These are the activities that define a child’s classroom experience, the lessons students remember long after they have moved on to the next grade level.

A collection of popular “Tried and True” columns originally published in the award-winning journal Science Scope, this volume offers the best versions of science teaching classics. Written by fellow teachers, these activities have been tweaked, time-tested, and classroom-approved. Activity sheets, sample data tables, connections to the National Science Education Standards, and more are often included.

Science Scope editor Inez Fugate Liftig, an educator with more than 40 years of classroom experience, has carefully selected and organized these 40 gems. Sections consist of “Instructional Strategies,” including “Developing Inquiry Skills” and “Classroom Management,” as well as each major science discipline: life science, Earth and space science, physics, and chemistry.

From novel approaches to age-old problems—such as “Peanut Butter and Jelly Science,” which helps kids appreciate the importance of clear scientific writing—to hands-on activities—“Solar System in the Hallway,” for example, which enables students to grasp the magnitude of our solar system using rulers and floor tiles—to meaningful field trips—see “The View at the Zoo”—this book offers lessons that pique students’ interests and impart essential science know-how. These ageless activities will fit easily into your middle school science curriculum and serve as permanent go-to resources.
tried & true
tried & true

TIME-TESTED ACTIVITIES FOR MIDDLE SCHOOL

Edited by Inez Fugate Liftig
CONTENTS

 Preface
 by Inez Fugate Liftig ix

 PART 1. INSTRUCTIONAL STRATEGIES

 DEVELOPING INQUIRY SKILLS

 Chapter 1. Taking Flight With an Inquiry Approach
 by Kathryn Silvis 1

 Chapter 2. Thinking Spatially: Taking Observation, Classification, and
 Communication Skills to a Higher Level of Reasoning
 by Douglas Llewellyn 7

 Chapter 3. Looking for Questions
 by Susan German 11

 Chapter 4. Peanut Butter and Jelly Science
 by Donna Farland 15

 Chapter 5. Write It, Do It
 by Erin Peters 17

 Classroom Management

 Chapter 6. It’s as Simple as Shuffling Cards
 by Mary Pella-Donnelly 21

 Chapter 7. Traffic Control Tips for Hands-On Labs
 by Tricia Hill 23

 PART 2. LIFE SCIENCE ACTIVITIES

 Chapter 8. Disrupted Food Webs: Exploring the Relationship Between
 Overfishing and Dead Zones in the Chesapeake Bay
 by Yael Wyner 25

 Chapter 9. Inquiry-Based Environmental Science Investigations With the Fantastic Fruit Fly
 by Ashlie M. Beals and Rebecca M. Krall 35

 Chapter 10. Investigating Ecosystems in a Biobottle
 by Arnica Breene and Donna Gilewski 43
Chapter 11. Feeding of *Diarmis Proboscis*  
*by* Jocelyn Young  
49

Chapter 12. Soil Is More Than Just Dirt  
*by* Carrie Taylor and C. John Graves  
53

Chapter 13. Inquiring About Water Quality  
*by* Margaret Dacko and Robbie Higdon  
59

Chapter 14. The View at the Zoo: Using a Photographic Scavenger Hunt as the Basis for an Interdisciplinary Field Trip  
*by* Lynn Gilbert, Pamela Breitbarth, Matthew Brungardt, Carrie Dorr, and Meena Balgopal  
63

Chapter 15. Cell Organelle Employment Advertisements  
*by* Rebekah Hammack  
69

Chapter 16. Presenting Mitosis  
*by* Stephanie Roche and Donna R. Sterling  
73

Chapter 17. Helicopter Seeds and Hypotheses … That’s Funny!  
*by* Leslie Wampler and Christopher Dobson  
77

Chapter 18. A Touch of Neuroscience  
*by* David Parlier and Melissa K. Demetrikopoulos  
81

Chapter 19. How the Brain Visually Perceives the World  
*by* Rogene M. Eichler West  
85

**PART 3. EARTH AND SPACE SCIENCE ACTIVITIES**

Chapter 20. Chipping Away at the Rock Cycle  
*by* Debi Molina-Walters and Jill Cox  
91

Chapter 21. Rock Cycle Project: Rock and Rap CD Cover  
*by* Sandra Rutherford and Cindy Corlett  
95

Chapter 22. Volcano Résumés  
*by* Sandra Rutherford and Cindy Corlett  
101

Chapter 23. How Old? Tested and Trouble-Free Ways to Convey Geologic Time  
*by* Renee Clary and James Wandersee  
105

Chapter 24. Solar System in the Hallway  
*by* Malonne Davies, Linda Landis, and Arthur Landis  
111

**PART 4. PHYSICS ACTIVITIES**

*by* Deborah McCarthy  
117

Chapter 26. Balloons and Newton’s Third Law  
*by* Diana Stroup and Angela Matta  
123

Chapter 27. An Eggciting Alternative to a Science Olympiad  
*by* Patricia Doney  
127
Every rock band has its signature songs, every restaurant has its specialties, and every magician has a famous trick. So it is with science teachers. We each have our own special activities and demonstrations, and we improve upon them every year. We may not remember where we originally found the lessons—perhaps from a former teacher, a mentor, a textbook, or a workshop—but they have become an integral part of our classroom instruction.

Every year, some of our incoming students know they will do certain labs or see particular demonstrations in our classrooms. Word is passed down from sibling to sibling, and some students start asking for these activities on the very first day of school. Older students who come back to visit us often recall these activities and vividly describe their favorites.

It is these kinds of activities that Science Scope hoped to capture when the editors introduced the “Tried and True” column in February 2003. We did not solicit or recruit a specific writer, as we do for other columns, because we wanted submissions from as many of our readers as possible. We wanted as full a representation of the nature and variety of classic science activities as we could get. So our call for papers has remained more or less the same over the intervening years:

Do you have an activity that has withstood the test of time, one that deserves a place in any collection of lab classics? Perhaps you have been doing it so long that you have forgotten where you originally found it, or you have changed it so much that it hardly resembles the original. Tell us what makes the activity worth keeping. Is it the never-fail excitement it generates with students? Is it the clarity with which it teaches a concept? Is it the ease with which it develops valued lab or process skills? What special ingredients or twists do you add to make the classic version even better?

Many of these activities originated before computers and calculators were used in classrooms, but they are timeless and most can easily be refitted to incorporate today’s technology—including probes, gauges, sensors, computers, and other interactive media devices.

Every teacher has his or her own special reason for using a Tried and True activity, but the multipurpose, flexible nature of these classics is part of what makes them so enduring and so endearing. What serves as a springboard introductory activity for one teacher can be a unit capstone for another; what is a formative assessment in one class can be part of a summative assessment in another. For example, if the “Egg-in-the-Bottle Demonstration” is done at the start of a unit on heat and air pressure, as the author suggests, it will reveal students’ prior knowledge of the topic and any preconceptions they might have. However, the same activity would work equally well as a summative assessment at the end of an air pressure unit to let the teacher know whether the students had understood the concepts taught. In the same way,
assigning the writing task described in “Peanut Butter and Jelly Science” before reviewing procedure writing will let the teacher know how much practice students need with the process. That same exercise, on the other hand, could be turned into an excellent essay question at the end of a review unit on direction writing.

**Organization of This Book**

The volume in your hands contains a varied and useful collection of “Tried and True” columns from the past seven years. They are organized by instructional strategies and the core science disciplines—life science, Earth and space science, physics, and chemistry.

Activities that can be used as stand-alone lessons to develop particular science skills appear first in the book, under the heading “Developing Inquiry Skills.” However, applicable content can be easily incorporated into any of these lessons to teach science skills in tandem with other topics of study. Similarly, many of the content-specific lessons listed in core areas of science can be turned into stand-alone science skills activities.

Some of the activities in this collection fit more than one science content area. “Soil Is More Than Just Dirt,” for example, is listed as a life science activity, but it could easily be crafted into an Earth science activity as well. Similarly, “Evaporating Is Cool,” which falls under chemistry here, would make an excellent weather or water cycle–related Earth science activity.

You can also use the lesson formats of these activities as templates for designing or restructuring your own investigations and demonstrations. “Tried and True” activities can be enhanced with the use of higher-level critical-thinking questions or extended into more open-ended inquiry investigations. With additions, many of these activities can easily become 5E inquiry lessons, and those which are more teacher-centered can be made more student-centered by giving fewer directions and less information to students.

Veteran teachers will find new activities within this collection, or new twists to activities they are already doing, but this collection will be especially useful to new teachers who are just developing their own signature lessons. Will students start to know you as the teacher who shuffles cards? Or perhaps as the one who asks her students to write advertisements for cell organelle jobs? Only time will tell.

**Safety Note**

These activities do contain safety precautions. However, before attempting any activity with students, work through it step-by-step on your own so you know what to expect. Then add whatever supplemental safety instructions or warnings you feel are necessary.
These classic activities explore how our eyes and brain receive and process visual information. Each activity requires approximately five minutes. For a richer experience with these activities, consult a neuroanatomy guide with labeled images of the named visual and brain regions, and see if you can determine the pathways along which visual information is being processed.

Acknowledgments
The project incorporating these activities, the Science of Art program at the Museum of Glass in Tacoma, Washington, is generously supported through funding from the Washington State Arts Commission’s Art in Education Program.
Activity Worksheet 1
See like a bee

Materials
- Ultraviolet/black light
- Flowers
- Miscellaneous objects

Background Information
Perceiving the world around us begins with vision, and vision would not be possible without light. This is because our eyes, with all their biological complexity and beauty, are really just sophisticated photon detectors. Photons are very small particles that are emitted by light sources such as the Sun or a lightbulb. Photons travel away from their source at the speed of light ($3.0 \times 10^8$ m/sec) but at different wavelengths, depending on the amount of energy they contain. Certain wavelengths activate the receptors in our eyes. Only a small range of the entire spectrum, or range of wavelengths, is visible to humans. We perceive the longer wavelengths in the visible spectrum as red and the shorter wavelengths in the visible spectrum as violet. Some animals, such as bees, can see farther into the ultraviolet range than humans. What would the world look like if we could see like a bee?

Safety Note
UVA light sources are safest (do not use UVB or UVC), but even UVA black lights should be used judiciously. Never stare into the light or expose skin to the light. UV-protective eyewear should be worn during prolonged or repeated exposure. Follow all usual precautions with electrical devices.

Procedures
1. Examine the objects at the table under normal light and then under ultraviolet light.
2. Describe how their appearances change under the ultraviolet light.
Activity Worksheet 2

Disappearing dot

Materials
- Copies of Figures 1 and 2

Background Information
Can you name all the parts of your eye? The white part is called the sclera. The colored part is called the iris. The iris constricts and dilates to control the amount of light (number of photons) entering the eye through the pupil. The cornea and lens focus this light onto the retina, which is located on the back wall of the eye. The retina is composed of two different kinds of light-sensitive receptor cells: rods and cones. Their concentration is highest in an area of the retina called the fovea. In contrast, there is another location, called the blind spot, or optic disk, where there are not any receptors. This is to make room for nerve fibers and blood vessels to exit the eye via the optic nerve, sending signals onward to the brain (see Figure 1). How is visual acuity influenced by this arrangement?

Procedures
1. While holding Figure 2 at arm’s length, close your right eye while focusing your left eye on the +. Slowly move the paper toward you while keeping your eye focused on the +.
2. At a certain distance—specifically, when the light from the image falls onto the portion of the retina without receptors—the dot will “disappear.” Keep moving the paper toward you until the dot reappears.
3. Repeat this exercise with the opposite eye.

Figure 2
In your blind spot
**Activity Worksheet 3**

**Color correction**

**Materials**
- Copies of Figure 3

**Background Information**
Rods are more sensitive to light than cones. In fact, rods are so sensitive that they will respond to a single photon! The retina contains more than 10 times as many rods as there are cones. However, rods don’t respond with information about color; they send a black-and-white picture of the world to the brain. Cones transmit color information. There are three kinds of cones, each primarily sensitive to light of a particular wavelength (red, green, and blue). The light-sensitive chemicals inside rods and cones, called photopigments, are a form of vitamin A. There are a number of optical illusions caused by activating only some of the cones. These illusions are known as afterimages.

**Procedures**
1. Stare at the image in Figure 3 for 15–30 seconds. Then shift your gaze to a sheet of white paper.
2. What colors do you see in the white area and how are these colors related to the colors in the image? (Hint: When you stare at a particular color for too long, the cones associated with those colors become fatigued. Then, when you look away, the information sent from the combination of cones is no longer in balance and you see the complementary colors, which represent activity of the nonfatigued cones.)

**Activity Worksheet 4**

**Gone in the blink of an eye**

**Materials**
- Copies of Figure 4 (for reference)

**Background Information**
The retina contains five types of neurons that form a network to combine and process the signals produced by the rods and cones before relaying information to the brain. The optic nerve is composed of one of these neuron types, the ganglion cells. Via the optic nerve, each eye sends a two-dimensional imprint of the world to the brain. In an area of the brain called the optic chiasm (see Figure 4), the signals from both eyes are split such that information about the left half of the visual field is sent to the right side of the brain and information about the right half of the visual field is sent to the left side of the brain. It is the brain, and not the eyes, that reconstructs our perception of the world as three-dimensional.

**Procedures**
1. Focus on an object 6 to 10 m away. Close one eye and hold up your arm to line your finger up with the object.
2. Without moving your finger or your head, change which eye is open. (You will find that the farther away the object, the greater the distance your tracking finger will appear to move when you change eyes.)
3. Propose a theory as to how the brain uses these differences to estimate depth.
Activity Worksheet 5

Bright sight

Materials
■ Copies of Figure 5

Background Information

The optic nerves make connections with other neurons in the lateral geniculate nucleus (LGN), the superior colliculus, and the pretectal region. These structures are all located in the brain stem. The LGN enhances the contrast between signals from adjacent areas of the retina before forwarding the signal on to the visual cortex. As a consequence of this contrast adjustment, we find that the appearance of an object depends not just on the color and intensity of the object, but also on the color and intensity that surrounds it. Contrast allows our brains to compute the edges, or boundaries, that define objects in our visual environment. When these contrasts change over time, we perceive movement.

Figure 5
Shades of gray

Procedures

1. Which gray square in Figure 5 appears the brightest?
2. Cut out the two gray squares and remove their inner squares as well. Place them on a sheet of white paper. Now which square appears the brightest?
3. How do you account for any changes in your perception?
Activity Worksheet 6

Role Call for Pupils

Materials
- Penlight, low intensity with a focused beam (less than 10 lumens is considered both safe and effective) and a colored cap

Background Information
The pretectal region of the brain controls the pupillary light reflex by sending messages back to the muscles controlling the constrictor muscles of the iris. The reflex is consensual: When one eye is exposed to bright light, the pupils of both eyes will constrict (although not always to the same extent). Physicians often test this reflex in accident victims to determine whether the brain stem has been damaged.

Procedures
1. Turn off the classroom lights and go to an area near a window with a friend. Take note of the relative size of the pupils in both of your friend’s eyes in natural light.
2. Shine a small light at your friend’s forehead, between the eyes but not directly into either eye, for a few seconds. Then examine both eyes again.
3. What size are the pupils now? Did both eyes change size or just the eye that was illuminated? Sketch the eyes before and after the light.

Figure 6

Before

After
## Index

*Page numbers printed in **boldface** type refer to figures or tables.*

### A
- Adaptations of organisms, 49–52
  - activity worksheet for, 51
- Amonton’s Law, 134
- Amplification and transformation of sound, 159
- Archimedes’ Principle, 137
- Activity worksheet for, 51
- Amonton’s Law, 134
- Biobottle ecosystem investigations, 43, 43-47
  - activity journal for, 45, 46
  - appropriate organisms for, 44
  - classroom management for, 43-44
  - creation of biobottles, 44
  - of decomposition, 46
  - scoring rubric for, 46
  - student preparation for, 43, 44-46
- Biomimicry, 53, 57
- Blue bottle demonstration, 165-168, 166
  - common student hypotheses and testing of, 167-168
  - explanation of, 168
  - guided inquiry for, 166
  - safety precautions for, 165
- Boats, floating of, 137-139
  - activity worksheets for, 138, 139

### B
- Balloon activity and Newton’s third law, 123–125
- Berlese funnel, 55, 55
- Biobottle ecosystem investigations, 43, 43-47
  - activity journal for, 45, 46
  - appropriate organisms for, 44
  - classroom management for, 43-44
  - creation of biobottles, 44
  - of decomposition, 46
  - scoring rubric for, 46
  - student preparation for, 43, 44-46
- Biomimicry, 53, 57
- Blue bottle demonstration, 165-168, 166
  - common student hypotheses and testing of, 167-168
  - explanation of, 168
  - guided inquiry for, 166
  - safety precautions for, 165
- Boats, floating of, 137-139
  - activity worksheets for, 138, 139

### C
- Cameras for zoo field trip, 64
- Carbon dioxide, oxygen and combustion, 162–163
- Card-shuffling activity to increase student participation, 21, 21-22
- Cell division. See Mitosis slide show
- Cell organelle employment advertisement, 69–71
  - activity worksheet for, 71
  - sample of, 71
  - scoring rubric for, 70, 70
- Changes in matter, molecular modeling of, 169–172, 171
- Chemistry activities
  - blue bottle demonstration, 165-168
  - dissolving, 181-187
- evaporation, 173–175
- modeling changes in matter, 169–172
- paper chromatography, 177–180
- periodic table, 189–191
- physical nature of gases, 161–163
- Chesapeake Bay ecosystem, 25–34
  - activity worksheets for, 27, 28, 31, 32
  - before large-scale fishing, 26, 27, 29
  - with large-scale fishing, 29, 29–30
  - reasons for dead zones in, 26–27
  - seafood cards on, 34
  - testing hypothesis that oysters reduce nutrient pollution in, 30–33
  - watching media about, 33–34
- Classification skills, 7–10, 9
- Classroom management. See also specific activities
  - increasing student participation, 21, 21-22
  - traffic control tips for hands-on activities, 23-24
- Color vision, 88, 88
- Composting, 56, 57
- Cones and rods, 88, 88
- Constants, 1, 4
- Cost of materials for hands-on activities, 24

### D
- Deep time, 105
  - background information on, 105–106
  - bathroom tissue time line, 107–108, 108
  - clapping the Earth’s life, 106–107, 107
  - classroom implementation of deep-time activities, 108–109, 109
  - concept of, 105
  - past research on, 106
  - presenting in informal settings, 106, 107
  - student and teacher perceptions of deep-time activities, 110
  - tactile and auditory methods for conveying, 106–108
- Diagrams, interpretation of, 9
- Dissolving, 181–187
  - beginning inquiry activity on, 182, 182–183
  - critical thinking about, 185–186
  - experiments on, 184–185
  - inquiry process on, 181–182

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INDEX

reworking questions on, 183, 183–184
student lab book for experiment on, 185

E
Earth and space science activities
- geologic time, 105–110
- rock cycle candy chip investigation, 91–94
- rock cycle Rock and Rap CD cover, 95–99
- solar system, 111–115
- volcano résumé, 101–103

Ecosystem activities
- biobottle, 43–47
- Chesapeake Bay food webs, 25–34

Egg-in-the-bottle demonstration, 133–135
- explanation for, 134
- extensions of, 134–135
- inspiration for, 133
- posing question for, 133
- safety precautions for, 134

Eggcitement (egg drop), 127–132
- activity worksheet for, 131
- additional suggestions for, 131–132
- designing egg protection for, 128
- materials for, 127–128, 129
- plumb line for, 129
- post-activity summaries of, 130–131
- procedure for, 129
- science concepts for, 130
- scoring rubric for, 130
- site for, 127, 129

Eisenia fetida for composting, 57

Electrical circuits, 141–145
- content standards related to, 141
- correcting misconceptions about, 141–142, 141–143

5E Instructional Model for, 143–145, 144
- materials for, 142
- safety precautions for, 142

Evaporation, 173–175
- activity worksheet for, 175
- teacher background on, 173–174

Eye structure, 87, 87

F
Field trip to zoo, 63–67
5E Instructional Model, 1–5
Floating a boat, 137–139
- activity worksheets for, 138, 139

Food in classroom, 11
Food webs in Chesapeake Bay, 25–34
- activity worksheets for, 27, 28, 31, 32
- before large-scale fishing, 26, 27, 29

with large-scale fishing, 29, 29–30
reasons for dead zones, 26–27
seafood cards for, 34
testing hypothesis that oysters reduce nutrient pollution, 30–33
watching media about, 33–34

Fruit fly investigations, 35–41
- activity worksheet for, 38
- assessment of individual and group learning, 41
- creating an anesthetizing chamber for, 37
- elaborating students’ understanding, 39–41
- engaging students in, 36–38
- lab report scoring guide for, 40
- life cycle, 35–36
- of population growth, 39
- preparing for, 36

G
Gases, physical nature of, 161–163
- oxygen, carbon dioxide and combustion, 162–163
- volume of gases, 162
- water cycle, 161–162

Geologic time, 105–110
- background information on, 105–106
- bathroom tissue time line, 107–108, 108
- clapping the Earth’s life, 106–107, 107
- classroom implementation of deep-time activities, 108–109, 109
- concept of deep time, 105
- past research on, 106
- presenting in informal settings, 106, 107
- student and teacher perceptions of deep-time activities, 110
- tactile and auditory methods for conveying, 106–108

H
Hearing, 158, 158. See also Sound
Helicopter seeds, 77–80
- extended activities on, 80
- observing flight patterns of, 79–80
- sizes and shapes of, 78, 78
- testing hypotheses with, 78–79, 79

I
Illustrations, interpretation of, 9
Inquiry skills
- 5E Instructional Model for, 1–5
- generating questions, 11–14, 13
- scientific writing, 15–19
- thinking spatially, 7–10

Inquiry starters, 12
Instructional strategies
generating questions, 11–14, 13
increasing student participation, 21, 21–22
inquiry approach, 1–5
scientific writing skills, 15–19
spatial-thinking skills, 7–10
traffic control tips for hands-on activities, 23–24

L
LEGO building activity, 17–19, 19
Life science activities
adaptations of organisms, 49–52
cell organelle functions, 69–71
ecosystems in a biobottle, 43–47
food webs, 25–34
fruit fly investigations, 35–41
helicopter seeds, 77–80
mitosis, 73–75
photographic scavenger hunt at the zoo, 63–67
soil, 53–58
somatosensation, 81–84
visual information processing, 85–90
water purification, 59–62
Light reflection in mirror, 147–148

M
Maple samaras, 77–80
extended activities on, 80
observing flight patterns of, 79–80
sizes and shapes of, 78, 78
testing hypotheses with, 78–79
Mathematics skills
deep-time activities, 105–110
paper airplane flights activity, 1–5
solar system in the hallway activity, 111–115
Mirrors, 147–149
activity worksheets for, 147–149
repeated reflection, 147–148
Mitosis slide show, 73–75
assessment rubric for, 74, 75
samples of, 73
student creation of, 73–74
Molecular modeling of changes in matter, 169–172, 171
extensions of, 121
invention phase activity of, 117
Newton’s third law, 123–125
activity worksheet for, 124
balloon activity for, 123–125

O
Observation and classification skills, 7–10, 9
Observations to generate questions, 11–14, 13
Ocean ecosystems, 25–34. See also Food webs in Chesapeake Bay
Optic nerve, 88, 88
Oxygen, carbon dioxide and combustion, 162–163

P
Paper airplane flight experiment, 1–5
5E instructional model for, 1–5
group data sheet for, 3
sample airplane models for, 2
Paper chromatography, 177–180
classic activity on, 177, 177–178
extending inquiry on, 178–180
order of color appearance on filter paper strips, 178, 179
time for colors to appear on filter paper strips, 179, 179
Periodic table created by students, 189–191
assigning elements for, 189
construction of, 190
handout for assignment on, 189
questions for, 190–191
samples of, 191
scoring rubric for, 190
Photographic scavenger hunt at the zoo, 63–67
activity worksheet for, 65
background of, 63–64
cameras for, 64
data-collection sheet for, 66
poster presentations of, 66–67, 67
preparation for, 64
student roles at the zoo, 66
Physics activities
balloons and Newton’s third law, 123–125
egg drop, 127–132
egg-in-the-bottle demonstration, 133–135
electric circuits, 141–145
floating a boat, 137–139
mirrors, 147–149
Newton’s first law of motion, 117–121
solar ovens, 151–154
sound, 155–160
Pitch (sound), 156
INDEX

Poster presentations, of photographic scavenger hunt at the zoo, 66–67, 67
Pupillary light reflex, 90, 90

Q
Questions, generation of, 11–14, 13
T-chart for, 12, 13

R
Reading reversal in mirror, 149
Rock cycle: candy chip investigation, 91–94
activity worksheet for, 93
classroom management for, 92
discussion of, 94
materials for, 92
student preparation for, 91, 94
teacher lab preparation for, 94
Rock cycle: Rock and Rap CD cover, 95–99
connection to Earth system, 95
grading rubric for, 98
parts of, 97–99
rock cycle diagram, 96
samples of inside and outside of, 97
Rods and cones, 88, 88

S
Science terms and concepts, 1
Scientific writing skills, 15–19
LEGO building activity, 17–19, 19
peanut butter and jelly sandwich activity, 15–16
Soil, 53–58
background information on, 54
composting to solve environmental problem, 56, 57
decomposition in, 55–57, 56
investigation of, 53–55, 55
Solar ovens, 151–154, 152
assessment of, 153
communicating results of, 152
creating and testing of, 152
learning from failure of, 154
planning and design of, 152
safety precautions for, 153
Solar system in the hallway, 111–115
activity worksheet for, 114
data collection for, 112, 112
measurements for, 113, 113
post-activity questions and discussion for, 113–115
tile counts for, 112, 112
Somatosensation, 81–84
activity worksheet on, 83
“challenge questions” background on, 82
classroom management for activity on, 81–82
inquiry adaptations for activity on, 82
Sound, 155–160
activity worksheets for, 155–159
feeling vibrations, 155, 155
in a glass, 159
hearing vibrations, 158, 158
pitch, 156
seeing vibrations, 157, 157
special sound effects, 159
Spatial-thinking skills, 7–10
applications of, 8–9
classroom activities to foster, 10
content standards and, 9–10
definition of, 8
integration into curriculum, 9
Student participation, card-shuffling activity to increase, 21, 21–22

T
Time management for lab activities, 23
Touch, sense of, 81–84. See also Somatosensation
Traffic control tips for hands-on activities, 23–24

Tuning fork, 159

U
Ultraviolet light spectrum, 86

V
Variables, dependent and independent, 1, 4
Vibrations, 155–159. See also Sound
Visual information processing, 85–90
activity worksheets for, 86–90
color vision, 88, 88
contrast, 89, 89
eye structure, 87, 87
optic nerve, 88, 88
pupillary light reflex, 90, 90
ultraviolet light spectrum, 86
Vocal cords, 155–156
Volcano résumé, 101–103
grading rubric for, 102, 103
requirements for, 101
sample of, 102
Volume of gases, 162

W
Water cycle, 161–162
Water evaporation, 173–175
activity worksheet for, 175
teacher background on, 173–174
Water purification, 59–62
INDEX

activity worksheet for, 62
classroom management for, 59–60
safety precautions for, 61
scoring rubric for, 61
teacher preparation for, 60–61

Worms for composting, 57

Writing skills
activity journal for biobottle activity, 45, 46
LEGO building activity, 17–19, 19
peanut butter and jelly sandwich activity, 15–16

Z
Zoo field trip, 63–67
activity worksheet for, 65
background of, 63–64
cameras for, 64
data-collection sheet for, 66
poster presentations of, 66–67, 67
preparation for, 64
student roles at the zoo, 66