact lenses or eyeglasses to correct the focal point. Find a lens to correct the far-sighted eye. What kind of lens works? ________________________

Challenge

Can you give the normal “eye” sunglasses that filter out only red light? How? (Sketch and describe your method on the back of this sheet.)

Mix It Up

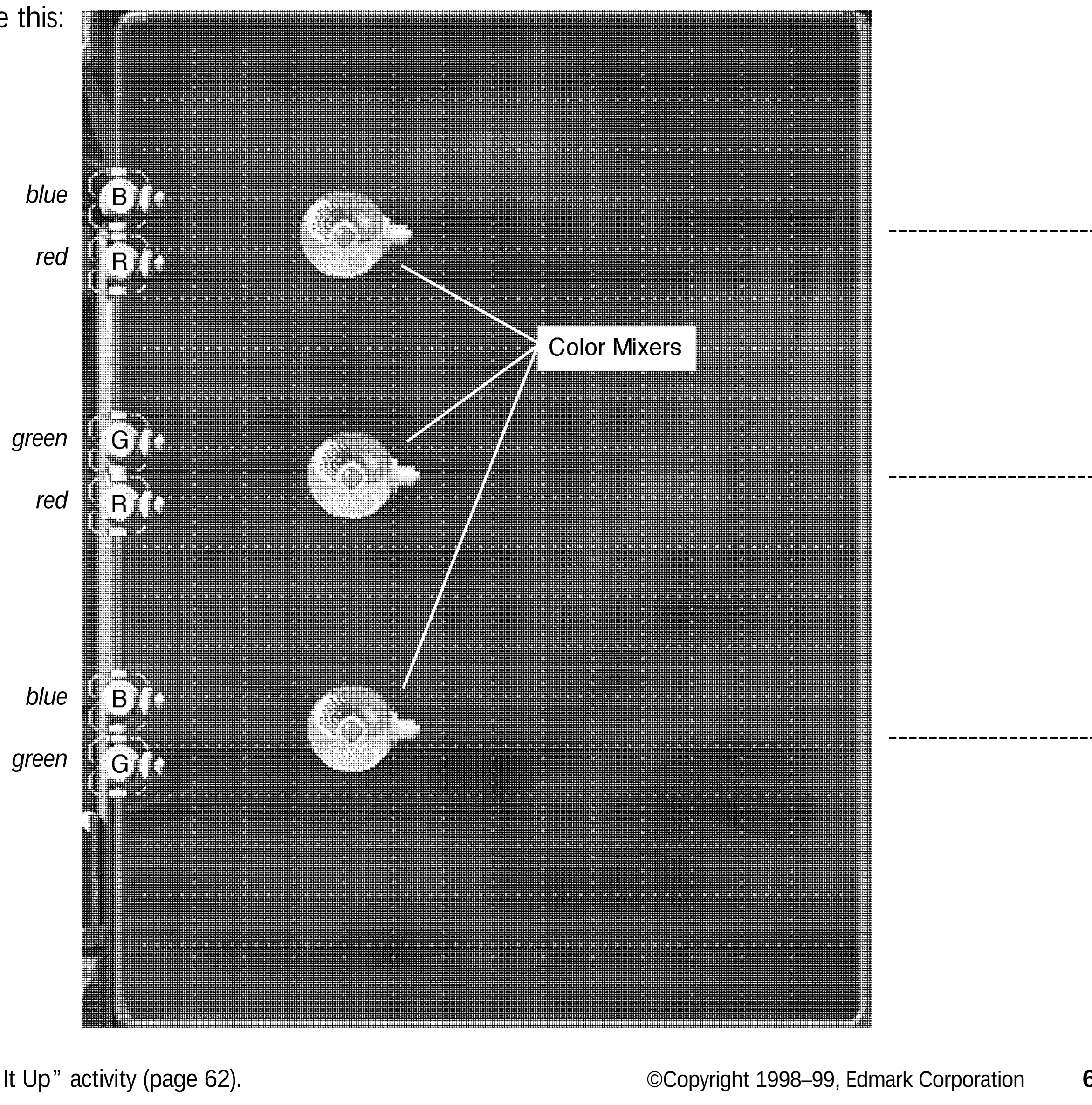
The three primary colors of light in the real world are the three colors found in the Laser Lab's lasers—blue, green, and red. All other colors of light can be made by combining them. Put your knowledge of colored light mixing to the test, using *Zap!*

1. Click  from Backstage. Then click Explore to enter the Explore Mode of the Laser Lab. Make sure you are in Don't Snap mode. Now you're ready to mix it up!

2. Make sure the lasers are turned off. Take the following out of the Tube:

- 2 red single-beam light sources
- 2 blue single-beam light sources
- 2 green single-beam light sources
- 3 color mixers

Set them up like this:



2. What color will each combination make? Write your prediction on the dashed line next to each color mixer. (If you need help, open the Sci-Clopedia or the Quick Reference for clues.) After you've written your predictions, turn on the lasers to check. Were you right? Correct your answers if necessary.

3. Now take a red color splitter, a blue color splitter, and a green color splitter out of the Tube. When light hits a color splitter, two things happen: (a) Its own color of light passes through. (b) Any other colors of light are reflected (bounced) away. Use three splitters to turn each colored beam back into its original two colors. (**Hint:** There are two arrangements of splitters that work.)

a. Which splitter did you use on the top beam? ________________________________

b. Which splitter did you use on the middle beam?________________________________

c. Which splitter did you use on the bottom beam? ________________________________

4. Clear your screen by turning the lasers off (by clicking) and then clicking . Take the following out of the Tube:

- 1 red single-beam light source
- 1 blue single-beam light source
- 1 green single-beam light source
- 1 color mixer

Use these tools to create a single beam of white light, then sketch your setup here.

5. Clear your screen by turning the lasers off (by clicking) and then clicking . Take the following out of the Tube:

- 1 red single-beam light source
- 1 blue single-beam light source
- 2 green single-beam light sources
- 3 color mixers

Use these tools to create a single beam of white light, then sketch your setup on the back of this sheet.

DeLIGHTful Creations

Would you like to create these deLIGHTful shapes using beams of light? To give it a go, follow the directions below!

1. Click  from Backstage and then click 

to enter the Explore Mode. Make sure you're in 

mode, too.

2. Look at the shape you want to make. Think about how a line could be bent or changed to make it.

3. Take the *What to Use* items (listed below) out of the Tube. Turn the lasers on by clicking . Make sure you're in 

mode.

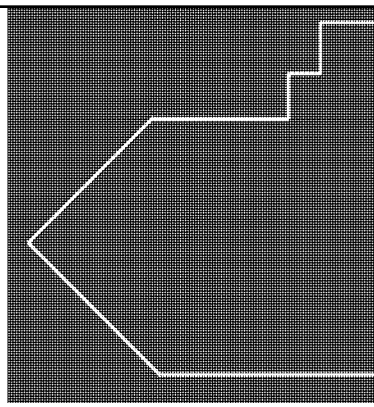
4. Use the tools to create the shape. When you think you've got it right, switch to 

mode to check. Good luck!

Home Sweet Home

What to Use:

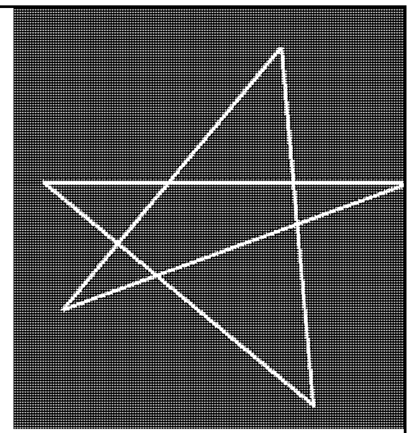
- 1 single-beam light source
- 7 flat mirrors



Star Light, Star Bright

What to Use:

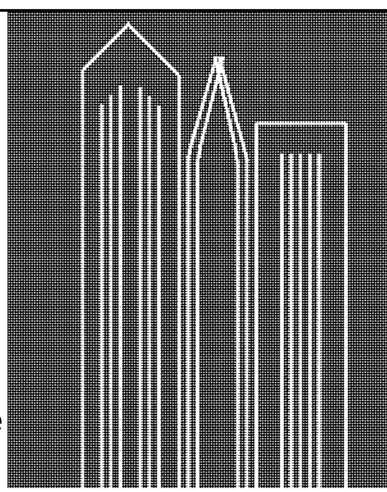
- 1 single-beam light source
- 4 convex mirrors with shallow curves



Sky Scrapers

What to Use:

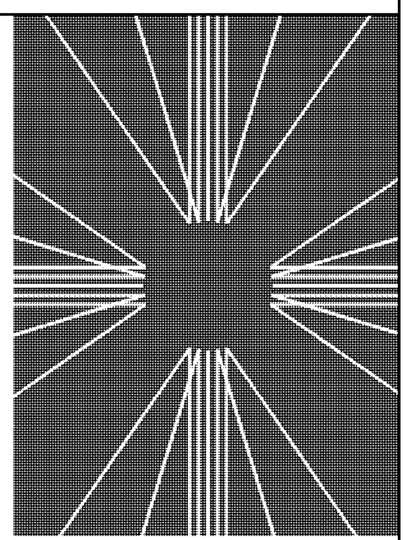
- 4 triple-beam light sources
- 1 five-beam light source
- 1 convex lens with a deep curve
- 4 barriers
- 5 flat mirrors



Sun Rays

What to Use:

- 4 five-beam light sources
- 4 convex mirrors with deep curves



SoundWave Studio

Who's Dancing Now?

Procedure

In this activity, students use SoundWave Studio's recording feature and the Wave Editor to alter the sounds of their own voices and observe the effect on the BoogieBots.

Photocopy the Who's Dancing Now? activity sheet and provide one copy to each student (or cooperative pair). Students can follow the directions on the sheet to complete the activity. Once the activity is concluded, you may want to discuss students' findings as a class.

SOFTWARE NOTE: Most recorded voices will include some silence (before speaking begins and during pauses between words). *Zap!* registers silence as a small amplitude, low frequency sound. The result is that most recorded voices will create a dull-red ring at first and cause the red SpaceBot (small amplitude, low frequency) to dance, regardless of the pitch and loudness of the student's sound. That's why Step 5 of the Who's Dancing Now? activity sheet challenges students to simply make a particular BoogieBot dance and not worry if others dance as well.

- **Primary Emphasis**
  Discover and identify the properties of frequency (or pitch) and amplitude (or loudness)
- **Subject Area**
  Science
- **Materials Needed**
  Zap! software; Who's Dancing Now? student activity sheet (page 77)
- **Grouping**
  Individual students or cooperative pairs

Health Extension

Students can model the differences in pitch between lower- and higher-voiced vocal cords. Wrap a rubber band around a book and slide two pencils underneath it. Strum the rubber band with the pencils far apart to model long vocal cords and with the pencils closer together to model shorter ones. Which produces a higher pitch?

Strike Up the Band

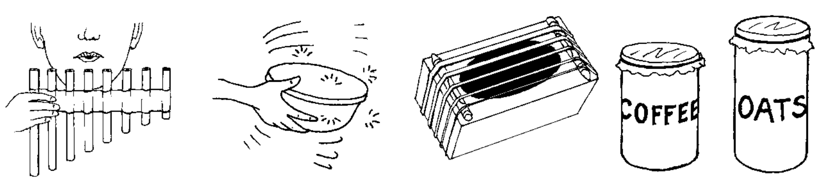
Background

Musical instruments differ in how they produce sounds. All sound comes from vibration, but different instruments vibrate different things in different ways to produce their unique sounds. A system of classifying instruments by their method of sound production was pioneered around the turn of the 20th century. This system uses four categories, based on what is vibrating to produce sound—air, membrane, string, or the instrument itself. (See page 81. A fifth category, electrophones, was introduced later, and contains instruments in which an electric current aids in either the production or the amplification of sound. Computerized sound machines, synthesizers, and electric guitars are all electrophones.)

Procedure

Demonstrate different musical instruments and ask the students to discover in each case what is vibrating to make the sound. Do sounds coming from an air-vibrating instrument sound different from those of a string-vibrating instrument?

Invite students to make the instruments on the Strike Up the Band activity sheet. The designs are simple and can be adapted for a variety of materials. Encourage students to innovate, creating their own unique sounds.



Music Extension

Instruments can also be classified by the four choirs of the orchestra: strings, woodwinds, brasses, and percussion. The World Book Bonus Science Reference (see page 42 of this Guide) contains information on the four choirs. (Click the Sound link, then click the Music entry and scroll down to the *Musical Instruments* section.)

Challenge students to compare and contrast the choir system with the *"-phone"* system discussed above. Where is there overlap? Where is there conflict?

- **Primary Emphases**
  Discover and identify the properties of pitch, frequency, loudness, and amplitude; classify musical instruments by their method of sound generation
- **Subject Areas**
  Science and Music
- **Materials Needed**
  Strike Up the Band student activity sheets (pages 80–81); musical instruments of your choice; jumbo drinking straws; strong tape (such as duct or packing tape); empty tissue box; rubber bands of varying sizes; empty coffee cans or oatmeal boxes; tracing paper; plastic trash bags; empty margarine or similar tubs; small objects such as beans, pebbles, marbles, or pennies
- **Grouping**
  (1) Class
  (2) Small groups

(continued)

Social Studies & Music Extension

Invite students to research some of the less-familiar instruments in Sound Wave Studio, such as the celeste, koto, kalimba, marimba, and harpsichord. In what culture or time period did each instrument originate? What kind of traditional music is played on it? Students can conduct research in the library, on a multimedia encyclopedia, or with the Internet.

Bottle Bells and Water Whistles

Background

Aerophones (in this case, glass bottles that students blow across) make sound by vibrating a column of air. The longer or larger the column, the slower the vibration and the lower the pitch. When air is blown across a nearly-empty bottle, the sound's pitch is low because the column of air is long. When the bottle is nearly full, only a short column of air vibrates, and the pitch is high.

Idiophones (in this case, glass bottles that students tap) are themselves the material that vibrates to make sound. An empty glass bottle has a natural pitch when it is tapped. When water is added to it, there is now more mass that has to vibrate when the bottle is tapped, and this slows down the vibration. The more water you add, the more slowly the bottle will vibrate and the lower the pitch.

Procedure

In this activity students compare the pitch of bottles as they are tapped and blown. Photocopy the Bottle Bells and Water Whistles activity sheets and hand out a copy to each group. Ask students to work through the instructions on the sheet. Make sure they fill out their predictions before experimenting!

Music Extension

Invite students to compose songs for the "bottle bells," record them on index cards, and exchange them with other students. Students can also build and play a "glass harmonica" by filling water glasses with varying heights of water and rubbing the rims with wet fingers.

- **Primary Emphases**
  Discover and identify the properties of pitch and frequency; compare idiophonic and aerophonic instruments
- **Subject Areas**
  Science and Music
- **Materials Needed**
  Bottle Bells and Water Whistles student activity sheets (pages 82–83); five identical glass bottles that hold at least 10 oz. each (such as juice, soda, catsup, or salad-dressing bottles); permanent marker; ruler; water;
  metal fork or spoon
- **Grouping**
  Cooperative pairs or small groups

Build a Better Phone

Procedure

Students can put their scientific-method skills to work while building a better tin-can telephone.

Photocopy the Build a Better Phone activity sheets and distribute one copy to each pair of students. As a class, review the basic design at the top of the page. Use it to get students thinking about ways to improve the basic design. You might ask:

- What part of the telephone vibrates? (The bottom of the cans or cups.)
- Do all materials vibrate as easily as others? (No, rubber or paper vibrates more easily than wood or stone.)

These questions can start students thinking about which materials to choose. Other ideas to consider introducing are replacing the bottom of the cans or cups with a superior vibrating material (rubber, foil, thin paper) or using a clip, button, or penny to anchor the string, rather than a simple knot.

Allow students to work with the materials and come up with a working telephone. All phones should satisfy these minimum criteria: With back turned to the speaker, the listener can understand what the speaker says in a low voice.

Once students are satisfied with their designs, have them complete their sheets. Students may also enjoy making "party lines" by crossing the wires of two phones.

Social Studies Extension

Invite students to research Alexander Graham Bell's invention of his telephone. Draw attention to his scientific method. How did he test and improve his invention?

- **Primary Emphasis**
  Use the concepts of vibration, loudness, and amplitude to design and build a "tin can telephone"
- **Subject Areas**
  Science and Technology
- **Materials Needed**
  Build a Better Phone student activity sheets (pages 84–85); empty tin cans with single nail-holes in their bottoms; paper cups; plastic cups; 10-foot lengths of fine wire, kite string, twine, dental floss, fishing line, and so on; paper clips; pennies; buttons; tracing paper; balloons; sharpened pencils
  Note: This is a suggested list of materials. The idea is to give students enough choices to encourage experimentation. Feel free to add or substitute materials. The basics are simply a 10-foot length of string and two cups or cans.
- **Student Grouping**
  Cooperative pairs

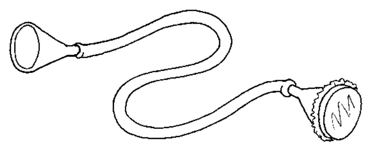
Tuning Into Your Insides

Background

A stethoscope is an instrument that isolates and clarifies body sounds, allowing a doctor or nurse to better hear low-amplitude sounds, such as a heartbeat or breathing. One kind of stethoscope has a thin plastic disc or membrane that vibrates in response to sounds. The vibrating membrane causes the air inside the tube to vibrate and the tube carries the vibrations—or sounds—to the ear.

Procedure

Students can make a simple stethoscope and use it to listen to the sounds of their bodies.



1. Blow up a balloon to stretch the rubber. Deflate it and cut off the top half. Stretch the balloon top over one of the funnels, as tightly as possible. Whether or not the balloon stays on will depend on the shape and material of the funnel. Use a rubber band or duct tape to secure the balloon if needed.

2. Fit the tubing ends over the funnel spouts. They should fit snugly in order to get good amplification. However, if they are just a bit slack, use duct tape to secure them. Your stethoscope is ready!

3. A student holds the open funnel to an ear and the balloon-covered funnel over the heart. Students should use their stethoscopes in a quiet room.

Students can listen to each other's heartbeat, count the number of beats in 15 seconds, and multiply this number by four to calculate the heart rate.

Notes:

- If several students are using the same stethoscope, you may want to clean the listening end with alcohol wipes between students.
- The stethescope amplifies sounds, but the sound of a heartbeat is still very soft. Students must be very quiet and listen carefully. If they still do not hear a heartbeat, check to be sure the covered end of the stethescope is placed directly over a student's heart.

Health Extension

Use the stethoscope to take a resting heart rate. Then take the same person's heart rate after he or she runs in place for two minutes. How does the heart rate change?

- **Primary Emphases**
  Discover and identify the property of amplitude (or loudness); learn about the human body
- **Subject Areas**
  Science and Health
- **Materials Needed (per stethoscope)**
  Round balloon; two small funnels; rubber band; two-foot length of plastic tubing that can fit snugly over the funnel spouts; duct tape; watch, clock with second hand, or stopwatch
- **Grouping**
  Cooperative pairs or small groups

Who's Dancing Now?

You think you've got what it takes to be a star? You know, to really get the crowds grooving? Try out your own voice on the dancing BoogieBots and find out!

1. Click  from the Main Menu. Then click  to enter the Explore Mode of the SoundWave Studio. Move the ear so it touches the speaker in the center of the Workspace. This way you'll hear the sounds sooner.

2. Click  in the Tube. Take the following objects from the Tube and place them on the workspace: one red SpaceBot , one blue SpaceBot, one red BugBot , and one blue BugBot. (Hint: You need to click the red arrow at the bottom of the Tube to find some of the Bots.)

3. Find the CD player  in the bottom right of the screen.

4. You can use the CD player to record and listen to sounds such as your voice, two hands clapping, or pencils tapping. Then you can play your sounds and watch the BoogieBots dance. Here's how:

- Click the red  button on the CD player.
- Make your sound quickly. You have three seconds!
- Click  as soon as you're finished to stop recording.
- Click the green  button on the CD player to hear the sound. Watch the BoogieBots dance. (You can click  as many times as you want.)

5. Now try to record a sound that makes the blue BugBot dance. (Don't worry if other BoogieBots dance, too. That's OK.) If you don't remember what kind of sounds make each Bot dance, click the green arrow in the top left corner of the screen or hold a cursor over the Bot and read the information box.

What sound worked for the blue BugBot? Describe it here.

What was the sound? (talking, whistling, etc.): ______________________________

Was the sound:

❏ loud (big amplitude) or ❏ soft (small amplitude)?

❏ high-pitched (high frequency) or ❏ low-pitched (low frequency)?

6. Repeat Step 5 for the blue SpaceBot, red SpaceBot, and red BugBot. What sound made each Bot dance? Describe the sounds here:

Blue SpaceBot

What was the sound? ____

❏ loud (big amplitude) or ❏ soft (small amplitude)

❏ high-pitched (high frequency) or ❏ low-pitched (low frequency)

Red SpaceBot

What was the sound? ____

❏ loud (big amplitude) or ❏ soft (small amplitude)

❏ high-pitched (high frequency) or ❏ low-pitched (low frequency)

Red BugBot

What was the sound?: ____

❏ loud (big amplitude) or ❏ soft (small amplitude)

❏ high-pitched (high frequency) or ❏ low-pitched (low frequency)

7. Use the recordable CD to record yourself saying, "My name is ____________(your name) ." Speak in a good strong voice!

8. Play back your voice and watch which BoogieBots dance. In row 1 of the chart on the next page, place a check under each Bot that danced. (Remember, you can hit as many times as you need.)

9. Open the Wave Editor by clicking its handle . Change the amplitude and frequency settings of the dials to the settings given in row 2 of the chart on the next page. (Just click the setting you want and the dial will move.) Then close the Wave Editor by clicking its handle .

10. Push the green button on the CD player to hear the changed recording of your voice. Watch which BoogieBots dance and check off the dancers in the boxes in row 2.

11. Repeat steps 9 and 10 for rows 3–9 to complete the chart.

12. Total the checks in each column.

Which BoogieBot danced the most? ____________________________________

Which danced the least? ____

	Red SpaceBot  Dances to: Small Amplitude, Low Frequency	**Blue SpaceBot**  Dances to: Small Amplitude, High Frequency	**Red BugBot**  Dances to: Big Amplitude, Low Frequency	**Blue BugBot**  Dances to: Big Amplitude, High Frequency
1. Normal Amplitude = 0 Frequency = 0				
2. Amplitude = 0 Frequency = +2				
3. Amplitude = 0 Frequency = -2				
4. Amplitude = +2 Frequency = 0				
5. Amplitude = +2 Frequency = +2				
6. Amplitude = +2 Frequency = -2				
7. Amplitude = -2 Frequency = 0				
8. Amplitude = -2 Frequency = +2				
9. Amplitude = -2 Frequency = -2				
TOTALS:				

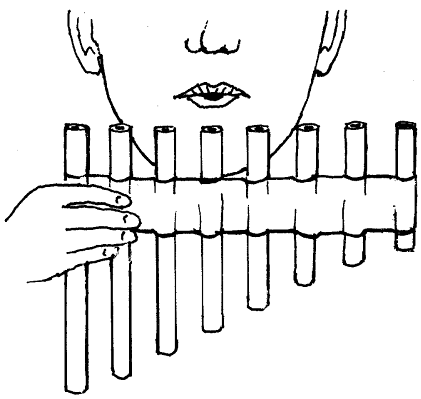
Use with the “Who’s Dancing Now?” activity (page 72).

Strike Up the Band
Part 1

Here are four easy-to-make instruments to help you and three friends start a band. After assembling the instruments, you can make music together. Remember to practice!

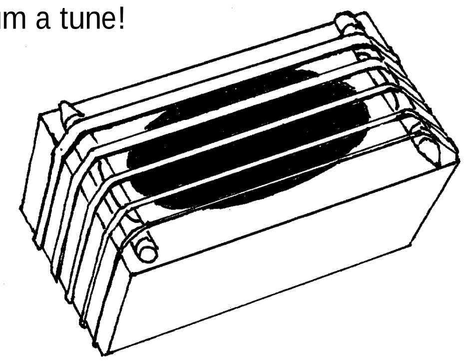
Straw Pan Pipes

Use strong tape to fasten together eight jumbo drinking straws. Then cut the straws to different lengths as shown below. Play the pan pipes by blowing across them.



Tissue Box Guitar

Wrap rubber bands of different widths and lengths around an empty tissue box. Place the bands from lowest to highest pitch. (Usually the narrower and tighter the rubber band, the higher the pitch.) Slide a crayon or short pencil under each end to support the "strings." Strum a tune!



Drums

Cover an empty coffee can or oatmeal box with the top of a large balloon or a circle of tracing paper or trash bag plastic. Use a rubber band to hold the covering on tight. Make two different kinds of drums to tap out two kinds of sounds.

Margarine Tub Maraca

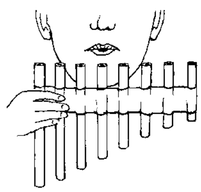
Pour a handful of beans, stones, marbles, coins, or thumb tacks into a margarine tub and put the lid back on. Now shake up a sound!

 Use with the "Strike Up the Band" activity (page 73).

Strike Up the Band
Part 2

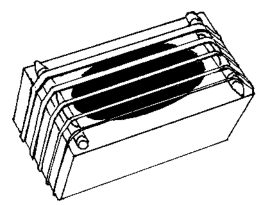
Musical instruments make sounds by creating vibrations. Different instruments vibrate in different ways. Blowing into a trumpet vibrates air, for example. Strumming a guitar vibrates strings. Musical instruments can be sorted by what vibrates to produce the sound.

Take another look at the four instruments you made. As you play each instrument, try to figure out what is vibrating to make the sound.

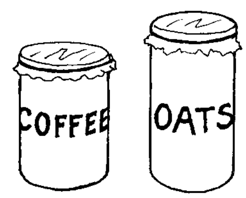


Pan Pipes

Maracas



Guitar



Drums

Here are four types of instruments, grouped by what they vibrate to produce sound.

CHORDOPHONES (string-sounders)

These instruments make sound by vibrating strings. The strings can be plucked, strummed, or hit with mallets or hammers.

Example: Harp

Which of the instruments you built is a chordophone? ___________________________

MEMBRANOPHONES (skin-sounders)

These instruments make sound by vibrating a skin or covering. The skin can be hit with hands or sticks.

Example: Snare Drum

Which of the instruments you built is a membranophone? _______________________

AEROPHONES (air-sounders)

These instruments make sound by vibrating air. The air can be in a tube, pipe, coil, or other enclosed place.

Example: Trumpet

Which of the instruments you built is an aerophone? _____________________________

IDIOPHONES (self-sounders)

These instruments make sound by vibrating themselves. The vibrating material can be anything—metal, wood, stone, glass, or plastic.

Example: Tubular Bells

Which of the instruments you built is an idiophone? ______________________________

Use with the "Strike Up the Band" activity (page 73).

Bottle Bells and Water Whistles

The longer the column of vibrating air in an instrument, the lower the instrument's pitch. Think of a very long flute compared to a short one. The longer flute has a lower sound, right?

The bigger and heavier things are, the harder they are to move. Big, heavy instruments vibrate more slowly than their smaller, lighter partners. Which would have the lower-pitched sound, a large bell or a small one? (A large bell has a lower pitch.)

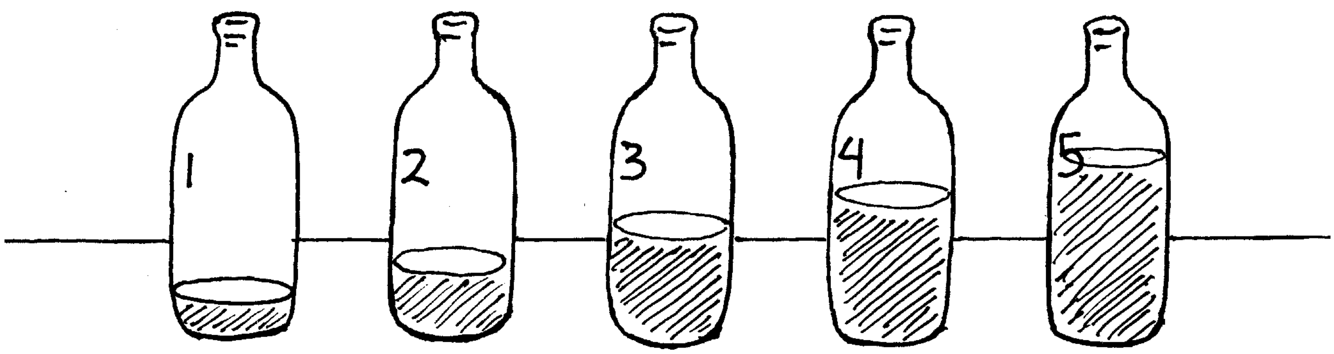
In this activity, you'll discover how you can use air and water to change the pitch of musical bottles.

1. Use a permanent marker to number the five bottles 1 to 5.

2. Use a ruler and the marker to draw a small line on each bottle at a height (from the bottom) equal to the bottle number. Mark Bottle 1 at one inch from the bottom, Bottle 2 at two inches, and so on.

3. Fill each bottle to its mark with water and line them up, as shown below.

Air Blown Across



Glass Tapped Below Water Line

4. Look at bottle 1.

a. Think: Is its column of **air** short or long? ________________

b. Predict: Will the pitch be higher or lower than bottle 5 when air is blown across the top of the bottle? ________________

5. Look at bottle 5.

a. Think: Is its column of air short or long? ________________

b. Predict: Will the pitch be higher or lower than bottle 1 when air is blown across the top of the bottle? ________________

6. Blow across bottle 1. Then blow across bottle 5. Compare the sounds. Were you right? Mark the bottles “highest pitch” and “lowest pitch” on the picture, near the words “Air Blown Across.”

7. Look at bottle 1 again.

a. Think: Is the bottle plus its water heavier or lighter than bottle 5?

b. Predict: Will the pitch be higher or lower than bottle 5 when the bottle is tapped?

8. Use the fork or spoon to tap bottle 1 *below* the water line. Then tap bottle 5 below the water line. Compare the sounds. Were you right? Mark the bottles “highest pitch” and “lowest pitch” on the picture above, near the words, “Glass Tapped Below Water Line.”

9. Now you can play a tune! Try tapping out this “jingly” one:

3, 3, 3

3, 3, 3

3, 1, 5, 4, 3

2, 2, 2

2, 2, 3, 3

3, 3, 1, 1, 2, 4, 5

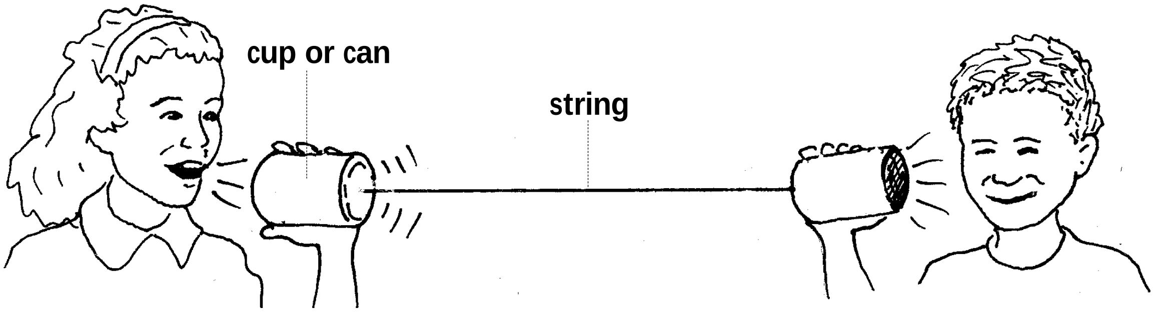
Do you recognize the song you just played?

Challenge

When is a bottle an *idiophone* (an instrument that makes sound by vibrating itself)? When you tap it or when you blow across it? ____

When is a bottle an *aerophone* (an instrument that makes sound by vibrating air)? When you tap it or when you blow across it? ____

Build a Better Phone



How it works:

1. A speaker talks and the sound of her voice travels through the air in her can as vibrations.

2. Her voice's sound vibrates the bottom of her can.

3. The vibrating can bottom causes the string to vibrate, passing the sound along it.

4. The sound travels along the string and reaches the bottom of the listener's can, causing his can to vibrate.

5. The sound's vibrations travel through the air in the listener's can to his ear. He hears!

YOUR DESIGN

Draw your phone. Label its parts.

Materials used: ______________________________

How to make the phone: ______________________________

How we tested the phone: ______________________________

Why we think it works well: ______________________________

What might make it better: ______________________________

ElectroLoft

Electric Personalities

Background

Electricity is a relatively new science. The work of the six researchers featured in Electric Personalities spans only the past 300 years. Students can learn how the ideas of electromagnetism were developed as they study the lives of these pioneering scientists and inventors.

Procedure

Photocopy the Electric Personalities activity sheets and give one copy to each student. Encourage students to use a variety of sources to find the missing facts: the Internet, encyclopedias, books, magazines, and so on. All six researchers are also featured in the World Book Bonus Science Reference. (See page 42 of this Guide.) Note that the Fun Facts section provides room for each student to contribute an additional fact that he or she finds interesting.

Extensions

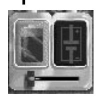
- Invite students to use these short biographies as starters for more in-depth reports.
- Student groups can play "round-robin" trivia games, asking questions based on the activity sheets ("Which two researchers were Americans?" "Who nearly became a bookbinder?" and so on).
- Let one student assume the character of one of the Electric Personalities and then have classmates conduct an interview.
- As a class, script an original play about one of the historic figures.
- Design a web page about one of the electrical pioneers and include links to his or her birth place, inventions, and so on.
- Build models of an invention created by one of the researchers. Students can build "virtual" models in the ElectroLoft or create "real-life" models away from the computer.
- Create a multimedia presentation about one of the scientists or inventors, using a HyperCard stack, slide-show software, or Edmark's *Imagination Express®*, *Destination: Time Trip, U.S.A®* software.

- **Primary Emphasis**
  Investigate some of the early researchers in the field of electricity
- **Subject Areas**
  Science and Social Studies
- **Materials Needed**
  Electric Personalities student activity sheets (pages 93–94); encyclopedias, books, or other resources

  Optional: World Book Bonus Science Reference (included on the *Zap!* CD)
- **Grouping**
  Individual students

Symbol Search

Background

Engineers, electricians, and other technology workers use symbols to represent the parts in electric circuit diagrams. Standardized symbols allow designers, engineers, and electricians to accurately communicate the lamp, switch, battery, or other part to be used. The ElectroLoft in the *Zap!* software allows students to view each circuit as a pegboard showing electrical parts or as a schematic diagram made up of symbols. (Students can toggle between views by clicking .)

Procedure

Students complete a variety of activities to identify sixteen electronic symbols used in the ElectroLoft. Reproduce both Symbol Search activity sheets and hand a copy to each student. Ask students to follow the instructions on page 96 to complete the sheet. Note that students write the names of the symbols only on page 96, not on the page with the pictures. Remind students to carefully check the numbers of the boxes as they work! (The numbers run left to right on page 96 but right to left on page 97.)

- **Primary Emphasis**
  Identify the engineering symbols for parts of a circuit
- **Subject Area**
  Science
- **Materials Needed**
  Zap! software; Symbol Search student activity sheets (pages 95–96)

  Optional: Glue or paste; heavy paper or poster board; scissors
- **Grouping**
  Individual Students and Cooperative Pairs

Once students have correctly completed page 96, a number of activities can be generated using the pages. Here are a few ideas:

- Paste the two pages back to back and cut out the cards. (Students can layer a piece of heavy paper or poster board between the reproducible pages for strength, if desired.) Use the cards as flash cards. Students can work with a partner to learn the symbols.
- Paste each page separately onto heavy paper or poster board and cut out the cards. Students can now play “concentration” with the cards by turning them all over and matching each name card to its symbol. Students can play alone or with others.
- Students can use the cards to plan circuits before building them in the Explore Mode of the ElectroLoft in *Zap!* (You may want to give each student more than one copy of page 96, so students can plan more complex circuits.)

Science Extension

Obtain real schematic diagrams of electrical circuits for students to decipher. (Wiring “how-to” books and local technical-vocational schools are two possible sources.) How do these diagrams differ from the schematic symbols in the ElectroLoft? How are they similar?

Careers Extension

Invite an electrician, electrical engineer, or other “high-tech” professional to speak to the class about her or his job. Have students prepare questions ahead of time. Ask the guest to bring some schematic diagrams, if possible, and to explain how they and other models are used on the job.

Will the Flow Go?

Background

Electrical *conductors* are materials through which electricity flows. *Insulators* do not allow the flow of electricity (or allow very little). Coated wiring, for example, is made of a conductor (the copper wire) surrounded by a protective insulator (the plastic coating). Metals are generally good conductors, while wood and plastic are good insulators. Salt water is a better conductor of electricity than fresh water. Graphite or pencil lead is another non-metal conductor.

Procedure

Provide student pairs or groups with the materials listed on the right. Assist students in building their test circuits. If students are having trouble getting their bulbs to light in step 5, check the circuit thoroughly and consult the NOT LIGHTING? box, below.

Once the groups have finished testing the conductivity of the different objects, allow the class to pool their findings. Divide the board into two halves, labeling the sides CONDUCTORS and INSULATORS. As a class, list all the tested items in the appropriate categories. Challenge students to draw conclusions about which kinds of materials make good or poor conductors.

NOT LIGHTING?

- Are there tears in the foil strips? Replace torn strips.
- Is the bottom of the bulb touching the foil? It needs to!
- Is the strip wrapped around the bulb touching the foil strip it's sitting on? It shouldn't! This shorts out the circuit.
- Are the batteries taped together tightly? (Squeeze them to check.)
- Is the rubber band fastened tightly enough?
- Are the batteries and bulbs good? Test them in a flashlight.

- **Primary Emphasis**
  Understand that electrical current is a flow of charge; understand the elements of a circuit and practice completing circuits; recognize that charge flows better through some materials than others
- **Subject Area**
  Science
- **Materials Needed**
  Will the Flow Go? student activity sheets (pages 97–98); 8 1/2" X 11" sheet of heavy paper or cardboard (the back of a notepad works well); two 1/2" X 16" strips and one 1/2" X 8" strip of aluminum foil; two D cell batteries; transparent tape; duct tape or packing tape; rubber band; flashlight bulb (a 2.38–volt/.5 amp bulb works well and is often available at Radio Shack); flashlight; clothespin; penny; eraser; paper clips; plastic buttons; other objects to test, such as bottle caps and craft sticks
- **Grouping**
  Cooperative pairs or small groups

Ladder of Light

Background

In a simple *series circuit* (such as the one in *Will the Flow Go?*, page 97), everything is in a single loop—like a string of old-fashioned Christmas lights. If one bulb burns out, the circuit is no longer complete, no current flows, and none of the bulbs light. *A parallel circuit* avoids this problem because each light (or other component) has its own path to the battery. If one bulb fails, each of the others still has a complete circuit and continues to function.

Procedure

Students will build and test parallel circuits.

Tip: Before you assign this activity, we recommend that students work through the Electroloft Grow Slide Topics (see page 9) up to and including Level F (parallel circuit problems), to gain a background in simple and parallel circuits.

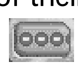
Provide each student group or pair with the materials listed on the right. Ask students to follow the instructions to construct and test their parallel circuits. Make sure they note their observations as they proceed.

If students are having trouble getting their bulbs to light in step 5, check the circuit thoroughly and consult the NOT LIGHTING? box on page 88.

Extension

When students have connected the maximum number of bulbs that will light, invite them to disconnect an inner bulb. What happens? Why don't all of the bulbs go out?

Software Extension

Ask students to build models of their parallel circuits in the Explode Mode of the ElectroLoft. Click  to watch the electricity flow as each new bulb is added.

- **Primary Emphasis**
  Understand that electrical current is a flow of charge; understand the elements of a circuit and practice completing circuits
- **Subject Area**
  Science
- **Materials Needed**
  Ladder of Light student activity sheets (pages 99–100); one 8 1/2" X 11" sheet of cardboard (the back of a notepad works well); one 1/2" X 16" strip, one 1/2" X 12" strip, and nine 1/2" X 6" strips of aluminum foil; three D cell batteries; transparent tape; duct tape or packing tape; rubber band; 5 flashlight bulbs (2.38-volt/.5 amp bulbs work well and are often available at Radio Shack); flashlight; five clothespins
- **Grouping**
  Cooperative pairs or small groups

Make an Electroscope

Background

Static electricity—the same kind that your students experience as winter carpet "zaps" and dryer cling—is created when positive and negative electric charges build up in separate areas. Students experience harmless static electricity discharges in this activity, and then build an instrument to detect the static electric charge of various objects. **Note:** This activity works best on dry (non-humid) days.

Procedure

Invite students to first experience static electricity. If it's a dry day and you have a carpet in your room, students can shuffle across the floor and then touch metal—or each other—to get a zap of static electricity. Or, have students blow up balloons, rub them on their heads, and touch the rubbed areas with a dull pencil tip. They'll be able to hear crackles of electricity.

Once students are convinced of static electricity's existence, ask them to follow these steps to assemble an electroscope—an instrument for detecting the electrical charge of an object.

- **Primary Emphasis**
  Develop problem-solving and analysis skills; experiment with static electricity
- **Subject Area**
  Science
- **Materials Needed**
  Balloon; two flexible drinking straws; Scotch Magic cellophane tape (other kinds of tape may work, but try them first); wool mitten, yarn, hat or piece of fur; pen or magic marker; objects to test such as balloons and static-filled combs and brushes.
- **Grouping**
  Cooperative pairs

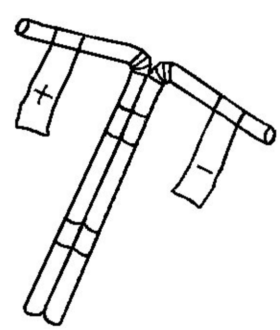
1. Bend the two straws into "L" shapes and tape them together to make a "T" shape. (Look at the finished picture below for help.)

2. Tear off two 3-inch strips of cellophane tape and attach them to the edge of a desk or table.

3. Write a "–" symbol on the smooth side about midway down on one strip of tape and a "+" on the other strip.

4. Stick the sticky side of the "+" tape onto the smooth side of the "–" tape, and then quickly peel them apart.

5. Stick one end of each tape strip onto an end of the straw so they dangle down. The smooth sides of both strips should face the same way.



6. The electroscope is ready! The two strips of tape acquired opposite charges when they were separated. The strip of tape that moves forward toward the object indicates that the object has the opposite charge. (An object that attracts the positive tape has a negative charge, while an object that attracts the negative tape has a positive charge.)

- Use a balloon rubbed on hair or wool to test the electroscope.
- Put two electroscopes near each other. Do the two "+" sides repel? How about a "+" side and a "–" side?

7. Challenge students to make predictions about the charge of various objects and then test them. Have students record their predictions and results on a chart, then compare them. Some objects that are often charged are computer or TV screens (only the teacher should try this example, for safety reasons), cloth that has been rubbed with a wool sock or mitten, and static-filled combs or brushes.

Health Extension

Lightning is static electricity on a grand scale. In the United States, about 180 people a year are killed by lightning. Challenge groups of students to investigate lightning safety and create informative public safety posters or multimedia presentations for the school or community.

Software Extension

Invite students to find out more about static electricity in the Sci-Clopedia (see page 35 of this Guide) and to research the electroscope in the World Book Bonus Science Reference (see page 42 of this Guide).

Can You Build Me a ____ ?

Background

Electric circuits are everywhere around us, performing many everyday tasks. Some are complex circuits, while others are simple. This activity asks students to combine problem-solving skills and creativity to design a circuit that accomplishes a given task.

Procedure

Photocopy page 101 and place a copy by each computer. Have photocopies of page 102 available to all students or ask them to draw their designs on paper of their own. (Students can also save or print their designs at the computer. See page 15 for details on saving *Zap!* creations.)

Ask students to follow the instructions on page 101 to design and draw their circuits. Remind them that no design is “wrong” if it accomplishes the task specified. There are many ways to design successful circuits. Depending on your students’ skill, interest, and time available, ask students to simply choose one or two circuits or to complete them all.

- **Primary Emphases**
  Develop problem-solving and analysis skills; work with different kinds of switches
- **Subject Area**
  Science
- **Materials Needed**
  Zap! software; Can You Build Me a ___ ? student activity sheets (pages 101 and 102)
- **Grouping**
  Individual students or cooperative pairs

Extension

Have students write additional design challenges on index cards and leave them in a box by the computer for classmates to complete.

Calculating Current

Background

The amount of electric current flowing in a resistive circuit is proportional to the circuit's voltage. For a given voltage, the higher the resistance, the smaller the current. The relationship among current, voltage, and resistance is called Ohm's Law and can be expressed as **I = V/R**, with current (I) measured in amperes, voltage (V) in volts, and resistance (R) in ohms.

Procedure

Assess your students' math skills, then assign the appropriate Calculating Current activity sheet:

- Calculating Current I requires addition and subtraction mastery.
- Calculating Current II requires multiplication and division skills.

You may want to have advanced students start with sheet I, then complete sheet II another day.

Tip: Before you assign this activity, we recommend that students work through the Electroloft Grow Slide Topics (see page 9) up to and including Level R (using meters), to gain some experience in measuring current.

- **Primary Emphases**
  Measure current, voltage, and resistance, and understand the relationship between the three
- **Subject Areas**
  Science and Math
- **Materials Needed**
  Zap! software; Calculating Current student activity sheets (pages 103–106)

  Optional: Calculators
- **Grouping**
  Individual students

Photocopy the desired activity sheet(s) and distribute them to students. You may want to go over the introductory material at the top of Calculating Current I as a class. At the computer, ask students to follow the instructions on their sheets step by step. Make sure that students make predictions *before* experimenting in the ElectroLoft and that they write the units. You may want to allow students completing Calculating Current II to use calculators.

Math Extension

Use the activity sheets as templates to create additional problems for your students to complete either at or away from the computer.

Electric Personalities I

Benjamin Franklin

When did he live?: 1706-1790 *Where was he from?:* ____________________________

What was he?: Statesman, inventor, printer, author, and scientist

What big electric discoveries/inventions did he make?

- Franklin was one of the first people to experiment with electricity. He proved that lightning is electricity by flying a kite in a thunderstorm.
- He invented the lightning _____________________.

Fab Facts:

- Franklin went to school for only two years, from ages 8 to 10. He taught himself algebra, geometry, and science as well as five languages.
- He invented bifocals and the _____________________ stove, a more efficient wood-burning stove.
- ____

Count Alessandro Volta

When did he live?: 1745-__________ *Where was he from?:* Italy

What was he?: ____________________________

What big electric discoveries/inventions did he make?

- Volta invented an early electric battery, called the _____________________.
- He helped develop the idea of electric current flow.

What's a volt?: A unit of electrical potential, or "push". Batteries are rated in volts.

Fab Facts:

- After Volta showed his battery to Napoleon I in 1801, Napoleon made Volta a count!
- Volta invented the electrophorus, a device that produces charges of static electricity. Zap!
- ____

Andre-Marie Ampere

When did he live?: 1775-1836 *Where was he from?:* ____________________________

What was he?: Physicist and mathematician

What big electric discoveries/inventions did he make?

- Ampere discovered the laws of electromagnetism.
- He invented the galvanometer, the first meter for measuring electric current.

What's an ampere?: A unit of electrical _____________________.

Fab Facts:

- Ampere discovered that two parallel wires carrying a current attract each other when the currents run in opposite directions, and repel each other when they run the same way.
- ____

Electric Personalities II

Georg Simon Ohm

When did he live?: __________-1854 *Where was he from?:* Germany

What was he?: Physicist

What electric discoveries did he make?:

- He figured out that the amount of electrical current depends on the voltage and electrical ________ .

What's Ohm's Law?:

It says the electrical current (I) is related to the amount of voltage (V) and resistance (R), or $I = V/R$

What's an ohm?: A unit of electrical resistance.

Fab Facts:

- Ohm was a math professor in Cologne, Germany when he came up with his law. When no one in Cologne appreciated his findings, he quit and became a physics professor in Nuremberg!
- ____

Michael Faraday

When did he live?: 1791-1867 *Where was he from?:* ____________________

What was he?: Physicist and ____________________.

What big electric discoveries did he make?

- Faraday discovered that moving a magnet through a coil of copper wire causes an electric current. This lead to the invention of electric generators.

What's a farad?: A unit of electrical capacitance. Capacitors are rated in farads.

Fab Facts:

- Faraday had very little formal schooling. He taught himself about science by reading books while apprenticing as a ____.
- Faraday discovered the chemical benzene.
- ____

Thomas Edison

When did he live?: 1847-__________ *Where was he from?:* United States

What was he? ____

What big electric inventions did he make?

- Edison invented the electric light bulb in __________ (year).
- He developed and installed the world's first electric power station in New York City.

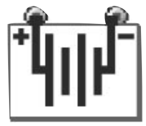
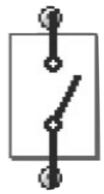
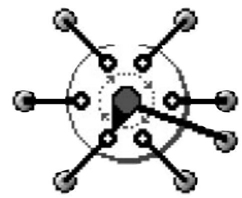
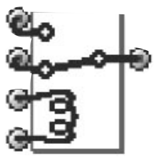
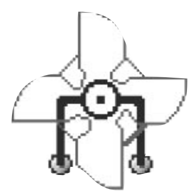
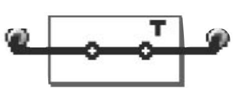
What's the Edison Effect?: The discovery that heated filaments in light bulbs give off electricity.

Fab Facts:

- Edison patented a world-record 1,093 inventions, including the phonograph (record player) and the first motion-picture viewing machine.
- Edison was given telegraph operation lessons as a reward after saving the life of a telegraph operator's child.
- ____

 Use with the "Electric Personalities" activity (page 86).

Symbol Search Cards (Sheet A)

1. 	2. 	3. 	4. 
5. 	6. 	7. 	8. 
9. 	10. 	11. 	12. 
13. 	14. 	15. 	16. 

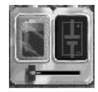
Use with the "Symbol Search" activity (page 87).

Symbol Search Cards (Sheet B)

Engineers and electricians use a special code of symbols when drawing their circuit designs. Can you crack their code?

1. Click  from Backstage, and then click 

to enter the Explore Mode of the ElectroLoft.

2. Click any of the buttons on top of the Tube. Then click  in the top left corner. Whatever is in the Tube should now look like a symbol.

3. Find the symbols on Sheet A in the Tube and write the name of each symbol on this page. Don't write on Sheet A. *Make sure the numbers of the boxes below match the numbers on the other page!* They're not in the same order.

4.	**3.**	**2.**	**1.**
8.	**7.**	**6.**	**5.**
12.	**11.**	**10.**	**9.**
16.	**15.**	**14.**	**13.**

 Use with the "Symbol Search" activity (page 87).

Will the Flow Go?

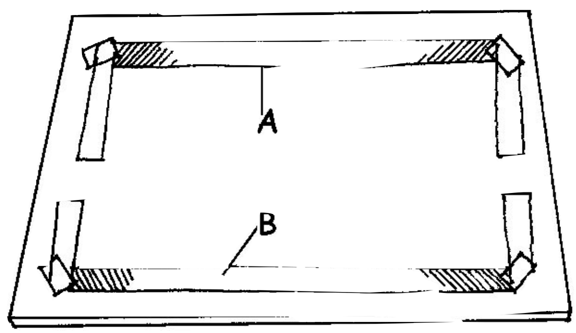
Electricity flows easily through some materials, called *conductors*. But other kinds of materials, called *insulators*, slow or stop the flow of electricity. What stops the flow and what lets it go?

Predict whether each of these objects will be an insulator (stops the flow of electricity) or a conductor (allows the flow of electricity to pass through it).

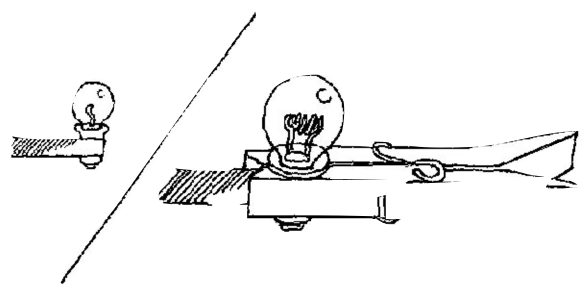
Penny: ____________________ Paper Clip: __________________

Eraser: ____________________ Plastic Button: _______________

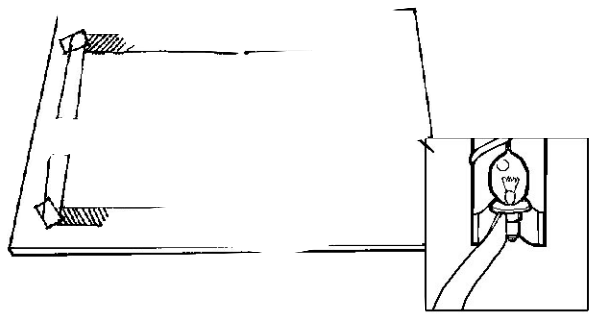
Now follow the directions below to build a circuit. When you're done, you can use your circuit to find out which materials are insulators and which are conductors.



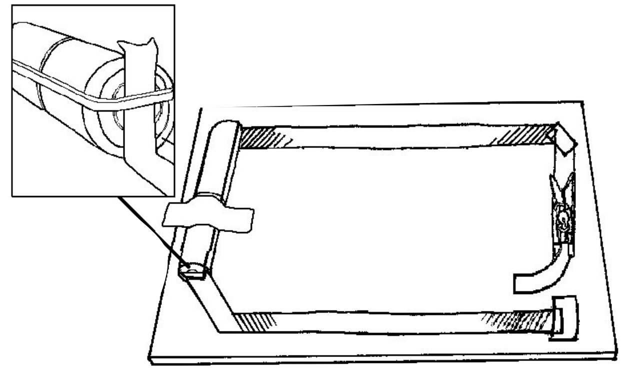
1. Set one of the long strips of foil along one long edge of the cardboard, fold up the ends, and tape them in place. (See "A," above). Then fold and tape the other long strip down on the other long edge.



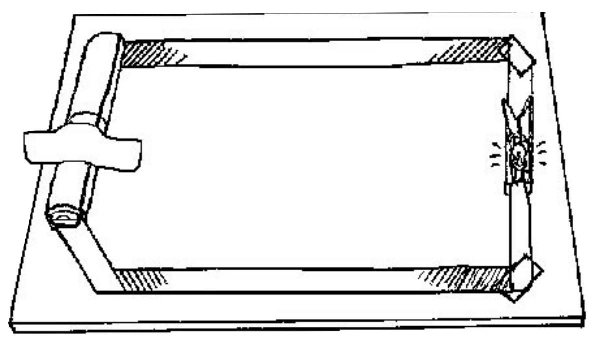
2. Fold the short foil strip in half lengthwise, so it's thinner. Wrap one end around the bulb and pinch the bulb in the clothespin.



3. Set the clothespin, with the bulb in it, on top of the end of the top foil strip. Make sure the bottom of the bulb touches the foil strip. Tape it in place.



4. Hold the two batteries so that a positive and negative end meet. Wrap a "belt" of tape around the area where the two batteries meet. Set the batteries at the end of the cardboard. Press a foil strip to each battery end. Wrap a rubber band around the foil and batteries to hold them in place. The rubber band must be tight! Then tape the batteries down.



5. The two loose ends of the foil strips make up the switch. Touch the ends together to complete the circuit. What happens? ______

____

6. Put a penny between the foil switch ends.

a. Does the bulb still light? _______________

b. Now try an eraser. Does the bulb light?

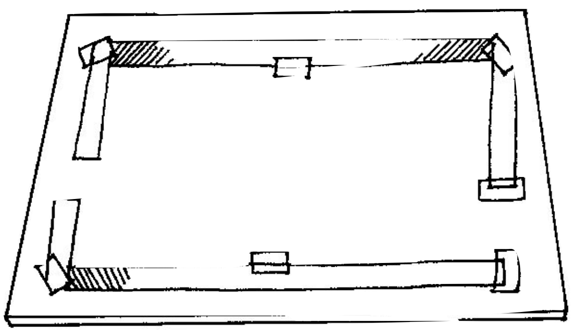
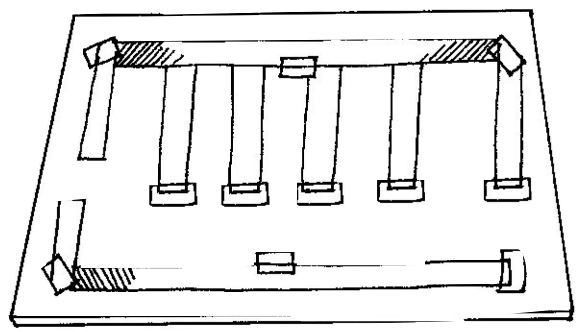
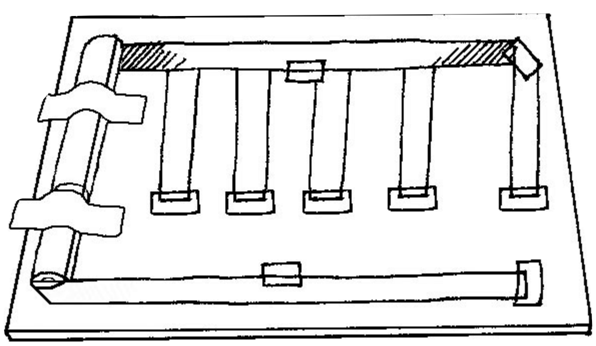
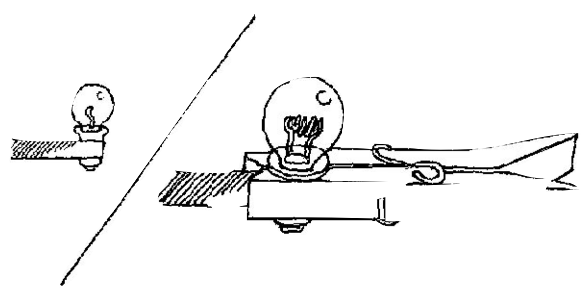
____

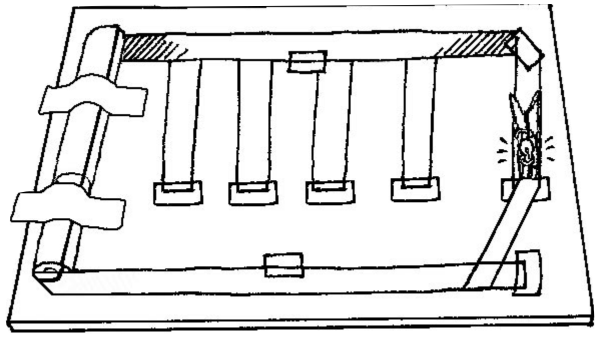
What else could you test? On a piece of paper, keep track of the items you test, and jot down whether or not the bulb lights. Do you remember the predictions you made at the start of the activity? (Look at the top of the first page.) Test as many of these objects as you can. Which materials are conductors? Which are insulators?

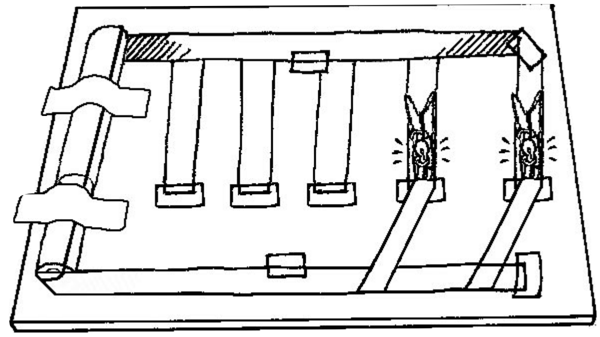
 Use with the "Will The Flow Go?" activity (page 88).

Ladder of Light

A *series circuit* is a simple closed loop, like a string of lights connected to a power source. If one of the lights on the loop breaks, the circuit is no longer complete, and none of the bulbs light. (Strings of holiday lights often work this way.) A *parallel circuit* avoids this problem, because each light has its own separate connection to the power source. If one bulb fails, the others still receive electricity, and so they light. To make and test your own parallel circuit, just follow these steps!

 **1.** Fold and tape the two longer strips of foil onto the cardboard as shown.	 **2.** Use four of the short strips to add four "arms" parallel to the far right arm, as shown above. Tape them down where they connect to the long strip and at their free ends.
 **3.** Stack the three batteries so that the positive and negative ends meet. Wrap a "belt" of tape around the area where the batteries meet. Set the batteries at the end of the cardboard. Press a foil strip to each battery end. Wrap a rubber band around the foil and batteries to hold the foil in place. The rubber band must be tight! Then tape the batteries down.	 **4.** Fold the remaining five short foil strips in half lengthwise, so they're thinner. Take one strip and wrap one end of it around a bulb. Pinch the bulb in a clothespin. Do this for all five bulbs. Set them aside.





5. Take one of the clothespins with a bulb and set it on the strip farthest from the batteries. Make sure the bottom of the bulb touches the strip! Next, touch the thin foil strip attached to the clothespin to the foil strip on the cardboard.

What happens? ______________________

____

____

6. Repeat steps 4 and 5 with a second clothespin as shown above.

What happens? ______________________

Predict: How many bulbs do you think you can add before they stop lighting?

Add a third clothespin. What happens?

____

Add a fourth clothespin. What happens?

____

Add a fifth clothespin. What happens?

____

How do the results compare to your prediction?

7. How many bulbs can your parallel circuit light?

How do you think you could add more?

8. What other changes do you notice as you add and remove bulbs?

Can You Build Me a ____ ?

Circuits, switches, and lights are useful things! Try to fill these customers' orders by designing a circuit that suits each person's particular need.

1. Click from Backstage, and then click to enter the Explore Mode of the ElectroLoft.

2. Go for it! Use any of the tools and parts to design one or more of the circuits below.

Hint: Clicking on will help you see the flow of electricity.

3. Now test your circuit to be sure it does what your customer ordered.

4. When you've built the circuit you want, decide how you want to draw it—as it looks now or using schematic symbols. Click a few times to help you decide. Then draw your plans on another sheet of paper. Make sure to label the parts of your diagram!

1. I need a string of colored flashing lights for my gas-station sign.	**5.** I want a set of four garage lights, connected so they won't all shut off if one bulb burns out or becomes disconnected.
2. I'd like a horn that can be turned on and off with a switch.	**6.** Can you wire my boat with a heater with a two-way switch: one way for low heat and one way for high heat?
3. Can you hook up an apartment doorbell that rings only when a button is pushed and held down?	**7.** I'd like a lamp that has both a bright and a dim setting, for reading in bed.
4. My bakery needs a fan that always runs unless a button is held down to turn it off.	**8.** Can you make me a fire alarm that will ring for 15 seconds after its switch is hit and then stop?

My Plan For ______________________

Draw a diagram of your device.

 Use with the "Can You Build Me a ______?" activity (page 91).

Calculating Current I

An electric circuit is a pathway for the flow of electric *current*. How much current flows through a circuit depends mainly on two things:

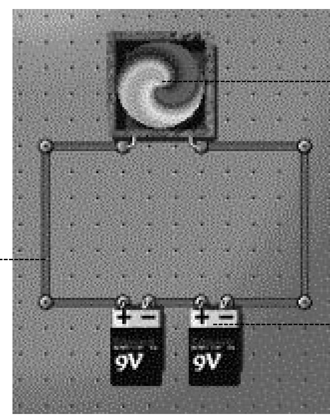
1. The strength of the power source (for example, a battery's *voltage*).

2. The total resistance in the circuit from devices such as bulbs and fans.

The more batteries you add to a series circuit, the higher the voltage will be. More current will be pushed through the circuit. The more devices you add in series, the higher the resistance to the current flow will be. The current will decrease. The relationship among current, resistance, and voltage is called *Ohm's Law*. The law is named after Georg Ohm, who discovered it. Come explore Ohm's Law in the ElectroLoft!

1. Click  from Backstage. Then click  to enter the Explore Mode of the ElectroLoft.

2. From the Tube, take out a spinner and two 9-volt batteries. Use them to build the circuit shown below. Make sure the spinner is spinning. You can click  to see the flow of electricity.



3. Look at the two batteries. Their "push," or voltage, is measured in volts. Add the two batteries' voltages together to calculate this circuit's total voltage. What is the voltage of this circuit? ________

4. Now check your prediction using the voltmeter. Click the  in the Multi-Meter to open the voltmeter. Take out the + probe and place it on the "+" sign of the left battery. Then take out the - probe and place it on the "-" sign of the right battery. Read the voltage in the voltmeter. (Having trouble? Click —in the lower right corner of the screen—and go to the "voltmeter" page for help.) What is the voltmeter reading?____

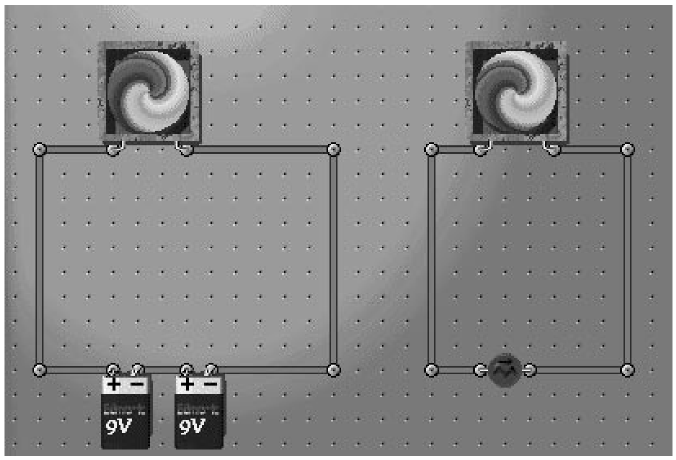
Does it match your prediction? ____

5. What's the resistance of the circuit? Resistance is measured in ohms. Remember, resistance comes from devices connected in the circuit. What adds resistance to this circuit? ____________________

How much? ____

(**Hint:** Hold the cursor over it to find out.)

6. You can check the resistance of devices by hooking them up to an ohmmeter. Next to your first circuit, build a new circuit that includes one spinner but **no** batteries. Then click Ohms in the Multi-Meter to open the ohmmeter. Drag an ohmmeter over to the new circuit and connect it with wires, as shown below. (Having trouble? Click ◀—in the lower right corner of the screen—and go to the "ohmmeter" page for help.) What does the ohmmeter read? ______________________
Is it the same as your prediction in step 5? ______________________



What would happen if you added a second spinner in series with the spinner connected to the ohmmeter? Would the resistance increase or decrease? ______________________
Hook up another spinner and find out. What happens? ______________________

____

7. Go back to your battery circuit. You know the voltage from step 4 and the resistance from step 5. But what is the current of the circuit? Current is measured in amperes or amps. Click Amps in the Multi-Meter to turn on the ammeter. Drag the ammeter to the circuit and hook it up to one of the wires. (Having trouble? Click ◀—in the lower right corner of the screen—and go to the "ammeter" page for help.) What does the ammeter read?______________________

What would happen if you added the second spinner in series to the battery circuit? Would the current increase or decrease? ______________________
Hook up the spinner and find out. What happens? ______________________

____

Calculating Current II

The relationship between current in amperes, voltage in volts, and resistance in ohms is called Ohm's law, or:

CURRENT = VOLTAGE ÷ RESISTANCE

Put your knowledge of Ohm's Law to the test by experimenting with circuits in the ElectroLoft! Click from the Main Menu. Then click Explore to enter the Explore Mode of the ElectroLoft. Set up each of the circuits below and fill in the blanks. You can use the Multi-Meter and the available information about the objects to find a circuit's voltage, resistance, and current. Make sure to write in the units, too!

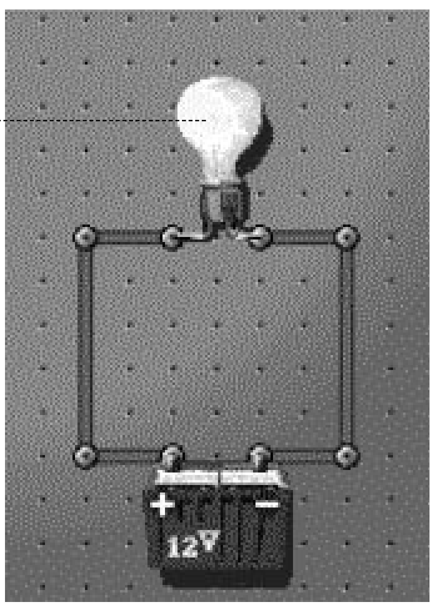
TO FIND VOLTAGE: Add together the volts on all the batteries. Then check your prediction with the voltmeter.

TO FIND RESISTANCE: Add together the ohms on *all* the devices. Then check your prediction with the ohmmeter. (**Important:** you'll need to temporarily remove the batteries to use the ohmmeter. Click and go to the "ohmmeter" page if you need help.)

TO FIND CURRENT: Divide the total voltage by the total resistance. This is the Calculated Circuit Current. Then re-attach the batteries and check your prediction with the ammeter. This is the Ammeter Circuit Current. Does it match the circuit current you calculated? It should!

1.

30-watt bulb



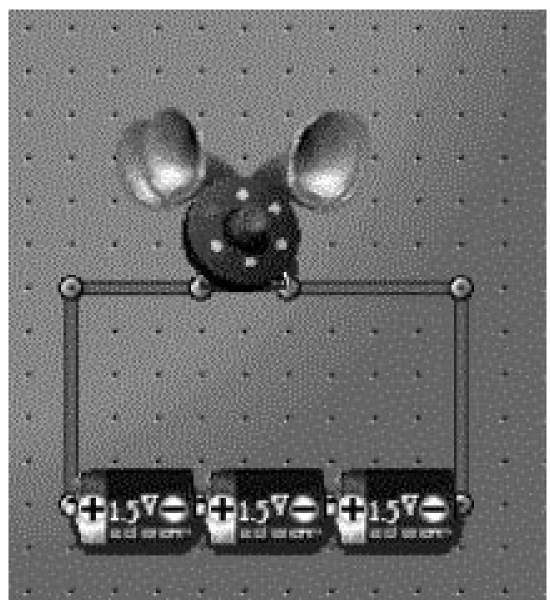
Circuit Voltage: ____________________

Circuit Resistance: ____________________

Calculated Circuit Current: ____________

Ammeter Circuit Current: ______________

2.



Circuit Voltage: ____________________

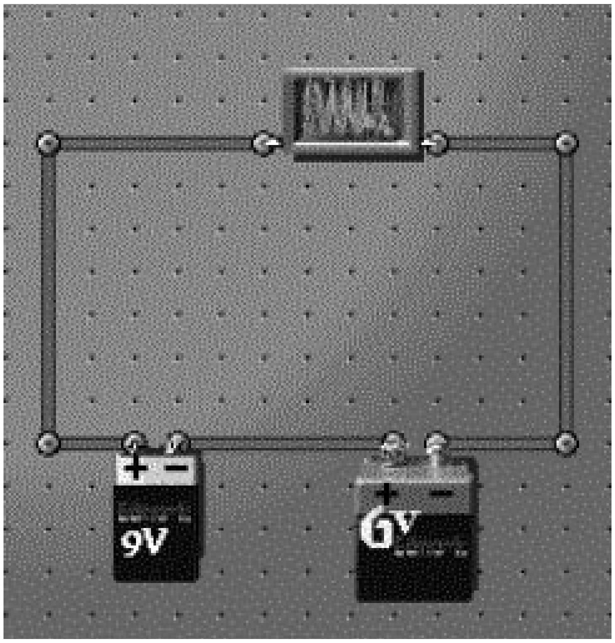
Circuit Resistance: ____________________

Calculated Circuit Current: ____________

Ammeter Circuit Current: ______________

Use with the "Calculating Current" activity (page 92).

3.



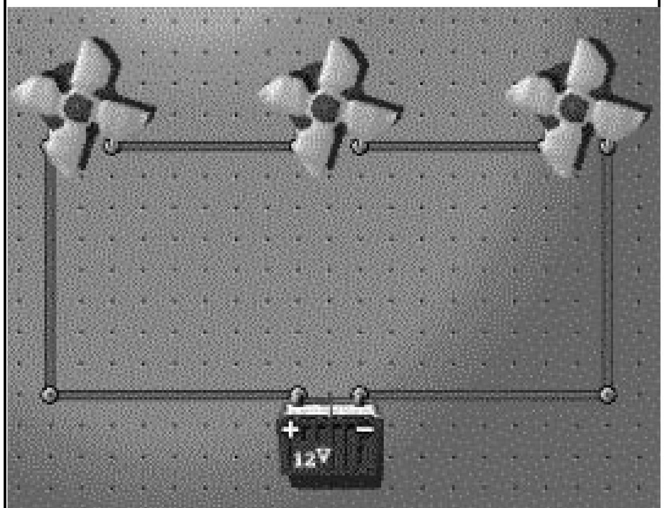
Circuit Voltage: ____________________

Circuit Resistance: ____________________

Calculated Circuit Current: ____________

Ammeter Circuit Current: ______________

4.



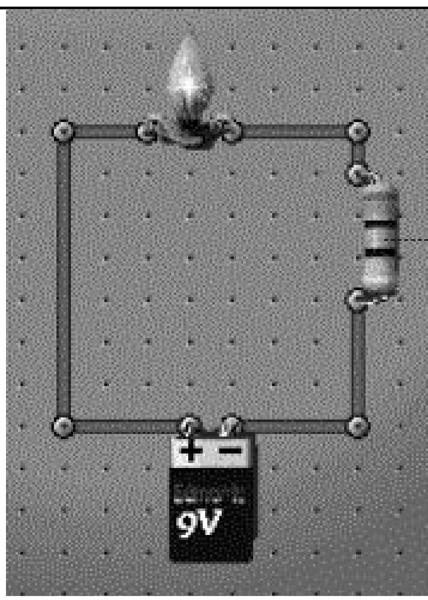
Circuit Voltage: ____________________

Circuit Resistance: ____________________

Calculated Circuit Current: ____________

Ammeter Circuit Current: ______________

5.



10-ohm resistor

Circuit Voltage: ____________________

Circuit Resistance: ____________________

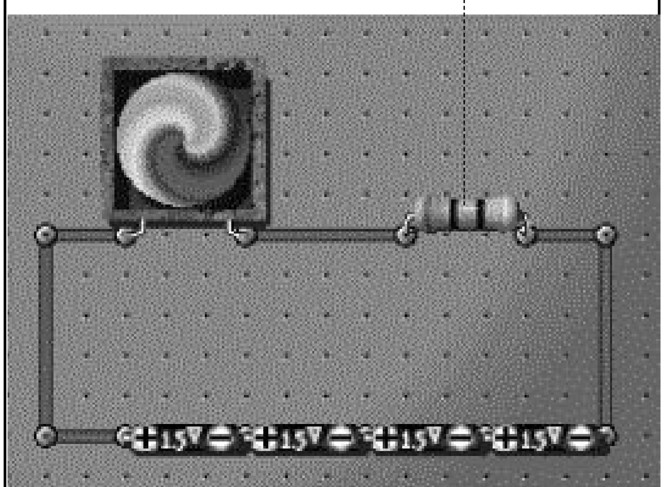
Calculated Circuit Current: ____________

Ammeter Circuit Current: ______________

Remove the resistor and reconnect the wires. What happens?

6.

10-ohm resistor



Circuit Voltage: ____________________

Circuit Resistance: ____________________

Calculated Circuit Current: ____________

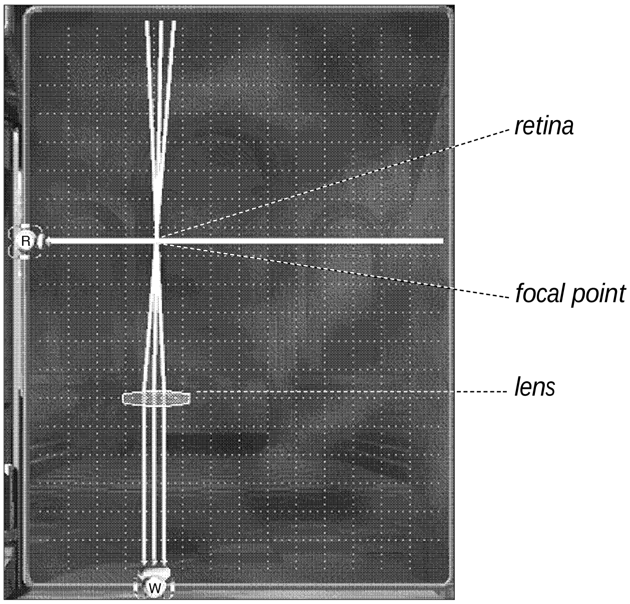
Ammeter Circuit Current: ______________

Remove the resistor and reconnect the wires. What happens?

Laser Lab Answer Keys

Get in Focus

3. and **4.**



6. No; before

7. A concave lens with a shallow curve.

8. No; after

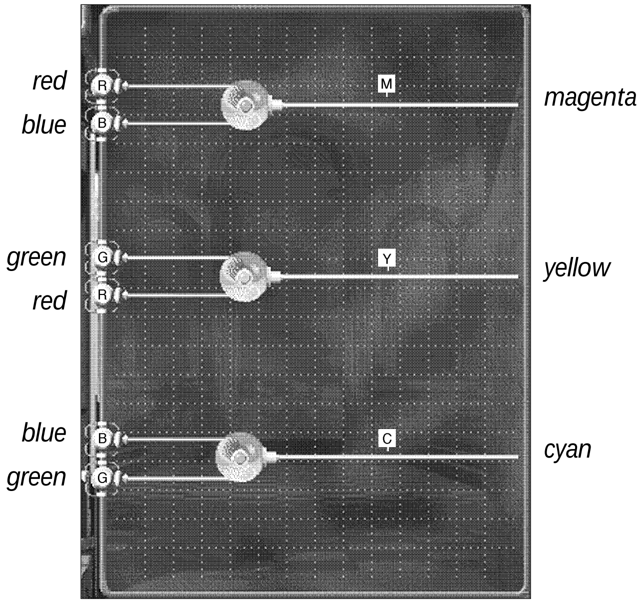
9. A convex lens with a shallow curve.

Challenge. Use a cyan light splitter.

(continued)

Mix it Up

2. Student predictions will vary.

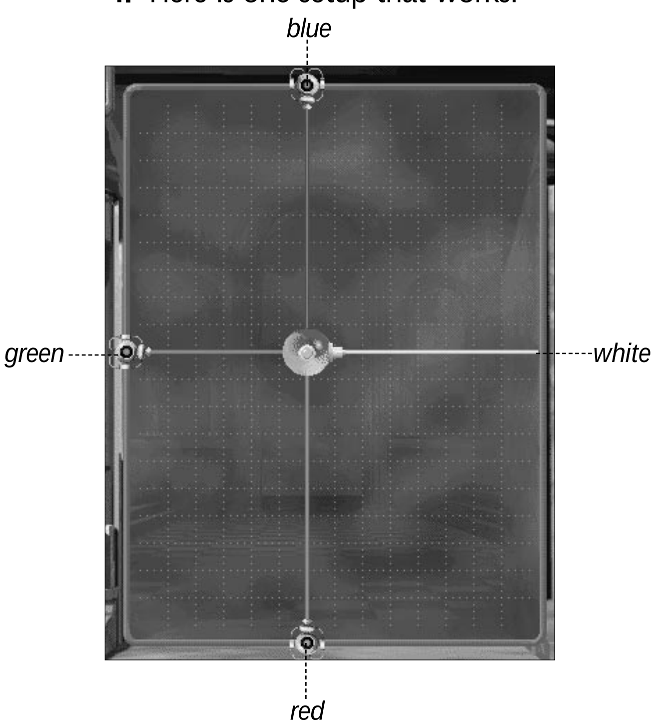


3. **a.** blue **b.** red **c.** green

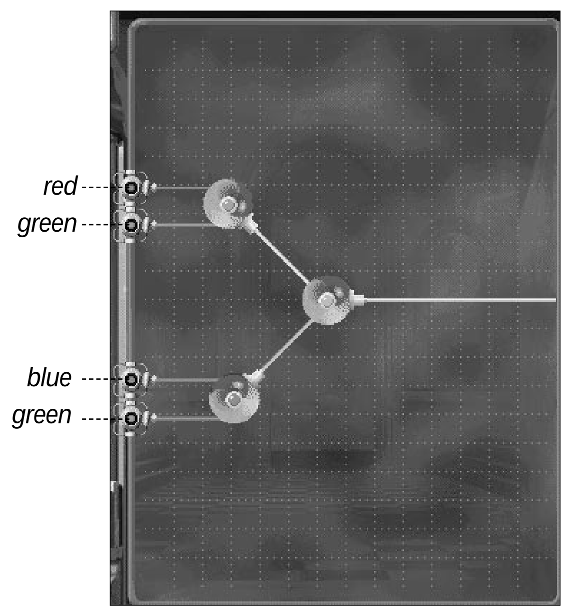
OR

a. red **b.** green **c.** blue

4. Here is one setup that works:

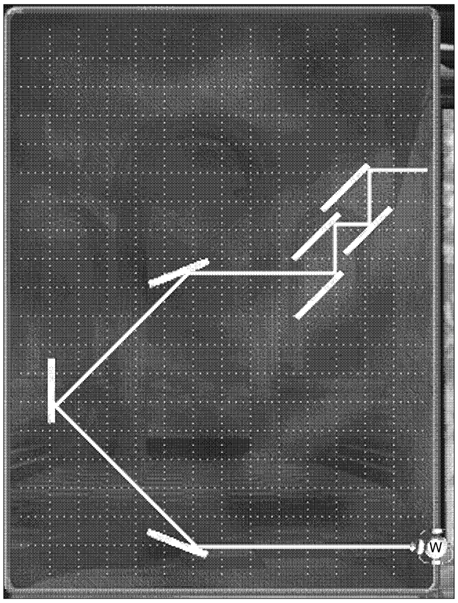


5. Here is one setup that works:

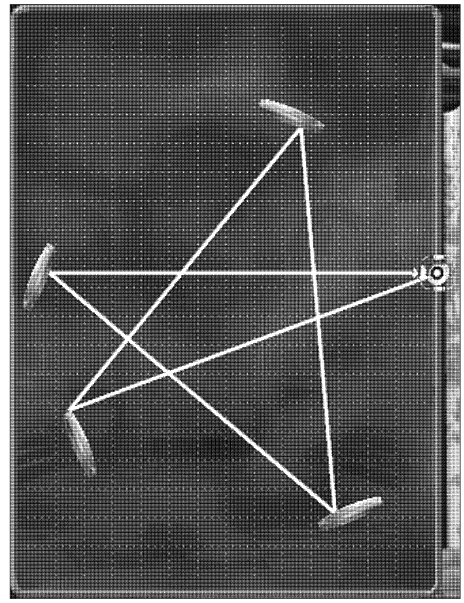


DeLIGHTful Creations

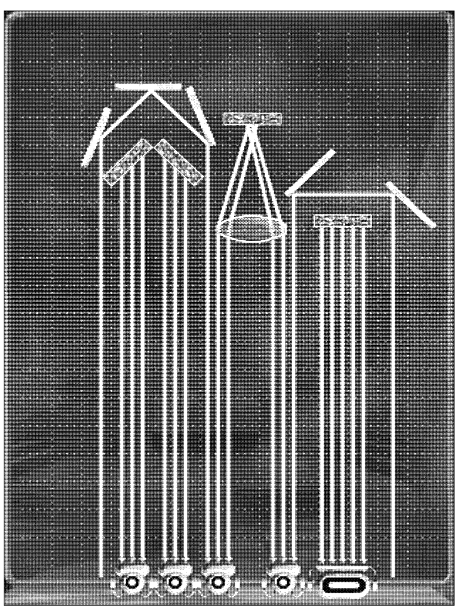
Home Sweet Home



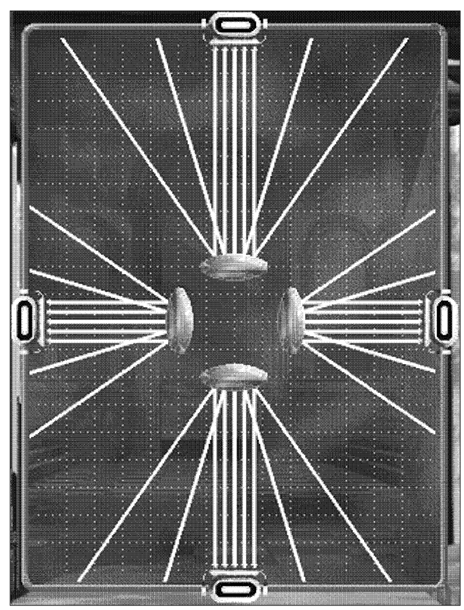
Star Light, Star Bright



Sky Scrapers



Sun Rays



Sound Wave Studio Answer Keys

Who's Dancing Now?

5. Blue BugBot: The specific sounds students use will vary, but they should be loud (big amplitude) and high-pitched (high frequency).

6.
- Blue SpaceBot: The specific sounds students use will vary, but they should be soft (small amplitude) and high-pitched (high frequency).
- Red SpaceBot: The specific sounds students use will vary, but they should be soft (small amplitude) and low-pitched (low frequency).
- Red BugBot: The specific sounds students use will vary, but they should be loud (big amplitude) and low-pitched (low frequency).

12. Answers will vary, depending on the student's voice and the sensitivity of the microphone.

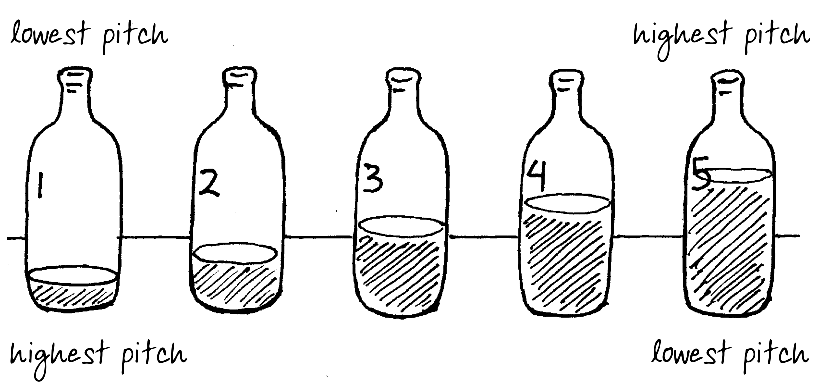
Chart: The answers will vary, depending on the student's voice and the sensitivity of the microphone. In general, +2 amplitudes will cause more BugBots (big amplitude) to dance and -2 amplitudes will cause more SpaceBots (small amplitude) to dance; +2 frequency will cause more blue Bots (high frequency) to dance while -2 will cause more red Bots (low frequency) to dance.

Strike Up the Band (Part 2)

Chordophone: tissue box guitar
Aerophone: straw pan pipes
Membranophone: drums
Idiophone: margarine tub maraca

Bottle Bells and Water Whistles

Air Blown Across



Glass Tapped Below Water Line

4. a. long
b. lower

5. a. short
b. higher

7. a. lighter
b. higher

Challenge: A bottle is an idiophone when tapped. A bottle is an aerophone when blown across.

Build a Better Phone

Answers will vary.

ElectroLoft Answer Keys

Electric Personalities

Note: Students' "Fab Facts" will vary.

Franklin:

- He was from the American Colonies and later the United States.
- He invented the lightning rod.
- He invented bifocals and the Franklin stove, a more efficient wood-burning stove.

Volta:

- He lived 1745-1827.
- He was a physicist..
- Volta invented an early electric battery, called the voltaic pile.

Ampere:

- He was from France.
- An ampere (amp) is a unit of electrical current.

Ohm:

- He lived 1789-1854.
- He figured out that the amount of electrical current depends on the voltage and electrical resistance.

Faraday:

- He was from England (or Great Britain).
- He was a physicist and chemist.
- Faraday had very little formal schooling. He taught himself about science by reading books while apprenticing as a bookbinder.

Edison:

- He lived from 1847-1931.
- He was an inventor.
- Edison invented the electric light bulb in 1879.

Symbol Search Cards (Sheet B)

1. Car Battery
2. Wall Switch
3. Capacitor
4. Distributor
5. Relay Switch
6. Fuse
7. Resistor
8. Light Bulb
9. Single Knife Switch
10. Teardrop Light Bulb
11. Fan
12. D Battery
13. Thermal Switch
14. Push Off Button
15. Push On Button
16. Heater

Will the Flow Go?

Student predictions about whether materials are conductors or insulators will vary. If they test the actual objects, they will find that a penny and a paper clip are both conductors; an eraser and a plastic button are both insulators.

5. The bulb lights.

6. a. Yes, the bulb still lights.
b. No, the bulb does not light.

Ladder of Light

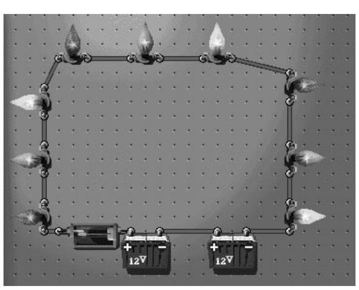
5. The bulb lights.

6. Answers will vary. Depending on the voltage of the bulb used, the bulbs may stop lighting when you add a second bulb, third, fourth, fifth, or more.

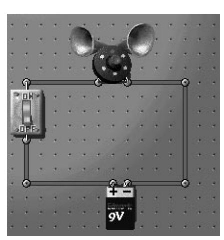
Can You Build Me a ____ ?

Note: These are only some of many possible answers. Any circuit that accomplishes the job is correct!

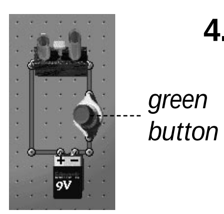
1.



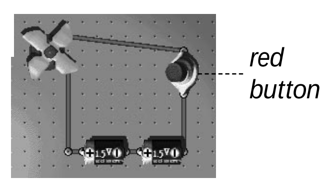
2.



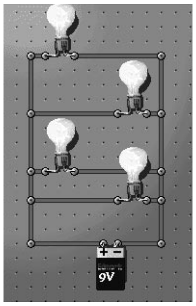
3.



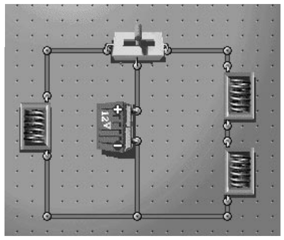
4.



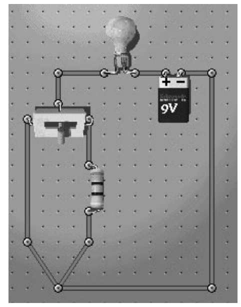
5.



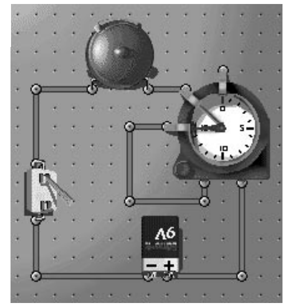
6.



7.



8.



Calculating Current I

3. 18 volts

4. 18 volts; yes

5. spinner; 5 ohms

6. 5 ohms; yes; increase (predictions will vary, but “increase” is a correct prediction); resistance increases to 10 ohms

7. 3.6 amps; decrease (predictions will vary, but “decrease” is a correct prediction); current decreases to 1.8 amps

Calculating Current II

1.
Circuit Voltage: 12 volts
Circuit Resistance: 5 ohms
Calculated Circuit Current: 2.4 amps
Ammeter Circuit Current: 2.4 amps

2.
Circuit Voltage: 4.5 volts
Circuit Resistance: 5 ohms
Calculated Circuit Current: 0.9 amps
Ammeter Circuit Current: 0.89 amps

3.
Circuit Voltage: 15 volts
Circuit Resistance: 5 ohms
Calculated Circuit Current: 3.0 amps
Ammeter Circuit Current: 3.0 amps

4.
Circuit Voltage: 12 volts
Circuit Resistance: 15 ohms
Calculated Circuit Current: 0.8 amps
Ammeter Circuit Current: 0.8 amps

5.
Circuit Voltage: 9 volts
Circuit Resistance: 15 ohms
Calculated Circuit Current: 0.6 amps
Ammeter Circuit Current: 0.6 amps

What happens? The current increases and the bulb blows.

6.
Circuit Voltage: 6 volts
Circuit Resistance: 15 ohms
Calculated Circuit Current: 0.4 amps
Ammeter Circuit Current: 0.4 amps

What happens? The current increases and the spinner speeds up.

Troubleshooting—Windows

All Windows Users

Q.The program was working fine yesterday, but today it won't run properly. What's wrong?

A. Many problems of this sort can be traced to a problem reading the CD. A common cause is a user leaving fingerprints (or peanut butter) on the blank side of the CD. Use a soft, dry cloth to gently wipe the blank side of the CD until it is clean.

Q.Why does the sound skip during the opening screen?

A. Skipping sound can be caused by outdated sound drivers or low speed (2X or less) CD-ROM drives. Try updating your sound drivers to correct the problem. (See *Where can I find updated drivers?,* below.)

Q.What is the purpose of updating the drivers on my computer?

A. Hardware drivers—such as video, sound, and CD-ROM drivers—provide the interface between your hardware and the Windows operating system. Upgrading drivers corrects incompatibilities in older versions and adds new utilities and features to the computer. (See *Where can I find updated drivers?,* below.)

Q.Where can I find updated drivers?

A. If you have Internet access, you can often download free updated drivers. Check the home pages of the company that manufactured your computer, video card, sound card, or CD-ROM drive. If you do not have Internet access, call the manufacturer to inquire about updated drivers. (Check the user's manual for phone numbers.)

Windows 95/98

Q.My screen shifts when I launch the program, preventing me from seeing the whole screen.

A. Use the controls on your monitor to adjust the placement and size of the screen so that the program is visible. If this doesn't work, check your video card and monitor manuals for information on adjusting screen placement.

Q.Why do I receive "Invalid Page Fault" or "Illegal Operation" errors when I run the program?

A. There are many possible reasons for this problem. Following these steps will help you eliminate the most common causes:

- Quit all applications and make sure no programs are running in the background.
- Check the LOAD= and RUN= lines of the **WIN.INI** file and ensure that they are blank. (Use the "**Find**" utility to search for the WIN.INI file on your computer if you are unsure of its location.)

- Ensure that your sound, video, and CD-ROM drivers are the latest versions available. (See *What is the purpose of updating the drivers on my computer*, above.)
- Try uninstalling your printer and running the program. After doing this, if the program works correctly, try downloading the latest printer drivers from the printer manufacturer's home page on the Internet, or contacting the printer manufacturer to find out about any known issues with your printer driver.

Windows 3.1

Q.Why do I receive Win32s errors when I try to launch the program?

A. Win32s errors are typically caused by one of two things: incorrect/incomplete Win32s setup or conflicts with video and sound drivers. Here are three steps you can take to try to correct the problem:

- Insert the Edmark CD and run D:\EDINST\WIN32S\SETUP.EXE to reinstall Win32s.
- In Windows Setup, open Display and select the SVGA drivers (available on the Edmark CD in the D:\EDINST\SVGA directory).
- Update your sound card and video card drivers. Many older drivers conflict with Win32s. (See *Where can I find updated drivers?*, above.)

Q.Why am I receiving the error message "Unexpected DOS error 21"?

A. This error message usually indicates lost or corrupt data on your hard drive. To correct the problem, try following these steps:

1. Delete the Edmark program from your hard drive.
2. Delete the C:\WINDOWS\SYSTEM\WIN32S directory.
3. Delete C:\WINDOWS\SYSTEM\w32sys.dll.
4. From DOS, run SCANDISK.EXE or CHKDSK.EXE and fix any problems on the hard drive.
5. Reinstall the Edmark program.

If you need more assistance, please contact Edmark technical support by phone, fax, or e-mail (see page 117).

Troubleshooting—Macintosh

Q.The program's icon does not appear on my desktop. What's wrong?

A. Some extensions needed to run the CD-ROM may be missing. These extensions include: Apple CD-ROM • Apple Audio CD • Foreign File Access • High Sierra File Access • ISO 9660 File Access. Some non-Apple CD-ROM drives are packaged with a different set of extensions. For information about these drives, please refer to your CD-ROM drive manual.

- *If you are using System 7.1 or lower*, correct the problem by opening the Extensions Folder (in your System Folder) and ensuring that these extensions are installed and enabled.
- *If you are using System 7.5 or higher*, correct the problem by opening the Extensions Manager control panel and enabling these extensions.

Q.The program was working fine yesterday, but today it won't run properly. What's wrong?

A. Many problems of this sort can be traced to a problem reading the CD. A common cause is a user leaving fingerprints (or peanut butter) on the blank side of the CD. Use a soft, dry cloth to gently wipe the blank side of the CD until it is clean.

Q.Why do I keep receiving a "Not enough memory" error message?

A. You may be running low on RAM; check the amount of RAM you have available by opening the Apple menu from the desktop and selecting About This Macintosh. There are four basic ways to solve this problem.

1. *Quit all applications before you launch the program.* (To see which applications are open, click the Application menu. The menu is found in the upper right-hand corner of the screen; look for the icon of the currently active application.) Quit all applications on the list—except the Finder—then run the program.
2. *Reduce the number of extensions loading at startup.* Use the Extension Manager control panel to select just the set that came with your System Software (for example, "System 7.5 Only").
3. *Open the Memory control panel and turn on Virtual Memory*. (However, use of Virtual Memory may result in poorer sound quality and general performance on some computers.)
4. *Add more RAM to your computer.*

If you need more assistance, please contact Edmark technical support by phone, fax, or e-mail (see page 117).

Contacting Edmark

Edmark Phone Numbers and E-Mail Addresses

- **Customer Service:** To order products or inquire about a purchase, call (800) 362-2890. (Please note that technical support is not available at this number.) You can also reach Customer Service by e-mail at edmarkteam@edmark.com.
- **Technical Support:** To inquire about a specific technical problem, please call (800) 528-7158, or fax a description of your problem to us at (425) 556-8940, Attn: Technical Support. (Please see *Contacting Technical Support*, below, for more information.)
- **Online Technical Support:** Reach our online representatives directly by e-mail at pctech@edmark.com or mactech@edmark.com.
- **World Wide Web:** Visit the Edmark home page at www.edmark.com, where you can read answers to frequently asked questions or send a message to our technical support staff.

Contacting Technical Support

Edmark products are designed for enjoyable and easy use. If a problem does arise, first consult the Troubleshooting pages in this Guide. (If you are a Windows user, please be sure to check the Help file installed with this product. For Windows 95/98, go to Start | Programs | Edmark | Zap!; for Windows 3.1, go to the Edmark group in the Program Manager.) If you do not find a solution, please call Edmark Technical Support, Monday through Friday, 8 a.m. to 6 p.m. (Pacific Time), at (800) 528-7158. Extended hours, evenings and weekends, vary by season.

In order for us to help you when you call, please have the following details available:

- The exact type of computer you are using, including the brand name and model (for example, IBM Aptiva 133 MHz Pentium or Power Macintosh 6500).
- Additional hardware information such as memory available, sound card, etc.
- System settings and operating system information (for example, Windows 98 or Mac OS 8.1).
- A detailed description of the problem, including specific error messages, your input before the problem occurred, etc. The more information you give us, the faster we can solve your problem.

Please have your computer turned on and ready to use. If possible, call from a nearby phone.

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KidDesk Internet Safe – PreK to 6th Grade
Personalized desktops give students access to teacher-defined Web sites, CDs, and programs, while locking out inappropriate Web sites and preventing unauthorized "surfing." The program allows students to work independently as it helps prevent applications and computer settings from being altered or deleted.
For Windows 95/98

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Five activities full of challenging problems cover basic Earth, life and physical science topics, and stimulate students' natural interest in the subject as they develop important problem-solving and science process skills.

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Three amazing learning labs introduce students to the science of light, sound, and electricity. Students experiment with lasers, sound waves, and circuits while solving problems and building scientific understanding.

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Zoo Zillions® – K to 2nd Grade
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Number Heroes® – 3rd to 6th Grade
Four math superheroes help students explore fractions, 2D geometry, probability, addition, subtraction, multiplication, division, and decimals.

Calculating Crew® – 3rd to 6th Grade
With the superheroes of *Calculating Crew* by their side, students learn about multiplication and division of whole numbers and decimals, number line concepts, 2D and 3D shapes and their properties, and money transactions.

Cosmic Geometry™ – 7th to 10th Grade
Students travel to a planet where they learn about attributes of shapes and solids, constructions, transformations, 2D and 3D coordinates, and the relationship between length, perimeter, area, and volume.

Astro Algebra® – 7th to 9th Grade
Features variables, expressions, equations and inequalities, patterns, functions, graphing, ratio and proportion, operations with fractions, decimals, and percentages.

Thinkin' Things® Series

Thinkin' Things FrippleTown™ – PreK to 3rd Grade
As they explore *FrippleTown,* students practice thinking strategies: analyzing attributes, using logic, working backward, identifying multiple solutions, and exercising creativity. These skills help students think more analytically, clearly, and independently.

Thinkin' Things Collection 1 – PreK to 4th Grade
Oranga Banga and other Thinkin' Things help students build memory, problem-solving, logic, and other thinking skills.

Thinkin' Things Collection 2 – 1st to 6th Grade
Students further develop memory, creativity, spatial awareness, and other higher-level thinking skills.

Thinkin' Things Collection 3 – 3rd to 8th Grade
Stocktopus and friends challenge students to develop logical reasoning, analyze and synthesize information, and build key problem-solving skills.

Thinkin' Things Sky Island Mysteries™ – 3rd to 7th Grade
Students solve 14 mysteries while developing skills for cross-curricular success, including: communication through multimedia, time and resource management, decision-making, and problem-solving.

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Strategy Challenges® Collection 1 – 3rd Grade and Up
Through classic games, students build effective strategies that can be used to solve problems across all academic subject areas and throughout life.

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Let's Go Read!™ Series

Let's Go Read!™ 1: An Island Adventure® – PreK to K
Robby and Emily join students on a fun-filled adventure as they learn to read! With innovative IBM® Speech Recognition technology, over 175 lessons and 12 interactive books, your students will develop reading skills, comprehension, and vocabulary to last a lifetime!

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Ocean – K to 8th Grade
Time Trip, USA® – K to 8th Grade
Pyramids – K to 8th Grade

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Provides a step-by-step environment for learning 275 vocabulary words and 186 plurals in English and Spanish.

Apple II Software for Students with Special Needs

Edmark has a rich tradition of offering excellent software designed for students with special learning needs. Students with language delays, English as a Second Language (ESL) students, and students with developmental disabilities especially benefit from the speech component included in most of the Apple II software listed below:

Edmark Reading Program Software
Edmark Functional Word Series Software
Vocabulary SkillBuilder Series
Early Concepts SkillBuilder Series
Number SkillBuilder Series
Letter Recognition SkillBuilder Series
School Activity SkillBuilder Series
Community Activity SkillBuilder Series
TouchMoney
Touch 'N See
Touch 'N Match
PuzzleMaker
Edmark LessonMaker

TouchWindow®

The TouchWindow provides an easy, low-cost way to achieve touch access and is one of the most direct and natural ways to interact with computer software.

Are you interested in more information? We will be happy to send you a FREE catalog. Call (800) 362-2890.

The Edmark Story

In the late 1960s, a group of educators at the University of Washington developed a dramatically different way to teach reading. This new method was remarkably effective with students who were unsuccessful using other programs. By slowly building skills, it ensured success and a feeling of confidence. The students who used this method began to believe in themselves and in their ability to read.

In 1970, the Edmark Corporation was formed to make this reading method and other quality educational products available to a broader market. Edmark's mission was to apply advanced educational concepts to the development of quality classroom materials. Since then, Edmark products have been used extensively in classrooms nationwide, and teachers have been vocal in their praise. "So much magic in one box!" wrote one. "Some of my students wouldn't be reading without Edmark's help."

Twenty-nine years later, Edmark continues to find new ways of empowering children to learn. Recognizing the computer as a powerful educational tool, we have developed a family of engaging, creative software products based on proven educational concepts.

Our *Early Learning Series, Thinkin' Things Series, Imagination Express Series, Strategy Series, Mighty Math Series,* and *KidDesk Family Edition* have received critical acclaim and major awards for educational excellence and innovation from educators, parents, and software experts. *Let's Go Read! 2: An Ocean Adventure, KidDesk Internet Safe, Travel the World with Timmy,* and three products in the *Thinkin' Things Series (FrippleTown, Toony the Loon's Lagoon* and *Galactic Brain Benders*) are the newest additions to our growing family of products.

At Edmark, we're driven by the wondrous look of children learning something new. Our goal is to ensure that if Edmark's name is on the box, there's a world of learning inside.

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Ignite the Curious Mind®