Chapter 3

# ACTIVITIES

The activities in this chapter are designed to give students direct experience with mechanisms and circuits. The activities were created and tested by classroom teachers. Many of their experiences with these or similar activities are described in Chapter 4, "Stories."

Activities 1-9 deal with mechanisms and the concepts related to mechanisms. Activities 10-14 deal with circuits. The activities are designed to give students experience with many of the concepts discussed in Chapter 2, "Concepts."

All of the activities are correlated to standards in Science, Mathematics, and English Language Arts. The standards are listed by number with each activity; the standards themselves are listed at the end of the chapter.

## ACTIVITIES AT A GLANCE

| Level | Activity Title | Page | What Students Learn About Mechanisms and Circuits | | |
|---|---|---|---|---|---|
| | | | What They Are | How They Work | Redesign/Design |
| **Introductory** | What Is a Mechanism? | 74 | × | | |
| | Be a Mechanism Detective | | | × | |
| | Mechanism Scavenger Hunt | 76 | × | | |
| | What Does a Tool Do? | 77 | × | | |
| | Can You Guess My Categories? | 79 | | | × |
| **Intermediate** | Ins and Outs of Inputs and Outputs | 80 | | × | |
| | How Do Levers Make Work Easier? | 82 | | × | |
| **Advanced** | Simple Machines | 85 | × | | |
| | How Does a Retractable Ballpoint Pen Work? | 89 | | × | |
| | Make a Model of a Mechanism | 91 | | × | × |
| | Conductors and Insulators | 94 | × | × | |
| | Electric Switches | 96 | × | × | × |
| | Two Switches, One Lamp | 98 | | × | × |
| | Electric Circuit Board Game | 100 | | × | × |
| | Water-Level Alarm | 102 | | × | × |

# Activity №1

# What Is a Mechanism?

## Grade Level
K – 5

## Prerequisites
None

## Overview
This is an introductory activity that uses discussion and concept-mapping to have students articulate what they know and believe about mechanisms.

## Concepts
- Mechanisms are found in everyday life.
- All mechanisms have moving parts.

## Vocabulary
Mechanism

## Skills
- Brainstorming
- Accessing prior knowledge

## Standards
- Standards for the English Language Arts:12
- Benchmarks for Science Literacy: 1B
- National Science Education Standards: A

## Time Needed
45 minutes

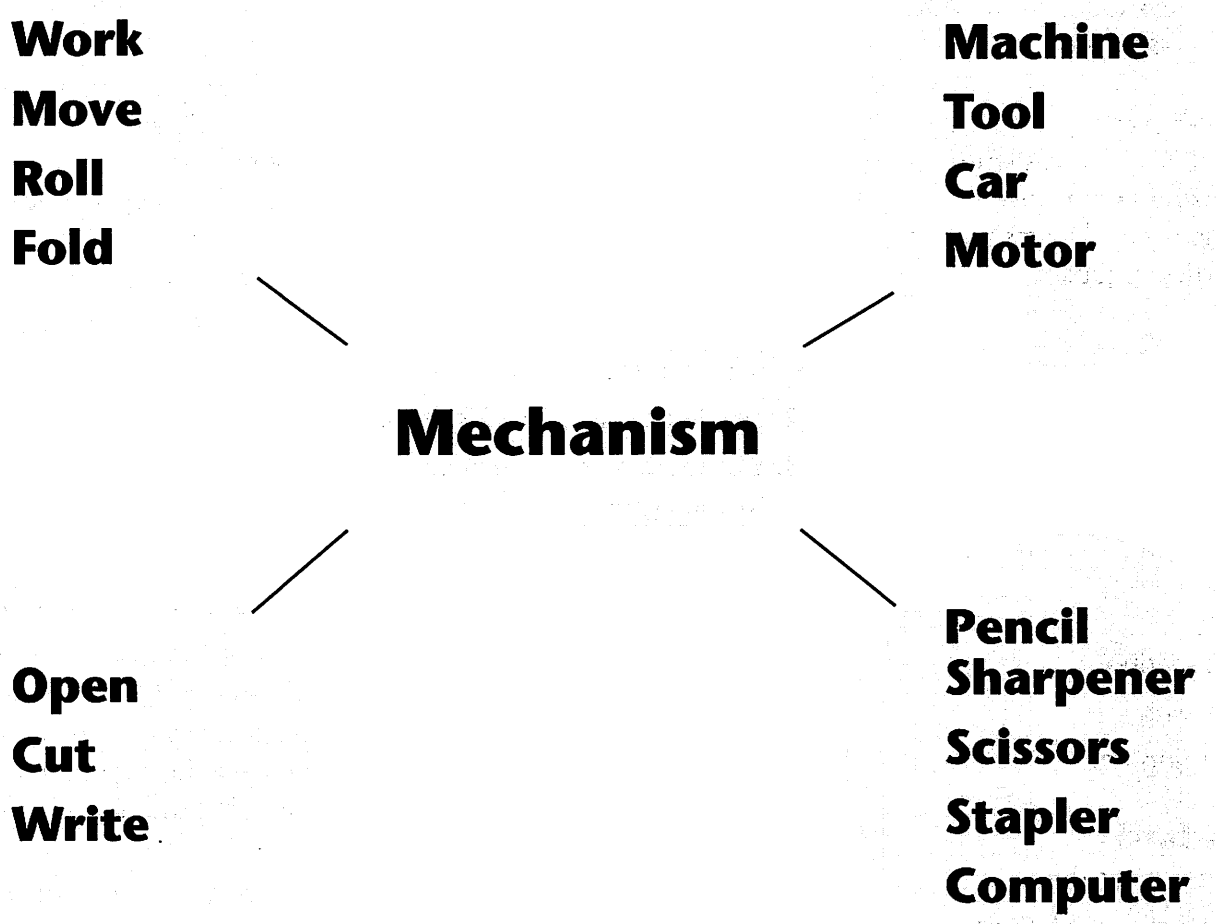
## Materials
- Chart tablet
- Markers

## Procedure
1. Bring students together for a group discussion.
2. Use questions like those below to elicit what students know and believe about mechanisms and to help them discover the idea that all mechanisms have moving parts. Guide students to describe places where mechanisms are used (e.g., kitchen, bathroom), examples of their functions (cut, slice), and kinds of motion (push, pull, turn).
   - What do you think the word mechanism means?
   - What do mechanisms do? What do we use them for?
   - What are some examples of mechanisms in our classroom?
   - Where else can you find mechanisms?
3. Record their responses on a word web (see page 75) and/or a K-W-L chart ("What do we **K**now?", "What do we **W**ant to know?", "What did we **L**earn?").
4. During this discussion, do not label students' answers as right or wrong. Instead, return to your record of this discussion as your study of mechanisms progresses. Then you can give students the chance to revise their own ideas and answers as they gain more knowledge and understanding.

## Tips
Help students identify the characteristics of mechanisms by showing them examples (e.g., a stapler or manual pencil sharpener) and asking them to describe what they see. Ask how the device is used, what happens when it is being used, which parts move, and how they move.

# Sample Word Web for Activity #1

## "What Is a Mechanism?"



# Activity №2

# Be a Mechanism Detective

## Grade Level
K-5

## Prerequisites
- Students must know safety rules before handling tools.
- Students should know what mechanisms are.

## Overview
This activity involves students in thinking about how common mechanisms work to do particular jobs.

## Concept
Common mechanisms work based on cause-and effect-relationships.

## Vocabulary
Mechanism

## Skills
- Investigating
- Observing
- Recording data

## Standards
- Standards for the English Language Arts: 12
- Principles and Standards for School Mathematics: G4
- Benchmarks for Science Literacy: 1B, 2A, 2C
- National Science Education Standards: A

## Time Needed
45 minutes

## Materials
- Common mechanisms such as hole punchers, nutcrackers, ice tongs, garlic presses, scissors (for grades 4 and 5, more complex mechanisms can be used)
- Chart tablet
- Markers, crayons

## Procedure
1. Review safety rules for handling mechanisms.
2. Divide class into groups of four.
3. Distribute several mechanisms to each group.
4. Have each group explore and examine their objects. Prompt them with questions such as "What does it do?" "What do you have to do to it to make it work?"
5. Have students trace or draw and describe their objects in writing.
6. Depending on grade level, have groups record or keep notes on their group discussions.
7. Have individuals and groups share their results.

## Tips
- For one teacher's experience with this activity, see Chapter 4 ("Stories"), page 118.
- Allow 30 minutes for investigation, and then encourage students to write at least one sentence.
- Encourage students to write about different aspects of their work: the process, their observations, their ideas, their questions.
- Model how students should draw and/or trace their mechanisms.
- Record safety rules on an experience chart for future reference.

## Homework
*Mechanism Scavenger Hunt*

Ask students to locate mechanisms at home and (with permission) bring in any that are not working or are no longer needed. During the next class meeting, discuss the scavenger hunt.

- Discuss how students identified objects as mechanisms.
- If students are unsure about whether something is a mechanism, encourage the class to discuss it and come to a consensus.

# Activity №3

# What Does a Tool Do?

## Grade Level
K-5

## Prerequisites
Students should be aware of safety issues before using tools.

## Overview
This is an introductory activity for the early grades or a getting started activity for the middle and upper grades. Children try to define the word "tool" and trace the positions of a simple tool in its open and closed positions.

## Concept
Mechanisms can be found in tools.

## Vocabulary
- Mechanism
- Tool
- Open
- Closed
- Rest
- Operating

## Skills
- Investigating
- Observing
- Recording data

## Standards
- Standards for the English Language Arts: 12
- Principles and Standards for School Mathematics: G1
- Benchmarks for Science Literacy: 1B, 2A, 3A
- National Science Education Standards: A, B

## Time Needed
45 minutes

## Materials
- Worksheet #3: "What Does a Tool Do," one for each student
- Chart tablet
- Markers
- Hole punchers (for grades K-2), one for each group of 3 to 5 students
- Vise grips (for grades 3-5), one for each group of 3 to 5 students

## Procedure
1. Review the class's discussions about mechanisms in connection with Activities 1 and 2, focusing on what students discovered about what a mechanism is and where mechanisms can be found.
2. Ask, "What is a tool?"
3. Record all student responses on an experience chart.
4. Place students in groups of 3 to 5.
5. Give out hole punchers (Grades K-2) or vise grips (grades 3-5). Elicit responses about the object by asking such questions as,
   - Is this a mechanism?
   - Is it a tool?
   - What do you think it is used for?
6. Record students' responses on the experience chart, without labeling them as right or wrong.
7. Distribute worksheets, one to each student.
8. Have students trace the mechanism in the open (rest) position and in the closed (contracted) position.
9. Encourage groups to discuss how it might work and its possible uses. Depending on grade level, groups can record their ideas.
10. Bring all groups together to share their experience and ideas.
11. Record students' responses and compare them with their responses in the earlier discussion. Revise the experience chart to reflect students' new insights and understanding.

## Tips
- For one teacher's experience with this activity, see Chapter 4, page 125.
- For younger students, model the tracing process in the open and closed positions. Label all positions.
- For ESL students, use vocabulary ("open," "closed," etc.) in both languages.

## Worksheet for Activity #3

# "What Does a Tool Do?"

Name _____

**Draw your tool when it is open and when it is closed.**

| Open position | Closed position |
| --- | --- |
| | |

This tool is called _____

What does this tool do?

_____

_____

_____

How does the mechanism work? (Write it here or on your pictures.)

_____

_____

_____

# Activity №4

# Can You Guess My Categories?

## (Who Am I and What Do I Do?)

### Grade Level
K-4

### Prerequisite
Knowledge of a variety of ways to classify

### Overview
This is a simple sorting activity made into a game using a variety of mechanisms. Students must sort mechanisms, try to name each one, and determine what it is used for.

### Concept
Mechanisms can be sorted and categorized according to their functions as well as other criteria.

### Vocabulary
- Category
- Categorize
- Sort

### Skills
- Collecting data
- Analyzing data
- Organizing data
- Sorting and classifying
- Recording data

### Standards
- Standards for the English Language Arts: 7, 12
- Principles and Standards for School Mathematics: A1
- Benchmarks for Science Literacy: 1B, 1C, 2C
- National Science Education Standards: A

### Time Needed
2 sessions, 45 minute each

### Materials
- Office and household tools or gadgets (e.g., nail clippers, lipstick, gluestick, eyelash curler, pencil sharpener, garlic press, etc.)
- Paper
- Pencils
- Notebooks
- References on simple machines or reference list of mechanisms
- Index cards
- Experience chart

### Procedure
1. With the whole group, discuss what it means to sort things by "category." If necessary, model categorizing a group of objects or people.
2. List responses on chart paper as students share ideas.
3. Divide students into groups.
4. Give each group a tray with several mechanisms for the students to classify.
5. Ask students in their groups to name each mechanism and discuss what it is used for.
6. If the students want to know what an unfamiliar object is, hold it before the class. If no one can name it or tell how it is used, ask them how they could find out what it is. Demonstrate the mechanism's use, if possible. If students are still unable to figure out what the mechanism is used for, record their questions on chart paper and return to the object later for further research.
7. After everyone in each group has examined the objects, the group decides how they should be categorized.
8. Students write the name of each category on an index card. (For younger students, have students tell you the category names so you can write them on cards.)
9. Ask the groups to present the objects in each category to the class without naming the category.
10. Invite the other groups to guess what the objects in each category have in common.
11. After each group has presented its grouped objects, discuss other possible categories, focusing on what the objects have in common.
12. Record all questions that may arise. Have references available on simple machines. Encourage students to record their experience in their journals.

### Tips
- If categorizing becomes difficult, students should practice by sorting various objects available in the classroom—e.g., crayons, toys, books, etc. They can also sort students by what they have in common—e.g., light or dark hair, kind of shoes, glasses or no glasses, etc.
- Encourage students to categorize their mechanisms by what they do or how they work rather than superficial characteristics such as size or color.

# Activity №5

# Ins and Outs of Inputs and Outputs

## Grade Level
3-6

## Prerequisite
Understanding of categorizing mechanisms and the ways mechanisms can be operated

## Overview
In this activity, students examine common mechanisms to find their inputs and outputs, and to identify the motions executed at both input and output.

## Concept
Mechanisms operate based on input and output.

## Vocabulary
- Input
- Output

*Note: For an introduction to these terms and concepts, see the Glossary at the back of this Guide.*

## Skills
- Problem solving
- Labeling

## Standards
- Standards for the English Language Arts: 12
- Principles and Standards for School Mathematics: G1
- Benchmarks for Science Literacy: 1B, 3A, 3B, 11A
- National Science Education Standards: A, B

## Time Needed
90 minutes

## Materials
- Worksheet #5, "Ins and Outs of Inputs and Outputs"
- Common mechanisms such as a can opener, bottle opener, eyelash curler, ice cream scoop, wrench, nail clippers, tweezers, staple remover, etc.
- Construction paper
- Pencils and markers

## Procedure
1. Choose one of the mechanisms from the classroom collection and demonstrate its operation in front of the class.
2. Lead a discussion about how the device works and what it does. Ask such questions as, "What makes this mechanism work?" Use the terms *input* and *output* to describe the operation of the mechanism.
3. Record students' responses and questions on an experience chart.
4. Draw the mechanism you've demonstrated on the experience chart. As you and your students describe and discuss the mechanism, label the drawing using the terms *input* and *output*.
5. Divide students into small groups and have each group pick an object to study. Ask each group to locate both the input and the output. If students are still unclear about what these terms mean, use prompts such as:
   - "What is the part that I use to make it work?"
   - "What is the part that actually does the job that I want this mechanism to do?"
6. Ask students to work together in their groups to draw diagrams of their objects, labeling the input and the output. Have them trace the motions of both input and output as the device is operated, and describe the differences between their motions.
7. Ask each group to share what it has found with the class.

## Tips
- Use simple objects so it's easier to identify the input/output relationship.
- While students are sharing their drawings, encourage them to use the appropriate vocabulary: *input* and *output*.
- If an overhead projector is available, students can demonstrate their devices by placing them directly on the projector. The object will be seen on the screen in silhouette.
- Encourage students to write about their experience with this activity in their journals, including what was easy and hard, what they learned, and what they don't understand.
- Always remember to review safety rules.

**Worksheet for Activity #5**

# "Ins and Outs of Inputs and Outputs"

Name _____

**Draw and label your mechanism using the terms *Input* and *Output*.**

What is the name of this mechanism? _____

What part of the mechanism do I have to move to make the mechanism work? _____

What part of the mechanism does the job? _____

# Activity №6

# How Do Levers Make Work Easier?

## Grade Level
2-6

## Prerequisite
General understanding of the terms *input* and *output* as they relate to how a mechanism works.

## Overview
This activity teaches the law of the lever, using a meter stick, a pencil, and a book.

## Concepts
- A lever is a simple mechanism that can be used to assist in lifting heavy objects.
- A lever requires a fulcrum.
- The effort required to lift a load is related to the position of the fulcrum in relation to the load.

## Vocabulary
- Input
- Output
- Effort
- Load
- Fulcrum
- Lever

## Skills
- Predicting
- Collecting data
- Analyzing data
- Organizing data
- Communicating ideas and information

## Standards
- Standards for the English Language Arts: 12
- Principles and Standards for School Mathematics: A1, DA & P1, DA & P3, C3, M1
- Benchmarks for Science Literacy: 1B, 2A, 3A
- National Science Education Standards: A, B

## Time Needed
45 minutes

## Materials
- Worksheet #6, "The Book-Lift Challenge," at least one for each student
- Meter sticks or yard sticks (one for each group of four students)
- Pencils (one for each group of four students)
- Hardcover books (one for each group of four students)
- Notebooks
- Chart paper

## Procedure
1. Place a hardcover book on a desk so that every one can see. Then show students a meter stick and a pencil.
2. Tell students that they are going to work in groups. Each group will have a book, a meter stick, and a pencil to solve a challenge. Write this challenge on the board: "Use the meter stick and the pencil to lift the book off of the desk or floor. The pencil must stay on the desk or floor at all times. Some part of the meter stick must always rest on the pencil. The end of the meter stick you push on cannot be the end that lifts the book."
3. Divide class into groups of three or four.
4. Distribute one book, one pencil, and one meter stick to each group. (Each group will need floor or desk space for their experiments.)
5. Distribute multiple copies of Worksheet #6 to each group. Explain to students that they should use the worksheets to describe all the different ways they tried to lift the book. Have extra worksheets available.

6. Give students about 10 minutes to work on the challenge. Help groups that are having trouble collaborating or conceptualizing solutions. If any groups don't seem to be coming up with a solution that involves creating a lever, ask questions to guide them toward that solution.
7. After about 10 minutes, ask the groups one at a time to describe what they did. During this discussion, use the term *input* to describe the pressure that was applied to the ruler and *output* to describe the lifting of the book.
8. Review the meanings of those terms from previous activities. Then explain that what students have made is a *lever.* Identify the pencil as the *fulcrum* of the lever. Finally, explain that with a lever, the force at one end is called the *effort* and the weight at the other end is called the *load.*
9. Set up the lever in front of the class, with one end of the meter stick under a book. Ask students if it makes any difference where on the meter stick you push down in order to lift the book. Is it easier or harder when you push close to the pencil than if you push at the end of the meter stick? Tell students their next challenge is to answer that question.
10. Give students another 10 minutes to investigate this question. Remind them to keep track of what they do on worksheets.
11. After about 10 minutes, bring the groups together again and discuss the results of their investigations. What they will have discovered is the *law of the lever* and the principle of *mechanical advantage.* Record questions, responses, and observations on chart paper for further investigation and reference.

## Extensions

- Ask students to explore the effect of moving the fulcrum closer to and further from the object being lifted.
- Ask students to think of ways a lever could be useful in everyday life.
- Ask students to explain how various tools use levers to make work easier. Some examples are pliers, scissors, can opener, nail clipper.

## Tips

- Introduce new vocabulary (lever, fulcrum, load, effort) in context as you demonstrate the lever and as you discuss students' problem-solving processes with them.
- Relate the lever to other mechanisms students have examined. Point out that the fulcrum is the part of the lever that does not move when the lever is being used.

## Worksheet for Activity #6

# "The Book-Lift Challenge"

Name _____

**How did you use the pencil and the meter stick to lift the book? (Describe it in words.)**

_____

_____

_____

Draw a picture of what you did. Show where you placed the book, the pencil, and the meter stick. Show what you did (the input) to lift the book (the output). Label the input and the output on your picture.

# Activity №7

# Simple Machines

## Grade Level
3-6

## Prerequisites
Some experience with the study of simple machines

## Overview
This activity connects the traditional science topic of simple machines with the study of mechanisms. It introduces the six simple machines: lever, wheel and axle, wedge, pulley, inclined plane, and screw. (All mechanical labor-saving devices are variations of those six.)

## Concept
Simple machines make everyday tasks easier

## Vocabulary
- Simple machine
- Lever
- Wheel-and-axle
- Wedge
- Pulley
- Inclined plane
- Screw

***Note:*** *For an introduction to these terms and concepts, see Chapter 2 ("Concepts"), page 43, as well as the Glossary at the back of this Guide.*

## Skills
- Understanding relationships of parts to whole
- Communicating ideas and information
- Collecting, analyzing and organizing data
- Observing
- Recording data

## Standards
- Standards for the English Language Arts: 12
- Benchmarks for Science Literacy: 1B, 2A
- National Science Education Standards: A, B, E

## Time Needed
90 minutes

## Materials
- Worksheet #7: "Simple Machines"
- Index cards
- Chart tablet
- Collection of objects that incorporate simple machines (e.g., door stop, wheel-and-axle, pulley, screw, lever) as well as more complex mechanisms (e.g., spool, toy car, umbrella, folding chair, tape player, typewriter, doll carriage)

## Procedure

1. If necessary, review your previous work with simple machines.
2. Have students sit in a circle. Place a variety of devices in front of them including some that are simple machines (e.g., wheel, screw, inclined plane, lever) and some that are not (e.g., toy car, umbrella)
3. Write the following vocabulary words on the chart tablet as well as index cards (one per card): "pulley," "inclined plane," "lever," "screw," "wedge," "wheel," "axle."
4. Place the index cards face up in a row inside the circle of students. Ask individual students to place an object under the corresponding index card. For example: doorstops would go under the index card labeled "inclined plane."
5. Ask which of the objects are simple machines.
6. Write students' responses on the chart tablet or chalkboard.
7. Divide students into small groups. Ask each group to pick one simple machine and devise a use for it, showing how it could help to make a job easier. For example, they could suggest moving a heavy desk using a lever, or using a ramp to move a heavy object onto a table.
8. Have each group share their work with the class.
9. Ask students where they have seen devices like these. Generate an experience chart.
10. Name more complex mechanisms, such as the bicycle, and ask students to tell what simple machines they might find in it.
11. Have each group examine one of the complex mechanisms and identify all of the simple machines they find in it. They should sketch some of the simple machines they find and explain what they do.

## Tips

- Use familiar and unfamiliar devices so students can move from the known to the unknown and apply what they learn.
- Review rules of safety.

**Worksheet for Activity #7**

# "Simple Machines"

Name _____

**Pick one simple machine. Think of a use for it showing how it could help to make a job easier. Draw or write your idea.**

This is a picture of _____

This is how this simple machine can make a job easier. _____

EXTENSION TO

Activity №7

# Looking at Larger Mechanisms

## Grade Level
3-6

## Overview
With this activity, students explore complex mechanisms in order to discover how subsystems contribute to larger systems.

## Vocabulary
Subsystem

## Skills
- Recording data
- Drawing to scale

## Standards
- Standards for the English Language Arts: 12
- Benchmarks for Science Literacy: 1B, 2A, 3A, 3B
- National Science Education Standards: A, B, E

## Time Needed
90 minutes

## Materials
- Discarded appliances such as VCR's, tape players, rotary dial phones, typewriters
- Screwdrivers
- Large pieces of construction paper
- Pencils
- Discarded cafeteria trays or other containers for holding small parts

## Procedure
1. Divide students into small groups of 3 or 4.
2. As in the Activity #7, each group should have a fairly complex mechanism.
3. Ask each group to make a diagram of their mechanism.
4. Have students in their groups remove the covers and any other parts needed in order to see the inside of their mechanism. Explain that they should remember this process because they'll need to reassemble the mechanism.
5. Ask groups to find at least one subsystem of the mechanism that they would like to investigate. For example, students may wish to examine how the stop/eject button works on a tape player or how pressing one key of a typewriter makes the type face strike the ribbon. The question should be manageable so that an investigation can take place.
6. Focusing on the question, students identify how the input leads to the output. They should describe what they find through diagrams and writing.
7. Encourage students to find and record every step in the cause-and-effect sequence leading from input to output.
8. Ask each group to record and answer questions about their discovery.
9. Bring the groups together to discuss their work.
10. Record any comments and/or questions that may arise during the discussion. These comments and/or questions may lead to other investigations.
11. Have the groups reassemble their mechanisms.

## Tip
Groups may need help finding a subsystem that is not too complex or too difficult to draw and describe.

# Activity №8

# How Does a Retractable Ballpoint Pen Work?

## Grade Level
3-6

## Prerequisites
- Knowledge of inputs/outputs
- Understanding of parts common in mechanisms

## Overview
Students focus on a particular device, a retractable ballpoint pen. This activity is presented in the context of a fanciful "situational challenge."

## Concepts
- Mechanisms operate based on cause-and-effect relationships among their parts.
- A mechanism cannot function properly when the cause-and-effect sequence is disrupted.

## Vocabulary
- Input
- Output
- Mechanism

## Skills
- Sketching
- Observing
- Sequencing cause and effect
- Writing

## Standards
- Standards for the English Language Arts: 12
- Benchmarks for Science Literacy: 1B, 3A
- National Science Education Standards: A, B, E

## Time Needed
45 minutes

## Materials
- Worksheet #8: "The King and the Special Pens"
- See-through retractable ballpoint pens (at least 1 for every 2 students)
- Journals/notebooks
- Drawing paper

## Procedure
1. Distribute Worksheet #8 to students and have them read the scenario.
2. Then demonstrate how to make the point of the pen appear and disappear without letting students see the inside of the pen.
3. Ask students to make a drawing of what they think is inside the pen based on your demonstration.
4. Ask students to think about the scenario. Ask them to look at their drawings and then to write a possible explanation for why some pens are not working.
5. Distribute pens to pairs of students.
6. Ask students to investigate what is actually inside the pen. Tell them they can disassemble the pen, but should record this process so they can reassemble the pen later.
7. Ask each pair of students to draw all of the parts of the pen and explain how each part functions to make the pen work.
8. After students have made their drawings, ask them to reassemble their pens.
9. Ask each pair to select a presenter and share their diagram.
10. Record any comments and questions on a chart tablet for further discussion. These might lead to other investigations.

## Extension
Have students write an instruction book for how to assemble a ballpoint pen and use it.

## Tips
- Familiarize yourself with the workings of the pen beforehand.
- Provide sufficient time and space for disassembling and reassembling the pens.

*Note: For one teacher's experience with this activity, see Chapter 4 ("Stories"), page 138.*

**Worksheet for Activity #8**

# "The King and the Special Pens"

A king wants to free his imprisoned subjects (the fifth-grade serfs) from his dungeon. However, vandals have damaged all of the special pens used to sign the official release forms. He would like to hire someone to fix his pens so that he could sign their freedom decrees. The king will hire a subject (student) to repair the pens if s/he can convince him that s/he is a capable pen-repair technician.

Try to convince the king that you can fix his pens. You want your freedom, as well as that of all the fifth-grade prisoners. To qualify as a repairperson, you must provide:

* A written explanation of what you think could be damaged in the pens;

* A diagram of what the pen looks like inside and how it works.

You will be called to share your expertise before the king and his subjects.

# Activity №9

# Make a Model of a Mechanism

## Grade Level

3-6

## Overview

This is a modeling activity in which students make a working model of a common mechanism from recycled newspaper and masking tape.

## Prerequisite

Knowledge of slide joints, pin joints (hinges), input, output, and levers

## Concept

Students will recognize mechanisms through the use of modeling

## Vocabulary

- Input
- Output
- Lever
- Joint
- Pin joint
- Slide joint
- Hinge

## Skills

- Observing
- Collecting data
- Drawing to scale

## Standards

- Benchmarks for Science Literacy: 1B, 2C, 3B, 3C, 8B, 11B, 11D, 12G
- National Science Education Standards: A, E
- Principles and Standards for School Mathematics: C1, M1, G1, G4

## Time Needed

Two 45-minute sessions (although more time may be needed, depending upon the mechanism)

## Materials

- Worksheet #9: "Make a Model of a Mechanism"
- Recycled newspaper
- Masking tape
- Scissors
- Rulers
- Cardboard
- Glue
- Rubber bands
- Stapler
- Small tools (screw drivers, wire cutters, etc.)
- Oak tag, notebooks
- Pencils
- Discarded mechanisms, including at least two umbrellas (one for each group of 3-4 students)

## Procedure

1. Explain to students that they will be designing a model of a mechanism using recycled materials. Use a working umbrella frame as an example.
2. Let students examine the umbrella.
3. Elicit from students their ideas about how the umbrella opens and closes. Encourage them to use vocabulary learned in prior lessons such as input, output, lever, joints, etc.
4. Record students' responses on chart paper or the board.

***Note:*** *For a review of the ideas behind this activity, see Chapter 1 ("Appetizers"), page 19.*

5. Discuss the role of joints in mechanisms. Demonstrate how slide joints and pin joints (hinges) work. To demonstrate the role of joints in an umbrella, cut away the fabric from one of the umbrellas.
6. Draw the umbrella mechanism on chart paper or the board.
7. Divide students into small groups of 3 or 4.
8. Let each group choose a mechanism they would like to make a model of.
9. Distribute copies of Worksheet #9.
10. Give groups time and materials to create their models.
11. When the models are complete, have each group present its model to the whole group and describe their design process, the problems they encountered, and how they solved them.

## Tips

- For further explanation of joints and how they operate, see Chapter 2 of this Guide.
- Each group should share any difficulties, questions, and comments with other groups. Time may be an issue; therefore allow enough time for the activity by limiting the types of mechanisms that students may model. Sample mechanisms may include a folding chair, office collator, vise grip, eyelash curler, tin snips, and nail clipper.

## Extension

Introduce students to Rube Goldberg's inventions and let them design and create a model of one of their own.

**Worksheet for Activity #9**

# "Make a Model of a Mechanism"

Name _____

**Draw and describe your model.**

# Activity №10

# Conductors and Insulators

## Grade Level
3-6

## Overview
Students test materials to determine whether or not they conduct electricity.

## Prerequisites
- Understanding of insulators and conductors
- Discuss safety rules regarding electrical wires.

## Concepts
- Different materials have different electrical properties
- The roles of insulators and conductors

## Vocabulary
- Conductor
- Insulator
- Circuit
- Current

## Skills
- Predicting outcomes
- Drawing conclusions
- Record keeping
- Collecting data

## Standards
- Benchmarks for Science Literacy: 1A, 4G
- Standards for the English Language Arts: 12
- Principles and Standards for School Mathematics: DA & P1, DA & P3
- National Science Education Standards: A, B

## Time Needed
45 minutes

## Materials
- Worksheet #10: "Conductors and Insulators"
- Notebooks
- Pencils
- One set-up for every group of students, consisting of:
  - 3 pieces of bell wire (6" each) with ends stripped
  - Battery holder
  - Socket
  - 1.5 volt bulbs
  - Size D batteries
  - Assorted objects to test (door knob, chairs, tables, jewelry, etc.)

## Procedure
1. Have one set-up displayed along with an object that insulates and one that conducts electricity.
2. Review the definitions of conductor and insulator and relate them to the examples available. (An electrical conductor allows electricity to flow through it. An insulator prevents electricity from flowing through it.)
3. Divide students into small groups.
4. Ask the groups to look around the classroom for objects to test as conductors and insulators.
5. Ask them to make predictions as to whether they believe each object is a conductor or an insulator. They should record their predictions on Worksheet #10.
6. Have each group make a circuit tester using 1 battery and holder, 1 socket and bulb, and 3 wires.
7. The groups then use their circuit testers to test their predictions, and record their findings on the Worksheet.
8. Bring the groups together to discuss their findings. Create one chart that lists all objects, the predictions, and the outcomes (insulator or conductor).

## Tips
- You may want to repeat this activity, using different objects to test.
- Encourage students to use vocabulary such as conductor, insulator, circuit, current, etc.

**Worksheet for Activity #10**

# "Conductors and Insulators"

Name _____

**List objects to be tested. Make predictions: Will an object conduct or insulate electricity? Then test each object.**

**Make a check mark under the appropriate column.**

| Object | Prediction | | Actual | |
|---|---|---|---|---|
| | Conduct | Insulate | Conduct | Insulate |
| | | | | |
| | | | | |
| | | | | |
| | | | | |
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| | | | | |
| | | | | |
| | | | | |

What other objects might conduct electricity? List them.

What other objects might insulate electricity? List them.

# Activity №11

# Electric Switches

## Grade Level
3-6

## Overview
Students will incorporate a switch into a battery/bulb circuit. Students will also use their knowledge of circuits to design and make their own switches using common materials.

## Prerequisite
Knowledge of how to create a circuit

## Concept
Electric current can be controlled with a switch

## Vocabulary
- Circuit
- Current
- Switch

***Note:*** *For a review of these concepts and terms, see the Glossary at the back of this Guide.*

## Skills
- Scientific testing
- Observing
- Collecting data
- Record-keeping

## Standards
- Benchmarks for Science Literacy: 1B, 3A, 8C, 11A, 11B
- Standards for the English Language Arts: 12
- National Science Education Standards: A, B, E

## Time Needed
45 minutes

## Materials
- Worksheet #11: "Electric Switches"
- One set-up for every group consisting of the following:
  - Different types of switches
  - Wire
  - Battery holder
  - D size battery
  - Socket,
  - 1.5 volt bulb
  - Motors
  - Buzzers
  - Paper clips
  - Metal hair clips
  - Aluminum foil
  - Pliers
  - Discarded toys and appliances

## Procedure
1. Ask students for examples of how switches are used. Record their responses on chart paper or the board.
2. Divide students into small groups.
3. Have students build a working circuit with just a battery and a bulb.
4. Next, ask them to add a switch in such a way that the switch turns the bulb on and off.
5. Have students draw and describe their circuits and switches on Worksheet #11.
6. Once they have been able to incorporate one type of switch, have each group create their own switch for their circuit using the materials provided.

## Tips
If students have difficulty in creating a switch, suggest they use a paper clip bent so it can just barely touch a piece of foil or another paper clip when pressed; or a paper fastener wedged in between a battery and battery holder which prevents them from making contact when pressed.

## Extension
Have students look for switches in discarded or appliances, toys, and other electrical devices. They can disassemble them to see how they work.

**Worksheet for Activity #11**

# "Electric Switches"

Name _____

**Draw the circuits you made.**

| Circuit without switch | Circuit with switch |
| --- | --- |
| | |

Describe what you did to make the bulb light using the switch.

_____

_____

_____

What did you use to make your own switch?

_____

_____

_____

# Activity №12

# Two Switches, One Lamp

## Grade Level
5-6

## Overview
This activity starts from an everyday situation, in which one light or appliance is controlled by two switches, which both have to be on for the device to operate. Students find examples of this type of circuit, and then model it using batteries and bulbs.

## Prerequisite
Knowledge of circuits, switches, conductors, and insulators

## Vocabulary
- Circuit
- Conductor
- Insulator
- Switch

*Note: For a review of these concepts and terms, see "Circuit Situations Revealed" in Chapter 2.*

## Skills
- Mapping
- Recording
- Observing
- Investigating

## Standards
- Benchmarks for Science Literacy: 1A, 1B, 3A, 8C, 11A, 11B
- Standards for the English Language Arts: 12
- Principles and Standards of School Mathematics: A1, A3, C3
- National Science Education Standards: A, B, E

## Time Needed
Two 45-minute sessions.

## Materials:
- Worksheet #12: "Two Switches, One Lamp"
- One set-up for each group consisting of the following:
  - D size battery
  - 1.5 volt bulb and socket
  - Bell wire
  - Battery holder
  - Two switches (ready made or home made)
- Small lamp
- Computer power strip

## Procedure
1. Show students the small lamp. Plug it into the computer power strip and plug the power strip into the wall. Ask if they can name two ways to turn the lamp on and off. If necessary, demonstrate for class. Anything plugged into it will turn on only if its own switch and the power strip switch are both on.
2. Divide students into groups providing one set-up per group.
3. Present them with the following challenge: Can you design a circuit that contains two switches, both of which control the flow of electricity to one bulb? Just as with the power strip and lamp switch, both switches have to be on for the bulb to come on.
4. Each group should draw a diagram of the circuit they think would work, and present it to the class.
5. Once each group has a viable diagram, students begin to construct their circuits with switches.
6. If any of the groups are having trouble, ask, "If either switch could stop the bulb from lighting, where would the switches have to be? If only one switch was open, would the other one allow the current to light the bulb?"
7. Each group shares their design after construction.

## Tips
- Allow plenty of time for each group to complete the assignment.
- Encourage students to visit other groups and brainstorm ideas.

**Worksheet for Activity #12**

# "Two Switches, One Lamp"

Name _____

**Draw your circuit design.**

Did your circuit/switches model your design? _____

Did you modify your design? If so, how? _____

How did your design work? _____

Did your design succeed or fail? Why? _____

# Activity №13

# Electric Circuit Board Game

## Grade Level
5-6

## Overview
Students use their knowledge of circuits to design and make an electric question-and-answer board game.

## Prerequisite
Knowledge of circuitry

## Concepts
Electric current behavior

## Skills
- Drawing conclusions
- Modeling
- Designing

## Standards
- Benchmarks for Science Literacy: 8C, 11A, 11B
- Standards for the English Language Arts: 12
- National Science Education Standards: A, B, E

## Time Needed
Two or three 45-minute sessions

## Materials
- Worksheet #13: "Electric Circuit Board Game"
- Oak tag
- Cardboard
- Markers
- Construction paper
- Aluminum foil
- Hole puncher
- Masking tape
- Paper fasteners
- Circuit testers (batteries, bulbs, wires)
- Large heavy duty rubber bands (to hold the game together)

## Procedure
1. Explain to students that they will be creating a game that will indicate right or wrong answers to questions.
2. Divide students into small groups.
3. Have students come up with questions and answers within their favorite curriculum areas to be used in their games.
4. Each group then designs a model of a game board on paper.
5. Here's how to construct the game:
   - On their cardboard game boards, students use pieces of aluminum foil to connect a small hole next to each question with another hole next to its correct answer. Masking tape should be used to insulate the aluminum foil, especially where two pieces of aluminum foil have to cross.
   - Students use oak tag with pre-cut holes to cover the circuitry, so that players can't see the aluminum foil connecting the questions and answers. The questions can be written directly on the oak tag.
6. The game is played using the circuit tester. (See Activity #10.) The player places 1 wire of the circuit tester in a hole next to the question, then places the 2nd wire in the hole next to a possible answer. If the answer is correct, the bulb will light.
7. Let groups take turns playing each others' games.

## Tips
- Review safety rules.
- It is easier to construct the circuit board first.
- Use heavy-duty aluminum foil.
- Model how to fold the aluminum and cover it with masking tape. Alternatively, wire and paper fasteners can be substituted for the aluminum foil.

**Worksheet for Activity #13**

# "Electric Circuit Board Game"

Name _____

**Draw your game board design.**

What problems came up when designing your game board?

What can you change in your design to make it better?

# Activity №14

# Water-Level Alarm

## Grade Level
5-6

## Overview
Students design and construct a float-controlled electric alarm system that lights a bulb or activates a buzzer when the water rises above a certain level. The float carries an automatic switch contact that automatically completes a circuit when it reaches the appropriate level.

## Prerequisite
Knowledge of designing a circuit

## Concept
Electric current behavior

## Skills
- Measuring
- Estimating
- Designing

## Standards
- Benchmarks for Science Literacy: 8C, 11A, 11B
- Standards for the English Language Arts: 12
- National Science Education Standards: A, B, E

## Time Needed
Two or three 45-minute sessions

## Materials
- Worksheet #14: "Water-Level Alarm"
- Plastic basin
- Water
- Insulated wire
- D size batteries
- Battery holder
- 1.5 volt bulbs or buzzers
- Sockets
- Pitchers
- Aluminum foil
- Pencils
- Paper
- Measuring cups
- Scissors
- Floats (styrofoam or wood)
- Screwdrivers
- Nails
- Funnels
- Rulers

## Procedure
1. Review safety and clean-up rules concerning water.
2. Describe this scenario to students: "You have been asked to design a water-level alarm for the sight- or hearing-impaired. It will be used in the bathroom to let a person know when their tub is full."
3. Divide students into small groups and distribute copies of Worksheet #14.
4. Ask each group to plan and draw their designs before starting construction.
5. Review circuits by having the students construct a simple circuit with a switch.
6. You may want to model several types of floats using styrofoam or wood.
7. If students have difficulties, facilitate their work with questions and design tips.
8. Have the groups share their designs with the class and describe their process, problems, and solutions.

## Tip
This lesson can be used as an assessment of Activities 10-13.

**Worksheet for Activity #14**

# "Water-Level Alarm"

Name _____

**Draw and describe your water-level alarm.**

Is this water level alarm made for a sight- or hearing-impaired person?

How would you change the design to make it better?

# Standards for Activities

## Activity #1: What Is a Mechanism?

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A*: Students should develop abilities to do scientific inquiry.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Describing things as accurately as possible is important in science because it enables people to compare their observations with those of others.

## Activity #2: Be a Mechanism Detective

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Principles and Standards for School Mathematics*
*Geometry Standard G4:* Use visualization, spatial reasoning, and geometric modeling to solve problems.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.
*Benchmark #2A:* Mathematics is the study of many kinds of patterns. Patterns are studied because they help to explain how the world works or how to solve practical problems.
*Benchmark #2C:* Mathematicians often represent things with abstract ideas, such as numbers or straight lines.

# Activity #3: What Does a Tool Do?

*Standards for the English Language Arts*
*Standard #12:* Students use spoken written language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.

*Principles and Standards for School Mathematics*
*Geometry Standard G1:* Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

*Benchmarks for Science Literacy*
*Benchmark #1B:* People can often learn about things around them by just observing those things carefully, but sometimes they can learn more by doing something to the things and noting what happens.
*Benchmark #2A:* Things move, or can be made to move, along straight, curved, circular, back-and-forth, and jagged paths.
*Benchmark #3A:* Tools are used to do things better or more easily and to do some things that could not otherwise be done at all.

# Activity #4: Can You Guess My Categories?

*Standards for the English Language Arts*
*Standard #7:* Students conduct research on issues. They gather, evaluate, and synthesize data from a variety of sources to communicate their discoveries in ways that suit their purpose and audience.
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Principles and Standards for School Mathematics*
*Algebra Standard A1:* Understand, patterns, relations, and functions.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere, collecting specimens for analysis, and doing experiments.
*Benchmark #1C:* In doing science, it is often helpful to work with a team and to share findings with others.
*Benchmark #2C:* Numbers and shapes—and operations on them—help to describe and predict things about the world around us.

# Activity #5: Ins and Outs of Inputs and Outputs

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.

*Principles and Standards for School Mathematics*
*Geometry Standard G1:* Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Results of scientific investigations are seldom exactly the same, but if the differences are large, it is important to try to figure out why.
*Benchmark #3A:* Technology enables scientists and others to observe things that are too small or too far away to be seen without them and to study the motion of objects that are moving very rapidly or are hardly moving at all.
*Benchmark #3B:* There is no perfect design. Designs that are best in one respect may be inferior in other ways.
*Benchmark #11A*: In something that consists of many parts, the parts usually influence one another.

# Activity #6: How Do Levers Make Work Easier?

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.

*Principles and Standards for School Mathematics*
*Algebra Standard A1:* Understand, patterns, relations, and functions.
*Data Analysis and Probability Standard DA & P 1*: Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.
*Data Analysis and Probability Standard DA & P 3*: Develop and evaluate inferences and predictions that are based on data.
*Connections Standard C3:* Recognize and apply mathematics in contexts outside of mathematics.
*Measurement Standard M1:* Understand measurable attributes of objects and the units, systems, and processes of measurement.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Results of scientific investigations are seldom the same, but if different it is important to figure out why. Following directions and keeping records of work is a way to provide information on what might have caused the differences.
*Benchmark #2A:* Mathematics is the study of many kinds of patterns, including numbers and shapes and operations on them.
*Benchmark #3A:* Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.

# Activity #7: Simple Machines

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.
*Content Standard E:* Students should develop understanding about science and technology.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think.
*Benchmark #2A:* Mathematics is the study of many kinds of patterns, including numbers and shapes and operations on them. Sometimes patterns are studied because they help to explain how the world works or how to solve practical problems.

# Activity #7 Extension: Looking at Larger Mechanisms

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.
*Content Standard E:* Students should develop understanding about science and technology.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Scientists' explanations about what happens in the world come partly from what they observe, partly from what they think.
*Benchmark #2A:* Mathematics is the study of many kinds of patterns, including numbers and shapes and operations on them. Sometimes patterns are studied because they help to explain how the world works or how to solve practical problems.
*Benchmark #3A:* Technology enables scientists to study the motion of objects that are moving very rapidly or are hardly moving at all.
*Benchmark #3B:* The solution to one problem may create other problems.

# Activity #8: How Does a Retractable Ballpoint Pen Work?

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*Benchmarks for Science Literacy*
*Benchmark #1B:* Scientific investigations may take many different forms, including observing what things are like or what is happening somewhere.
*Benchmark #3A:* Throughout all of history, people everywhere have invented and used tools. Most tools of today are different from those of the past but are modifications of ancient tools.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of position and motion of objects.
*Content Standard E:* Students should develop understanding about science and technology.

# Activity #9: Make a Model of a Mechanism

*Benchmarks for Science Literacy*

*Benchmark #1B:* Scientists do not pay much attention to claims about how something they know about works unless the claims are backed up with evidence that can be confirmed and with a logical argument.

*Benchmark #2C:* In using math, choices have to be made about what operations will give the best results. Results should always be judged by whether they make sense and are useful.

*Benchmark #3B:* There is no perfect design.

*Benchmark #3C:* Any invention is likely to lead to other inventions. Once an invention exists, people are likely to think up ways of using it that were never imagined at first.

*Benchmark #8B:* Discarded products contribute to the problem of waste disposal. Sometimes it is possible to use the materials in them to make new products, but materials differ widely in the ease with which they can be recycled.

*Benchmark #11B*: Seeing how a model works after changes are made to it may suggest how the real thing would work if the same were done to it.

*Benchmark #11D:* Almost anything has limits on how big or small it can be.

*Benchmark #12C:* Choose appropriate common materials for making simple mechanical constructions and repairing things.

*National Science Education Standards*

*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Content Standard B:* Students should develop an understanding of position and motion of objects.

*Content Standard E:* Students should develop understanding about science and technology.

*Principles and Standards for School Mathematics*

*Connections Standard C3:* Recognize and apply mathematics in contexts outside of mathematics.

*Measurement Standard M1:* Understand measurable attributes of objects and the units, systems, and processes of measurement.

*Geometry Standard G1:* Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.

*Geometry Standard G4:* Use visualization, spatial reasoning, and geometric modeling to solve problems.

# Activity #10: Conductors and Insulators

*Benchmarks for Science Literacy*

*Benchmark #1A:* Results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated.

*Benchmark #4G:* Different kinds of materials respond differently to electric forces. In conducting materials such as metal, electric charges flow easily, whereas in insulating materials such as glass, they can move hardly at all.

*Standards for the English Language Arts*

*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*

*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Content Standard B:* Students should develop an understanding of light, heat, electricity and magnetism.

*Principles and Standards for School Mathematics*

*Data Analysis and Probability Standard DA & P 1:* Formulate questions that can be addressed with data and collect, organize, and display relevant data to answer them.

*Data Analysis and Probability Standard DA & P 3:* Develop and evaluate inferences and predictions that are based on data.

# Activity #11: Electric Switches

*Benchmarks for Science Literacy*

*Benchmark #1B:* Scientific investigations may take many different forms including observing what things are like or what's happening somewhere, collecting specimens for analysis, and doing experiments.

*Benchmark #3A:* When trying to build something or to get something to work better, it usually helps to follow directions if there are any or to ask someone who has done it before for suggestions.

*Benchmark #8C:* Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy. Moreover electricity is used to distribute energy quickly and conveniently to distant locations.

Benchmark #11A: Something may not work as well (or at all) if a part of it is missing, broken, worn out, mismatched, or misconnected.

*Benchmark #11B:* Seeing how a model works after changes are made to it may suggest how the real thing would work if the same were done to it.

*Standards for the English Language Arts*

*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*

*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Content Standard B:* Students should develop an understanding of light, heat, electricity and magnetism.

*Content Standard E:* Students should develop understanding about science and technology.

# Activity #12: Two Switches, One Lamp

*Benchmarks for Science Literacy*

*Benchmark #1A:* Results of similar scientific investigations seldom turn out exactly the same. Sometimes this is because of unexpected differences in the things being investigated.

*Benchmark #1B:* What people expect to observe often affects what they actually do observe. Strong beliefs about what should happen can prevent them from detecting other results. One safeguard is to have different investigations conduct independent studies of the same questions.

*Benchmark #3A:* Engineers, architects, and others who engage in design and technology use scientific knowledge to solve practical problems, but they usually have to take human values and limitations into account as well.

*Benchmark #8C:* Different ways of obtaining, transforming, and distributing energy have different environmental consequences.

*Benchmark #11A:* Thinking about things as systems means looking for how every part relates to others. The output from one part of a system (which can include material, energy or information) can become the input to other parts. Such feedback can serve to control what goes on in the system as a whole.

*Benchmark #11B:* Models are often used to think about processes that happen too slowly, too quickly, or on too small a scale to observe directly, or that are too vast to be changed deliberately, or that are potentially dangerous.

*Standards for the English Language Arts*

*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*

*Content Standard A:* Students should develop abilities to do scientific inquiry.

*Content Standard B:* Students should develop an understanding of light, heat, electricity and magnetism.

*Content Standard E:* Students should develop abilities of technological design and understanding about science and technology.

*Principles and Standards for School Mathematics*

*Algebra Standard A1:* Understand, patterns, relations, and functions.

*Algebra Standard A3:* Use mathematical models to represent and understand quantitative relationships.

*Connections Standard C3:* Recognize and apply mathematics in contexts outside of mathematics.

# Activity #13: Electric Circuit Board Game

*Benchmarks for Science Literacy*
*Benchmark #8C:* Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other from of energy. Moreover, electricity is used to distribute energy quickly and conveniently to distant locations.
*Benchmark #11A:* A system can include processes as well as things.
*Benchmark #11B:* Different models can be used to represent the same things.

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of light, heat, electricity and magnetism.
*Content Standard E:* Students should develop abilities of technological design and understanding about science and technology.

# Activity #14: Water-Level Alarm

*Benchmarks for Science Literacy*
*Benchmark #8C:* Electrical energy can be produced from a variety of energy sources and can be transformed into almost any other form of energy. Moreover, electricity is used to distribute energy quickly and conveniently to distant locations.
*Benchmark #11A:* A system can include processes as well as things.
*Benchmark #11B:* Different models can be used to represent the same thing.

*Standards for the English Language Arts*
*Standard #12:* Students use spoken, written, and visual language to accomplish their own purposes.

*National Science Education Standards*
*Content Standard A:* Students should develop abilities to do scientific inquiry.
*Content Standard B:* Students should develop an understanding of light, heat, electricity and magnetism.
*Content Standard E:* Students should develop abilities of technological design and understanding about science and technology.