SCIENCE STANDARDS OF LEARNING
ENHANCED SCOPE & SEQUENCE
GRADE 3

Commonwealth of Virginia
Department of Education
Richmond, Virginia
2005
Introduction

The Science Standards of Learning Enhanced Scope and Sequence is a resource intended to help teachers align their classroom instruction with the Science Standards of Learning that were adopted by the Board of Education in January 2003. The Enhanced Scope and Sequence contains

- units organized by topics from the 2003 Science Standards of Learning Sample Scope and Sequence. Each topic lists the following:
  - Standards of Learning relating to that topic
  - essential understandings, knowledge, and skills from the Science Standards of Learning Curriculum Framework that students should acquire

- sample lesson plans aligned with the essential understandings, knowledge, and skills from the Curriculum Framework. Each lesson contains most or all of the following:
  - an overview
  - identification of the related Standard(s) of Learning
  - a list of objectives
  - a list of materials needed
  - a description of the instructional activity
  - one or more sample assessments
  - one or more follow-ups/extensions
  - a list of resources.

- sample released SOL test items for each organizing topic.

School divisions and teachers can use the Enhanced Scope and Sequence as a resource for developing sound curricular and instructional programs. These materials are intended as examples of ways the understandings, knowledge, and skills might be presented to students in a sequence of lessons that has been aligned with the Standards of Learning. Teachers who use the Enhanced Scope and Sequence should correlate the essential understandings, knowledge, and skills with available instructional resources as noted in the materials and determine the pacing of instruction as appropriate. This resource is not a complete curriculum and is neither required nor prescriptive, but it can be a valuable instructional tool.
Acknowledgments

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Richmond City Public Schools

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Newport News Public Schools

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## Organizing Topic — Investigating Metric Measurement

### Standards of Learning

3.1 The student will plan and conduct investigations in which
   d) volume is measured to the nearest milliliter and liter;
   e) length is measured to the nearest centimeter;
   f) mass is measured to the nearest gram;
   h) temperature is measured to the nearest degree Celsius;
   i) time is measured to the nearest minute.

<table>
<thead>
<tr>
<th>Essential Understandings, Knowledge, and Skills</th>
<th>Correlation to Textbooks and Other Instructional Materials</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students should be able to</td>
<td></td>
</tr>
<tr>
<td>• measure length to the nearest centimeter;</td>
<td></td>
</tr>
<tr>
<td>• (measure) mass to the nearest gram;</td>
<td></td>
</tr>
<tr>
<td>• (measure) volume to the nearest milliliter and liter;</td>
<td></td>
</tr>
<tr>
<td>• (measure) temperature to the nearest degree Celsius;</td>
<td></td>
</tr>
<tr>
<td>• (measure) time to the nearest minute, using the appropriate instrument.</td>
<td></td>
</tr>
</tbody>
</table>
Measuring Length

Overview
Students practice measuring the length of various objects.

Related Standards of Learning
3.1e

Objectives
The students should be able to
• measure length to the nearest centimeter.

Materials needed
Per each group of four or five students:
• Ruler
• Meter stick
• An assortment of objects around the room
Per student:
• Science journal
• Pencil
• “Measuring Length Data Sheet” handout (see p. 4)
• “Measuring Length Application Sheet” handout (see p. 5)

Instructional activity

Introduction
1. Give students the following true/false questions:
   • A brand new pencil is about 10 cm long. (False: most are closer to 20 cm.)
   • A piece of notebook paper is about 28 cm long. (True)
   • An adult hand is about 5½ inches long. (True)
   • A computer disk is about 3 inches long. (True)
   Ask the students, “Which questions were easier to answer? Why?” Go over the answers.
2. Lead a discussion about measuring, including inches, centimeters, and measuring tools. Tell the students that we are usually more used to using inches than centimeters, so we are better at estimating with inches. After today, though, we will all be experts at using centimeters, the metric unit for measuring length. What tool do we use to measure length in centimeters? (rulers or meter sticks)

Procedure
1. Ask students to find three one-centimeter-long objects in the classroom. Then, ask them to find three 10-centimeter-long objects; then three 50-centimeter-long objects; and finally three 1,000-centimeter-long objects. This exercise will enable students to begin to develop a concept of the lengths in centimeters of everyday objects. Have them record their findings on the “Measuring Length Data Sheet.”
2. Review students’ findings by recording answers on a chart. Hang the chart in a visible place in the classroom for quick reference as students work to get better at estimating lengths.
3. Have students estimate the measurement of the following objects, then allow student groups time to find the actual measurements:
   • Length of an unsharpened pencil
   • Length of a new piece of chalk
• Width of pinky finger
• Length of hand from end of thumb (where it connects to the hand) to tip of index finger
• Height of an apple.

**Observations and Conclusions**

1. Ask students for the definition of the term *length*. Then, ask students to name the tool that is used to measure length. Finally, ask them what unit they used to measure length and to give its abbreviation.

**Sample assessment**

• Have the students complete the “Measuring Length Application Sheet.”

**Follow-up/extension**


**Resources**


• *Measurement Resources: Elementary School Lessons & Materials for Teachers*. Math Forum @ Drexel University. [http://mathforum.org/paths/measurement/e.measlessons.html](http://mathforum.org/paths/measurement/e.measlessons.html). Presents ideas and resources for teaching measurement; includes lesson plans, materials, common questions, and software.


# Measuring Length Data Sheet

**Name:** ___________________________  **Date:** ___________________________

## Part One

<table>
<thead>
<tr>
<th>Objects that have a length of about one centimeter</th>
<th>Objects that have a length of about 10 centimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objects that have a length of about 50 centimeters</th>
<th>Objects that have a length of about 1,000 centimeters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Part Two

<table>
<thead>
<tr>
<th>Object</th>
<th>Estimated Length (cm)</th>
<th>Actual Length (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of unsharpened pencil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of new piece of chalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Width of pinky finger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length of hand from end of thumb</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height of apple</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Measuring Length Application Sheet

Name: ___________________________ Date: __________________

1. List one new classroom object (cannot be one used previously) that probably has a length of about one centimeter.

2. List one new classroom object (cannot be one used previously) that probably has a length of about 10 centimeters.

3. List one new classroom object (cannot be one used previously) that probably has a length of about 50 centimeters.

4. List one new classroom object (cannot be one used previously) that probably has a length of about 1,000 centimeters.

5. Circle the tool used to measure length:

   - Ruler
   - Thermometer
   - Stopwatch

6. Circle the unit that measures length:

   - mL
   - L
   - g
   - cm
   - tsp.
   - pt.
Measuring Mass

Overview
Students practice measuring the mass of various objects.

Related Standards of Learning
3.1f

Objectives
The students should be able to
• measure mass to the nearest gram.

Materials needed
Per each group of four or five students:
• Balance
• Gram masses
• Bags of assorted desk objects
• Unsharpened pencil
• 2 x 2 inch pad of sticky notes
• Plastic cup
• Scissors

Per student:
• Science journal
• Pencil
• “Measuring Mass Data Sheet” handout (see p. 8)
• “Measuring Mass Application Sheet” handout (see p. 9)

Instructional activity

Introduction
1. Ask students to tell you what matter is. They will probably respond, “the stuff that something is made of.” Ask them if they could figure out how much mass is in an apple? Tell them that they could find the mass of an apple by placing it on a balance. Show students the balance. Ask students if they know what weight is. Chances are they will say “how heavy something is.” Tell them that weight is how much gravity is pulling on something. Say, “My weight on the moon is a lot less than here. Anyone know why? Because there is less gravity on the moon. But my mass on the moon is the same as here. Mass is the amount of stuff that something is made of. I am still made of the same amount of stuff no matter where I am. The mass of an apple is a measure of the amount of matter it is made of. We measure mass in grams, which can be abbreviated with the letter g.”
2. Demonstrate for students the way to find the mass of an apple, using a balance.

Procedure
1. Ask students to find three objects, each having a mass of one gram. Then, ask them to find three with a mass of 10 grams. Then have them find three with a mass of 50 grams. Finally, have them find three objects with a mass of 1,000 grams. This exercise will enable students to begin to develop a concept of the masses in grams of everyday objects. Have them record their findings on the “Measuring Mass Data Sheet.”
2. Review students’ findings by recording answers on a chart. Hang the chart in a visible place in the classroom for quick reference as students work to get better at estimating masses.
3. Have students estimate the mass of the following objects, then allow student groups time to find the actual masses: unsharpened pencil, 2 x 2 inch pad of sticky notes, plastic cup, banana.

**Observations and Conclusions**

1. Ask students for the definition of the term *mass*. Then, ask students to name the tool that is used to measure mass. Finally, ask them what unit they used to measure mass and to give its abbreviation.

**Sample assessment**

- Have students complete the “Measuring Mass Application Sheet.”

**Follow-up/extension**


**Resources**

# Measuring Mass Data Sheet

**Name:** ____________________________ **Date:** ____________________________

<table>
<thead>
<tr>
<th>Objects that have a mass of about one gram</th>
<th>Objects that have a mass of about 10 grams</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Objects that have a mass of about 50 grams</th>
<th>Objects that have a mass of about 1,000 grams</th>
</tr>
</thead>
<tbody>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Measuring Mass Application Sheet

Name: ___________________________ Date: ________________

1. List one new food item (cannot be one used previously) that probably has a mass of about one gram.

2. Write one new food item (cannot be one used previously) that probably has a mass of about 10 grams.

3. Write one new food item (cannot be one used previously) that probably has a mass of about 50 grams.

4. Write one new food item (cannot be one used previously) that probably has a mass of about 1,000 grams.

5. Circle the tool used to measure mass:

   ![Tool Options]

6. Circle the unit that measures mass:

   mL  in.  g  mm  cm  m  yd.  mi.  tsp.  pt.
Measuring Volume

Overview
Students investigate measuring volume to the nearest liter and milliliter.

Related Standards of Learning 3.1d

Objectives
The students should be able to
• measure volume to the nearest milliliter and liter.

Materials needed
Per each group of four or five students:
• Funnel
• Container of water filled to a depth of two inches
• Beaker, labeled with the word beaker
• Graduated cylinder, labeled with the words graduated cylinder
• Straw marked with a line approximately two inches from one end
• 1-liter soda bottle
• 2-liter soda bottle
• Four assorted containers (e.g., film container, baby food jar, or quart milk container) filled with colored water

Per student:
• Science journal
• Pencil
• “Measuring Volume Data Sheet” handout (see p. 13)

Instructional activity

Introduction
1. Hold up a two-liter bottle of soda. Ask students if they know how much liquid is in the bottle. Most likely some students will know that it is a two-liter bottle. Ask students what liter means. Tell them that a liter is a unit of measure for the volume (or amount) of a liquid. Ask them if they know what unit could be used to measure the volume of liquid in a straw. Tell them that milliliters are used to describe very small amounts of a liquid.

2. Ask students to name some tools used to measure the volume of a liquid. Then show them a graduated cylinder, a beaker, a measuring cup, a teaspoon, a tablespoon, and a liter bottle. Tell students that today they will focus on how to use a graduated cylinder and a beaker to measure volume.

Procedure
1. Divide the class into small groups of four or five students each, and assign a materials manager from each group to secure materials for the group.

2. Tell each group to hold up the graduated cylinder, and practice saying the name “graduated cylinder” together. Ask students to tell you in what unit the graduated cylinder measure is reported. (ml) Tell students that the abbreviation for milliliters is “ml” with no period following. Again, ask students for the unit.
3. Tell students that the graduated cylinder is used to measure small amounts of a liquid and that their first job is to find the volume of liquid in two inches of a straw. Have one student in each group place the straw in the group’s container containing two inches of water, place a thumb over the top of the straw to seal it, and remove the straw from the water. The straw should now contain a two-inch column of water. The students should then carefully place their straws inside the graduated cylinders and release their thumbs.

4. Each group should now find the volume of the water by reading the water level in the graduated cylinder properly. It is important to know that the water in a glass graduated cylinder will have a meniscus (shown in the picture below). This is due to the adhesive property of water — its ability to “stick” to surfaces. When they see this, the water level should be read at its lowest point.

5. To give students a better idea of the size of a liter, ask students to fill the liter soda bottle by filling the beaker with water over and over, keeping track of how many times it is filled, and pouring the water carefully from the beaker into the soda bottle, using the funnel. Then, they should multiply the number of times the beaker was filled by the number of milliliters the beaker holds (or they can add this amount x-number of times). Students should find that it takes 1,000 ml to equal one liter.

6. Give students a variety of containers filled completely with colored water (this will help students to see more readily the water levels and to remember which container they are finding the volume of). Ask students to use the appropriate tool and unit to find the volume of each, and have them record their data on the data sheet or in their notebooks.

Observations and Conclusions
1. Discuss group answers — their differences and what might account for such differences. Review with students the names of the measuring tools used in each step and the corresponding volume units of measure. Ask students to fill in the blank in the following sentence: The measure of the amount of liquid is called its ____________. (volume)

Sample assessment
- Ask students what the best unit would be for each of the following:
  - Volume of water in an aquarium (liter)
  - Volume of liquid in a baby food jar (mL)
  - Volume of liquid that could fit on a quarter (mL)
  - Volume of liquid in a lunch-sized milk carton (mL)
  - Volume of liquid in a gallon of milk (liter)
- Give students a beaker and a graduated cylinder filled with water, and ask them to record the volume in each.

Follow-Up/Extensions
Resources

- *Measurement Resources: Elementary School Lessons & Materials for Teachers.* Math Forum @ Drexel University. [http://mathforum.org/paths/measurement/e.measlessons.html](http://mathforum.org/paths/measurement/e.measlessons.html). Presents ideas and resources for teaching measurement; includes lesson plans, materials, common questions, and software.
# Measuring Volume Data Sheet

Name: ___________________________  Date: __________________

1. Volume of 2 inches of water in straw: _____ mL

2. Number of beakers of water needed to make a liter: _____

3. How many ml are in a liter? _____

<table>
<thead>
<tr>
<th>Container</th>
<th>Volume of Liquid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Virginia Department of Education
Measuring Temperature

Overview
Students practice measuring the temperature of different phases of water.

Related Standards of Learning 3.1h

Objectives
The students should be able to
• measure temperature to the nearest degree Celsius.

Materials needed
• Classroom-size thermometer
• One hot pot
Per each group of four or five students:
• Thermometer
• Three beakers (or clear plastic containers), one containing ice water, one warm water, and one boiling water
Per student:
• Science journal
• Pencil
• Teacher-prepared data sheet handout

Instructional activity
Introduction
1. Lead the students into the activity by having a discussion about temperatures. Ask, “How hot is boiling water? How cold is water that is frozen? What does ‘room-temperature water’ mean? Today we will find out. First we need to know how to read a thermometer. What is the metric unit for measuring temperature?” (degrees Celsius) “Let’s practice reading a few thermometers.”
2. Use a classroom-size teaching thermometer to show students how to read a thermometer. Then have students read a thermometer that is at room temperature.

Procedure
1. Give each group of students two beakers, one containing ice water and one containing room-temperature water. Have them use thermometers to find the temperatures of the water in each and record their information on a teacher-prepared data sheet.
2. When the groups are ready to measure the temperature of the hot water, carefully pour some boiling water into a beaker for each group, one by one, and have each group quickly determine the temperature and record it on the data sheet. Do not pour the hot water ahead of time as it will lose some of its heat while students are taking the temperatures of the water in the other beakers. (Safety Note: Make certain that the students do not touch the hot beaker!) Another option is to do this step as a demonstration for the whole class.

Observations and Conclusions
1. Go over students’ results. Tell students that water freezes at 0°C and boils at 100°C. Ask students how the temperature of the room-temperature water compared with the air temperature shown on
the thermometers at the beginning of the lesson. (It should be the same, because room-temperature water means that the water is at the same temperature as the air in the room.)

**Sample assessment**

- Use the large teaching thermometer to display different temperatures, and have the students read the thermometer for each. Then, ask a student to come up and set the temperature to freezing. Have another student set it to boiling.

**Follow-up/extension**


**Resources**


- *Planning by Design Lesson Plans, Grade 3*. Richmond Public Schools. This lesson has been adapted from this source.
Measuring Time and Temperature

Overview
Students investigate the relationship between time and temperature and the temperature at which sugar will dissolve the fastest.

Related Standards of Learning 3.1i

Objectives
The students should be able to
• measure time to the nearest minute and second.

Materials needed
• One hot pot
Per each group of four or five students:
• Thermometer
• Three beakers (or clear plastic containers), one containing ice water, one warm water, and one boiling water
• Sugar
• Metal tablespoon
• Stopwatch
• “How Long Does It Take Sugar to Dissolve?” handout (see. p. 18)

Instructional activity

Introduction
1. Introduce the activity with a discussion about dissolving sugar in tea. Make sure students understand the meaning of the term dissolve. Then ask, “Have you ever tried to stir sugar into a glass of iced tea? What about hot tea? What about warm tea? Can you predict which kind of tea allows the sugar to dissolve the fastest? Today we’ll find out. We’ll use the second hand on the clock to measure how long it takes.”
2. Practice measuring time (in seconds), using the clock. Explain that you will clap your hands when the second hand gets to the twelve, and then clap them again a certain number of seconds later. The students must tell how much time went by between claps. Practice this several times. Tell them to watch the clock! Take student responses, and look for students that need some help.
3. Show students how to use a stopwatch to measure time.

Procedure
1. Give each group of students two beakers, one containing ice water and one containing room-temperature water. Have them use thermometers to find the temperatures of the water in each and record their information on a teacher-prepared data sheet.
2. When the groups are ready to measure the temperature of the hot water, carefully pour some boiling water into a beaker for each group, one by one, and have each group quickly determine the temperature and record it on the data sheet. Do not pour the hot water ahead of time as it will lose some of its heat while students are taking the temperatures of the water in the other beakers. (Safety Note: Make certain that the students do not touch the hot beaker!) Another option is to do this step as a demonstration for the whole class.
3. Have students stir one tablespoon of sugar into the hot water and measure (in seconds) how long it takes to dissolve completely. (Safety Note: Make sure students do not touch the hot water when
For safety reasons, the teacher may choose to execute this step as a classroom demonstration.

4. Have the students stir one tablespoon of sugar into the ice water and measure how long it takes to dissolve completely. Then have them repeat this process with the room-temperature water.

**Observations and Conclusions**

1. Go over students’ results. Tell students that water freezes at 0°C and boils at 100°C. Ask students how the temperature of the room-temperature water compared with the air temperature shown on the thermometers at the beginning of the lesson. (It should be the same, because room-temperature water means that the water is at the same temperature as the air in the room.) Have students share the results of their experiment regarding what temperature of water dissolved sugar the fastest.

**Sample assessment**

- Have students use the clock to measure (in minutes) how long it takes for ice water to get warmer than 0°C.

**Follow-up/extensions**

- Ask students to predict how salt might react in the three temperatures of water used in this lesson. Repeat the experiments with salt to confirm predictions.

**Resources**

How Long Does It Take Sugar to Dissolve?

Purpose: To see how fast sugar will dissolve in different temperatures of water.

Hypothesis: If the water is warmer, then sugar will dissolve _______.
(faster or slower)

Data Table

<table>
<thead>
<tr>
<th>Type of Water</th>
<th>Temperature (°C)</th>
<th>Time to Dissolve (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Freezing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Room-temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boiling</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Which temperature of water allowed sugar to dissolve the fastest? ______

Which temperature of water allowed sugar to dissolve the slowest? ______

Was your hypothesis supported in this experiment? ______
Sample Released SOL Test Items

Which of these beetles is 5 centimeters long?

A

B

C

D

Note that due to varying printer properties, measurement items may not appear in exact proportions.

What is the volume of salt water in this cylinder?

- A 40 mL
- B 41 mL
- C 44 mL
- D 50 mL

What is the temperature of the air around the thermometer?

- F 0°Celsius
- G 3°Celsius
- H 5°Celsius
- J 8°Celsius
What is the volume of water in the dropper?

A 2.0 milliliters
B 2.2 milliliters
C 20 milliliters
D 25 milliliters

The mass of this insect is —

F 1 g
G 2 g
H 3 g
J 4 g
Organizing Topic — Investigation Skills

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

Essential Understandings, Knowledge, and Skills

The students should be able to

• develop hypotheses from simple questions. These questions should be related to the concepts in the third-grade standards. Hypotheses should be stated in terms such as the following: “If an object is cut into smaller pieces, then the physical properties of the object and its smaller pieces will remain the same.”;

• make and communicate predictions about the outcomes of investigations;

• make and communicate careful observations;

• communicate results of investigations by displaying data in the form of tables, charts, and graphs. Students will construct bar graphs, picture graphs, and line plots to display data (Example: 3.7 — comparison of types of soil and their effect on plant growth);

• classify objects into at least two major sets and subsets based on similar characteristics, such as predator/prey and herbivore, carnivore, and omnivore;

• sequence natural events chronologically (Example: 3.9 — plant and animal life cycles, phases of the moon, the water cycle, and tidal change).
Hypothesize This!

Overview
Students develop a hypothesis for a simple experiment.

Related Standards of Learning
3.1c

Objectives
The students should be able to
- develop hypotheses from simple questions. These questions should be related to the concepts in the third-grade standards. Hypotheses should be stated in terms such as the following: “If an object is cut into smaller pieces, then the physical properties of the object and its smaller pieces will remain the same.”

Materials needed
Per each group of four or five students:
- Three metal washers of various sizes
- Three pieces of string, each 50 cm long
- Clock with a second hand, or a stopwatch
Per student:
- Science journal
- Pencil
- “Hypotheses Assessment Sheet” handout (see p. 24)
- “Pendulum Data Sheet” handout (see p. 25)

Instructional activity

Introduction
1. Introduce the activity by asking the students the following questions: “Have you ever wondered what might happen if you added food coloring to the water in which flowers are placed? Have you ever thought about whether or not plants can grow in the dark? Did you ever stop to consider the number of paper clips different magnets can pick up? If you’ve ever thought these things, then you probably have made a hypothesis.”

2. Discuss the term hypothesis with the students — that it is an educated guess about what will happen. It is much like a prediction as to how an experiment will turn out. It is not just a guess, however. It is based upon what you already know about something. For example, you might already know that plants make their own food, using light energy from the sun. If you know that, you might hypothesize or predict that plants cannot grow in the dark. This isn’t just a guess; it’s based upon what you already know about plants.

Procedure
1. Ask students how the swinging of a pendulum might be affected by the size of the weight on the pendulum. Have them predict or hypothesize about the answer to this question. It may be necessary to show students a pendulum made from a washer tied to the end of a piece of string 50 cm long and to let them count the number of swings it makes in one minute.

2. Next, ask students to identify the independent or manipulated variable that will change each time we try this (the size of the washer). Then ask them to identify the dependent or responding variable that will change as a result of changing the size of the washer.
(the number of swings). Ask students to write their hypothesis in this format: “If the size of the washer gets bigger, then the number of swings __________.” (Note: Students are not expected to know the terms independent/manipulated variable and dependent/responding variable at this level. However, it would be appropriate for students to identify what is being changed in an experiment and what happens as a result of that change.)

3. Next, allow students to test their hypothesis by giving each group three different-size washers and three pieces of string of the same length. Have each group count the number of swings in one minute of each washer, using a clock with a secondhand or a stopwatch. Ask students to record their data on the “Pendulum Data Sheet.”

4. Go over the data with students, and ask them to tell whether their hypothesis was supported by the data or not. Remind students that one experiment does not prove a hypothesis; it can only support the hypothesis since the next time you try the experiment, your data may be different.

5. Give students the following three questions:
   - Does the amount of soil affect how tall a potted plant will become?
   - Does the age of a person affect how fast he/she can run?
   - Does the weight of the paper affect the distance a paper airplane will fly?
Have each group identify for each question what was changed in the experiment and what was the result of that change.

6. Check group responses. Then ask them to write a hypothesis for each question in this form: “If the __________ increases (or decreases), then the __________ __________________.” (for example: “If the amount of soil increases, then the height of the plant __________.”).

7. Check students’ hypotheses from this guided practice. Ask students to explain any differences in student responses.

Observations and Conclusions
1. Have student groups write four different hypotheses that could be tested. They should write the hypotheses in the form in step 6 above.

Assessment
- Have students complete the “Hypotheses Assessment Sheet.” (see next page).

Resources
Hypotheses Assessment Sheet

Name: ________________________________ Date: __________________

Directions: Answer the following questions and write a hypothesis for each:

1. Does the amount of water added to a plant affect the height to which it will grow? _____
   
   If the amount of water is greater, ____________________________.

2. Does the size of the rubber ball affect the height to which it will bounce? _____
   
   If the rubber ball is bigger, ____________________________.

3. Does the length of a ramp affect the distance a matchbox car will travel across the floor? _____
   
   If the ramp is longer, ____________________________.
Pendulum Data Sheet

Name: ____________________________ Date: ______________

Record your data for the pendulum experiment in the table below:

<table>
<thead>
<tr>
<th>Size of the washer on the pendulum</th>
<th>Number of swings in one minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small washer</td>
<td></td>
</tr>
<tr>
<td>Medium washer</td>
<td></td>
</tr>
<tr>
<td>Large washer</td>
<td></td>
</tr>
</tbody>
</table>

What do you notice about the data? As the washer gets larger, what happens to the number of swings?
Did You Observe That?

Overview
Students make observations of a common object.

Related Standards of Learning
3.1a

Objectives
The students should be able to
- make and communicate careful observations.

Materials needed
Per each group of four or five students:
- Magnifying glass
- Ruler
- Balance scale and masses
Per student:
- Pebbles or gravel — at least one piece for each student. (Small river rocks will work well.)
- Science journal
- Pencil
- “Pebble Observations Data Sheet” handout (see p. 28)
- “Observations Data Sheet” handout (see p. 29)

Instructional activity

Introduction
1. Have someone from another classroom or the office stop by your class to deliver a package or folder. After the delivery person leaves, ask students to describe what the person looked like, was wearing, etc. If possible, have the person return in 10 or 15 minutes to let the students check the accuracy of their observations.
2. Tell students that observational skills are used every day, for example, when people fix their hair, cross the street, measure a piece of wood before cutting it, or measure the ingredients for a recipe. Tell them that today, they are going to test their skills of observation. Observations can be made unaided with all of the five senses (taste, touch, sight, smell, and hearing) as well as with the assistance of observational tools, such as a ruler, a magnifying glass, or a scale.

Procedure
1. Give each student a pebble and a copy of the “Pebble Observations Data Sheet.” Ask the students to write down as many observations about their pebble as they can. They may use any observational tool available to them (e.g., a ruler, a magnifying glass, and a balance scale) to assist them. Give students about five to ten minutes to observe and write. Move about the room, praising good observations aloud as students write in order to encourage other students to include more.
2. Ask students to raise their hands when they feel they have made careful observations. Then collect all the pebbles in one container, mix them up, and ask each student to find his or her pebble. After the students have found theirs, ask them to tell which observations were most helpful in making the identification. Students should discover that those who included descriptions of the pebble (qualitative observations) as well as measurements of the pebble (quantitative observations) could more easily identify their pebble.
3. Give students different pebbles, and ask them again to make observations that will help them identify their pebble from all the pebbles mixed together.

4. Again, mix all the pebbles, and have students find theirs. Ask them what they did differently this time to make the task easier.

**Observations and Conclusions**

1. Ask students to write a descriptive paragraph about their pebble. After editing their paragraphs, they may type their descriptions on the computer and insert a clip art picture of a pebble. Print out the finished documents, and have the students glue their real pebbles to their descriptions and hang the documents on a bulletin board.

2. Have the students complete the “Observations Data Sheet” found on p. 29.

**Sample assessment**

- Assess the paragraphs the students completed during the activity.
- Assess the observations recorded on the “Observations Data Sheet” during the activity.

**Follow-up/extension**

- Have each student sit at a table across from a partner with a large upright book acting as a barrier in between. Partners should be able to see each other but not what is on the table in front of their partner. Using attribute shape blocks, one student uses several blocks to make a design and then uses descriptive words to try to get his/her partner to duplicate the design. The only restriction is that color or shape words may not be used to describe the blocks.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Pebble Observations Data Sheet

Name: ___________________________ Date: _____________________

Record your observations of your pebble below.
Observations Data Sheet

Name: ___________________________ Date: __________________

Directions: Write five observations for each of the following things. At least two observations in each group of five should be measurements.

1. My science notebook:
   ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________

2. My pencil:
   ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________

3. My desk:
   ____________________________
   ____________________________
   ____________________________
   ____________________________
   ____________________________
Based on What I Know, I Predict

Overview
Students make predictions based on observations.

Related Standards of Learning 3.1a, j

Objectives
The students should be able to
• make and communicate predictions about the outcomes of investigations.

Materials needed
• One gallon-size zip bag filled with water to a depth of about three inches
• One sharpened pencil
Per group of students:
• One plastic cup filled about 1/3 full with water colored blue with food coloring
• One plastic cup filled 1/3 full with clear vegetable oil
• One cup of clear water
• One tsp. salt
• One plastic spoon
Per student:
• Science journal
• Pencil
• “Prediction Data Sheet” handout (see p. 32)

Instructional activity

Content/Teacher Notes
This lesson is an introductory lesson for students to learn how to make predictions based on their observations and previous knowledge.

Introduction
1. Ask students to make an educated guess about what might happen if you put water in a pot on the stove and turn the heat on under it. Take students answers. Tell them that any time they make a guess about what might happen, they are making a prediction.

Procedure
1. Show the class the bag containing three inches of water. Ask students to predict what might happen if the sharpened pencil were pushed through the bag down where the water is. Ask them to write their prediction on a piece of paper. When they are finished writing, have some students share their predictions with the class. Then stick the pencil through the bag. Surprisingly, no water leaks out! Tell students that sometimes our predictions are correct and sometimes they are not.
2. Give each group of students a plastic cup filled with blue water and another cup filled with vegetable oil. Ask students to predict what will happen if the blue water is poured into the cup containing vegetable oil. After their predictions are made, ask them to try it. Have students write down what happened and whether their prediction was correct. Have students share their results with the class.
3. Ask the students, “What is a prediction? What would you predict might happen if I placed a magnet near a paper clip? What if I held a penny in my hand above my head and then let go of it?” Discuss the difference between an educated guess and a wild guess.

**Observations and Conclusions**

1. Ask students to make a prediction of what will happen when salt is mixed with water. Then have students try it and record their findings on the “Prediction Data Sheet” found on the next page.

**Sample assessment**

- Informally assess students’ responses and observations during the lab activity.

**Follow-up/extension**

- Have each student create an activity that will have an unexpected result. Then, have the students share these with other students, asking them to make predications.

**Resources**

Prediction Data Sheet

Name: ___________________________ Date: __________________

1. Write a prediction about what will happen when salt is mixed with water.

2. Mix some salt with water and explain what actually happens.
Classifying with Class

Overview
Students classify some common objects into two major sets and subsets.

Related Standards of Learning 3.1b

Objectives
The students should be able to
• classify objects into at least two major sets and subsets based on similar attributes.

Materials needed
• Overhead attribute blocks
Per each group of four or five students:
• One bag of pasta in assorted shapes, sizes, and colors
• Bag of assorted buttons (Leaves or rocks can be substituted for buttons.)
Per student:
• Science journal
• Pencil

Instructional activity

Content/Teacher Notes
Tell students that scientists use classification to help them identify unknown objects. For example, if a new dinosaur skeleton is found, scientists use what they already know about dinosaurs to decide how to classify the newly discovered skeleton. They compare it to known dinosaur skeletons to decide how large it was, where it lived, what it ate, etc., and then classify it with the ones it most resembles.

Introduction
1. Place overhead attribute blocks on the overhead. Arrange them into two groups according to a certain property or attribute (e.g., shape, color, or size). Ask students to figure out what property you used to place them into these two sets.
2. Ask students to form a yes-or-no question that uses this property and that would help them put more shapes into these two groups. For example, “Does the shape have four sides?” Yes: goes into group one; No: goes into group two. Try this several more times using these shapes. Tell students that to classify means to put objects into groups based upon similar properties or attributes.

Procedure
1. Give each group of students a bag of assorted pasta. Ask one member of each group to separate (classify) the pasta into two sets based on a particular property or attribute that he or she secretly decides.
2. Have the other members of each group figure out the property or attribute used to classify the pasta and devise a yes-or-no question that could have been used to classify each piece of pasta. For example, “Does it have two sides?” or, “Is it green?”
3. Assign another student in each group to classify the pasta according to a different attribute, and have the remaining group members repeat the process.
4. Give each group a bag of assorted buttons. Ask them to classify the buttons into two sets based on a particular attribute and using the same yes/no process. Then, ask the groups to separate each of
these sets into two subsets based on different attributes and again using the yes/no process. Have students record their classifications in their science journals.

5. Next, give each group a new button, and ask the students to figure out where the button should go—i.e., to classify it—using their new classification system. Repeat this step with several new buttons.

6. Have students separate these sets of buttons into two subsets based on different properties. Have them practice this step with some more buttons.

**Observations and Conclusions**

1. Have the students discuss and share the different ways that they classified their sets of buttons. Discuss whether there is one right way to classify the buttons.

**Sample assessment**

- Give students a bag of assorted balls, and have them develop a classification system to separate the balls into two sets and then two subsets. Have students write down the yes-or-no questions they use for classifying the balls.

**Follow-up/extension**

- Connect this activity with other third-grade science content. For example, when starting the unit on soil, have students look at different types of soil and make a classification system for them. For the unit about mixtures, have students classify different types of mixtures based on observations.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Using Tables, Charts, and Graphs

Overview
Students practice some basic graphing skills, using data they collected and data from a table.

Related Standards of Learning 3.1g

Objectives
The students should be able to
• communicate results of investigations by displaying data in the form of tables, charts, and graphs;
• construct bar graphs, picture graphs, and line plots to display data.

Materials needed
• Aquarium filled with water
• A dime, a penny, a nickel, and a quarter
• Several stopwatches or a clock with visible second hand
Per student:
• Science journal
• Pencil
• “Bar and Picture Graph Scoring Sheet” handout (see p. 37)
• “Line Plot Scoring Sheet” handout (see p. 38)

Instructional activity
Content/Teacher Notes
Third-grade students should use graphs frequently in math and science classes. Many of the scientific investigations that students conduct throughout the year are good opportunities to incorporate graphing into the class activity.

Introduction
1. Ask students to predict which coin would fall faster through an aquarium filled with water: a dime, a penny, a nickel, or a quarter. Ask them how they might test their hypothesis, and take their responses. Then ask them how data for such an experiment might be recorded. Lead students to realize that data tables and graphs can be used to record and display such data.

Procedure
1. Before beginning the activity, have students construct a table in their journal similar to the one shown at right to record the data they will be collecting.

<table>
<thead>
<tr>
<th>Coin</th>
<th>Drop 1 time (sec.)</th>
<th>Drop 2 time (sec.)</th>
<th>Drop 3 time (sec.)</th>
<th>Drop 4 time (sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penny</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dime</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quarter</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Designate one student to be the dropper of the coins for the class, and designate several students to be timers. These students should time how long it takes the coin to fall from just above the surface of the water to the bottom of the tank. Time should begin the moment the coin leaves the dropper’s hand. The dropper should execute the same procedure for each drop to keep the experiment fair.

3. Have students conduct at least four trials for each coin and record the data in their table.
Observations and Conclusions
1. Ask students questions, such as: “Why do we use data tables? Why do we use picture graphs, line plots, bar graphs? What information can we tell from looking at our graphs?”
2. Have students use their data table and the “Bar and Picture Graph Scoring Sheet” to create a bar graph, a picture graph, and a line plot of the data.

Sample assessment
- Have the students copy the data table shown at right, and then have them draw a bar graph, using the data.

Mrs. Nettle’s Class’ Favorite Colors

<table>
<thead>
<tr>
<th>Colors</th>
<th>Number of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>14</td>
</tr>
<tr>
<td>Red</td>
<td>9</td>
</tr>
<tr>
<td>Green</td>
<td>5</td>
</tr>
</tbody>
</table>

Follow-up/extension
- Have students poll classmates on favorite activities, record the collected data in the table, and make a graph showing the results.
- Give students questions to ask their family about likes and dislikes, display the collected data in a class table, and then have students graph the results based on the whole-class data.
- Have students conduct a survey of birds they see outside their classroom for a month and then graph the results.
- Have students record the daily temperature for a month and then graph the results. Do this for the whole year, and have students look for trends and compare month-to-month data.

Resources
- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
Bar and Picture Graph Scoring Sheet

Name: __________________________________________ Date: ____________________

1. My graph has a title above it that tells what the graph shows. ______ Points (The most you can get is 5.)

2. My graph has a description under the X-axis (the axis that goes across). ______ Points (The most you can get is 5.)

3. My graph has a description beside the Y-axis (the axis that goes up and down). ______ Points (The most you can get is 5.)

4. My graph has bars or pictures that accurately show the data from my data table. ______ Points (The most you can get is 5.)

5. My graph is neat and easy to read. ______ Points (The most you can get is 5.)

Line Plot Scoring Sheet

Name: _______________________________ Date: __________________

1. My line has a description of what the line plot shows. ______ Points (The most you can get is 5.)

2. The Xs above my line accurately show the data. ______ Points (The most you can get is 5.)

3. My graph is neat and easy to read. ______ Points (The most you can get is 5.)

Sample Released SOL Test Items

<table>
<thead>
<tr>
<th>Average Date of the Last Frost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Richmond</td>
</tr>
<tr>
<td>Norfolk</td>
</tr>
<tr>
<td>Abingdon</td>
</tr>
<tr>
<td>Front Royal</td>
</tr>
</tbody>
</table>

Based on the chart, farmers near which city would plant their crops the earliest in the spring?

F Richmond
G Norfolk
H Abingdon
J Front Royal

Insects have six legs and three major body parts. Which of the animals below belongs in Box B with the other insects?

F
H
G
J
<table>
<thead>
<tr>
<th>Student</th>
<th>Favorite Flavor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joe</td>
<td>chocolate</td>
</tr>
<tr>
<td>Juan</td>
<td>vanilla</td>
</tr>
<tr>
<td>Jim</td>
<td>chocolate</td>
</tr>
<tr>
<td>Rose</td>
<td>strawberry</td>
</tr>
<tr>
<td>Sue</td>
<td>chocolate</td>
</tr>
<tr>
<td>Kim</td>
<td>vanilla</td>
</tr>
</tbody>
</table>

Which graph best represents the data above?

A

![Graph A](image)

B

![Graph B](image)

C

![Graph C](image)

D

![Graph D](image)

Which of these animals should be in a group that has six legs and only two wings?

F

![Animal F](image)

H

![Animal H](image)

G

![Animal G](image)

J

![Animal J](image)

The animals in box B are different from the animals in box A because the animals in box B have —

A short legs  
B feet for catching food  
C feathers  
D long beaks
The following chart shows the growth of two flowers for four weeks.

![Plant Growth Chart]

Which week did the wildflower grow the most?

- F Week 1
- G Week 2
- H Week 3
- J Week 4
Organizing Topic — Investigating Matter

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.3 The student will investigate and understand that objects are made of materials that can be
described by their physical properties. Key concepts include
   a) objects are made of one or more materials;
   b) materials are composed of parts that are too small to be seen without magnification; and
   c) physical properties remain the same as the material is reduced in size.

Essential Understandings, 
Knowledge, and Skills

The students should be able to

- infer that objects are made of one or more materials, based on observations of the physical properties that are common to each individual object.
- compare the physical properties of small pieces of a material to the physical properties of the entire material.
- conclude that materials have their own set of physical properties that are observable.
- explain that physical properties are observable characteristics that enable one to differentiate objects.
- design an investigation to determine if the physical properties of a material will remain the same when the material is reduced in size.
Science Enhanced Scope and Sequence – Grade 3

Matter Matters

Overview
Students investigate mixtures, solutions, and the physical properties of matter by observing “mystery substances.”

Related Standards of Learning 3.3a

Objectives
The students should be able to
• conclude that materials have their own set of physical properties that are observable.

Materials needed
Per group of students:
• One tsp. salt sealed in plastic bag labeled “Mystery Substance 1”
• One tsp. sugar sealed in plastic bag labeled “Mystery Substance 2”
• One tsp. sand sealed in plastic bag labeled “Mystery Substance 3”
• One tsp. clay sealed in plastic bag labeled “Mystery Substance 4”
• One tsp. barley flour sealed in plastic bag labeled “Mystery Substance 5”
• Five 4-inch squares of black paper numbered 1, 2, 3, 4, and 5
• Magnifying glass
• One-tsp. measuring spoon
• One-tbsp. measuring spoon
• One small bottle filled with at least 7 tbsp. of warm water
• Handful of dried grass
• Five small plastic cups labeled “Mystery Substance 1, 2, 3, 4, or 5”
• “Mystery Substance Observation Sheet” handout (see. p. 46)

Instructional activity

Content/Teacher Notes
In this investigation, students use their observation skills to investigate five different powdered substances, some of which dissolve and some of which do not. Students must solve the mystery of which substances would make good bricks and which would make good bread.

Concentrate on describing objects in terms of their physical properties. You might want to mention that when salt or sugar form a solution, something happens that we can’t see without magnification. However, once the water evaporates, the salt or sugar is left behind. You might also talk about how sand and clay are formed as rock erodes yet still have many of the same properties as the original rock, which makes them good choices for making bricks.

You may want to go over the following vocabulary words during this activity. The term dissolve is hard to define in words at a lower elementary level. Let the students experience what dissolve means and then define it. The students will see that the salt seems to disappear when it is in solution (dissolved in water), but that it appears again once the water has evaporated.

• Dissolve: to break into component parts or to pass into solution
• Mixture: something made up of a combination of different substances; two or more elements or compounds that are blended without combining chemically
• Solution: a mixture in which one substance (the solute) is dissolved in another substance (the solvent).
Introduction

1. If your class has never done an activity that focuses on observation of physical properties, you may start by asking, “What are the five senses?” As the students name the five senses, write them as headings on the board. Put a handful of dried grass (an ingredient in Egyptian bricks) where everyone can see it. Ask for descriptive words about grass for each of the senses — i.e., a few words to put under the headings Sight, Hearing, Touch, and Smell. Put an X over the Taste heading, and stress that scientists never taste their experiments! Ask students why they think this might be.

2. Once the students seem to have the concept of physical properties, summarize their descriptions, and tell them that they have just described the physical properties of grass. Reinforce the definition of physical property — something that can be observed using the five senses.

Procedure

1. Divide the class into five groups, and provide each group with a table or other appropriate surface for this experiment. Put a sheet of newspaper in the middle of the table, and have paper towels available so that the students can clean their fingers as needed.

2. Distribute the five bags of mystery substances to each group, and allow the students to examine them with the proviso that they must keep the bags sealed until you give them permission to open them. Also, tell the students that they must not smell or taste the substances. Good scientists never taste their experiments, and they use special smelling techniques when they use their sense of smell. Distribute the black paper squares and the magnifying glass to each group.

3. **Sight Observations:** Ask the students to observe each substance and write down at least four things they notice about it, using their unaided eyes. Then, ask them whether they can think of a tool that might help them see the substances more closely. Allow them to use the magnifying glass to make the observations again. If they need guidance, prompt them with questions, such as: “What color is the substance? Does it cling to the bag? How large or small are its particles?” Again, have the students write down at least four things they notice about each substance.

4. **Hearing Observations:** Warn the class that they must be very quiet during this step. Ask for a volunteer in each group to be the bag opener. The bag opener should carefully open the first bag. One of the other students should take a small pinch of Mystery Substance 1. The bag opener should then reseal the bag. Then the whole group should listen as the pincher lets the substance fall to the sheet of black paper numbered “1.” This procedure is then repeated for each of the other substances with a pause after each “drop” to let the students write down their observations.

5. **Touch Observations:** Next, the students should take turns touching each of the substances on the numbered sheets. If they need prompting, you might ask if the substance feels grainy or soft. Have the students write down their observations.

6. The class will expect the smell observations to come next. Surprise! Explain that you will come back to the smell observations after the next step. Smelling powdery substances can irritate the sinuses. Pass out the sets of labeled cups and the bottles of warm water.

7. Ask for a volunteer to be the water measurer. The water measurer should use the measuring spoon to measure and pour 1 tbsp. of warm water into each of the cups. Next the bag opener should carefully open the first bag. One of the other students should use the small measuring spoon to measure out 1 tsp. of Mystery Substance 1. The bag opener should then reseal the bag. The whole group should watch carefully as the substance measurer pours the tsp. of Mystery Substance 1 into the cup labeled Mystery Substance 1. The substance measurer should then gently swirl the cup around until the substance is completely wet. Repeat this procedure for each of the substances.
Some will dissolve, others will not. Pause between each step to let the students record their observations.

8. **Smell Observations**: Tell the students that scientists have a special technique for smelling unknown substances. It’s called wafting. The scientist gently waves a hand above the substance toward the nose and sniffs gently. (There are no dangerous substances in this experiment; however, it’s never a good idea to take a deep lungful of a completely unknown substance.) Let the students take turns wafting and smelling the substances in the cups and writing down their observations.

9. At the end of the exercise, let each group pick a different place to put their cups on a tray or piece of cardboard. You might suggest the windowsill, a shady corner, a shelf in a closet, an area far away from the heating source, and an area near the hearing source. Remind the students to check on the substances every day for the next week or so. Have students record their observations, and discuss them with the class.

**Observations and Conclusions**

1. Review the observations that the students made of the substances. You may want to make a list on the board. Let students hypothesize as to what each substance may be.

2. You may want to give them the list of possibilities for the substances at this point to see if they can match the correct name to each substance.

3. After students have matched names to the substances, have them tell what each substance is and describe how they came to each conclusion. Then, reveal the true names of the substances, and compare these to the students’ conclusions. Discuss any incorrect conclusions.

4. Review which of the substances dissolve in water and which do not.

**Sample assessment**

- Have students explain in their science journals what physical properties helped them to distinguish between one substance and another.
- Provide students with two very different objects and have students compare and contrast their physical properties.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs*. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Mystery Substance Observation Sheet

Group Names: ________________________________________________

_________________________________________________________

Mystery Substance # ___

Sight: _______________________________________________________

_________________________________________________________

Hearing: ____________________________________________________

_________________________________________________________

Touch: ______________________________________________________

_________________________________________________________

Smell: ______________________________________________________

(WARNING: Do the sense of smell observation only after you mix the mystery substance with water. Powdery substances can irritate your sinuses.)

Describe what happened when this mystery substance was mixed with water:

Did the substance dissolve? ______ (Yes or No)

Did the water get cloudy? ______ (Yes or No)

Did the color change? ______ (Yes or No)

Did the substance sink immediately? ______ (Yes or No)

Did the substance float at first? ______ (Yes or No)

Conclusions:

My group’s hypothesis is that this mystery substance is ______________.

This mystery substance turned out to be ______________.
Investigating Matter: Size

Overview
Students investigate mixtures and the fact that changing the size or shape of an object does not change its physical properties.

Related Standards of Learning 3.3a, b, c

Objectives
The students should be able to
• explain that physical properties are observable characteristics that enable one to differentiate objects;
• infer that objects are made of one or more materials, based on observations of the physical properties that are common to each individual object;
• compare the physical properties of small pieces of a material to the physical properties of the entire material;
• design an investigation to determine if the physical properties of a material will remain the same when the material is reduced in size;
• use a microscope to view material too small to be seen without magnification.

Materials needed
• Science journals
• Sand
• Salt
• Plastic cup and spoon
• Water
• Paper coffee filter
• Burner
• Pot
• Microscope (digital, if available)
• Magnifying lens

Instructional activity

Content/Teacher Notes
There are four states of matter: solid, liquid, gas, and plasma. In third grade, the students are held responsible for solid, liquid, and gas.

• Solid: the state of matter in which the molecules are close together; it has a definite volume and shape.
• Liquid: the state of matter in which the molecules are further apart; it has a definite volume but takes on the shape of its container.
• Gas: the state of matter in which the molecules are very far apart; it takes on the volume and shape of its container.

All matter is made up of molecules. The small particles that make up matter are called atoms. All matter has mass and takes up space (volume).
Matter can be described by its physical properties: color, size, shape, smell, feel, and sound.
**Part 1: Introduction**

1. Tell the students that everything in the world is made up of matter. It is all around us. Have the students look around the room, spot as many solids, liquids, and gases as they can, and name them. Be sure to include air in this discussion. Ask, “Since we can’t see air, which of the five senses can we use to observe it?” (We can feel it; therefore, we use our sense of touch to observe air.)

2. Talk to the students about how the molecules of solids, liquids, and gases are different. This is what makes matter different. Ask, “Is an object always made up of only one type of matter?”

3. Hold up a baggie containing a solid (e.g., a rock or ball), and introduce the term *solid*. Take the solid out of the bag, and ask students to look at it, feel it, etc. Ask, “Does it take up space? Does it have weight? Does it keep its shape?” Ask for other examples of solids and other properties of solids, recording them on a chart or the board.

4. Hold up a zip baggie containing water, and introduce the term *liquid*. Pass the baggie around, and let the children examine it. Ask, “Does the liquid take up space? Can you see it? Does it have weight? Does it keep its shape?” Pour the water into a clear plastic cup so the children can see that the liquid takes the shape of its container. List other liquids, discuss their properties, and record them on the chart or board.

5. Blow air into a third baggie, seal it, and introduce the term *gas*. Discuss with children: “What’s in the baggie? Does it take up space? Does it have weight?” (Accept the answer “no.”) “Does it keep its shape?” Let the air out of the bag, and ask children where it went. Discuss other properties and other gases, if any, that children may know the names of. Have them inhale very deeply to feel how their lungs expand like balloons when air fills them up.

6. Review from the board or chart the properties of solids, liquids, and gases.

**Part 1: Procedure**

1. Have the students write in their science journals the definition of *matter* and the states of matter (see Teacher Notes above). Explain that today you will talk about mixtures of matter. Sometimes objects are made up of more than one state of matter.

2. Divide students into small groups. Give each group sand, salt, water, cup, and spoon. Have them describe each object, naming the state of matter and its properties. Ask, “How are the sand and salt alike? Different? How is the water like the sand and salt?” (It has mass and takes up space.) “How is the water different?” Have the students record their observations in their science journals or on a lab sheet.

3. Have the students mix the sand and salt in the cup. Ask, “What happened? Did the matter change? Describe the mixture. Would it be easy to separate this mixture of solids?”

4. Now have the students add the water to the sand-salt mixture and stir. Ask, “What happened? Did the matter change? Describe the mixture. How many different states of matter do you see?” The salt will dissolve in the water, but the sand will not. The students should see the water with the dissolved salt and the sand. Have student think about how they can separate the mixtures and write down their ideas. Ask, “Can you change the mixture to another state of matter to separate the mixture?”

**Part 1: Observations and Conclusions**

1. Share the ideas that the groups came up with. Strain one of the group’s water-salt-sand mixture through a coffee filter over a pan so that the water-salt goes into the pan and the sand is in the filter. Ask, “How do we know we’ve separated two of the objects from the third?”
2. Ask again whether you can change the water-salt mixture’s state to separate the water and salt. Take all answers. Then, heat the water to boiling on the burner. Boil until the water evaporates. “What happened to the water? Did its state change?” (yes, to a gas) “What’s left in the pan?” (the salt)

Part 2: Introduction
1. Hold up a stick of clay, and ask students to describe it, using “matter properties.” Form it into a very different shape (e.g., a pancake), and ask, “What changed?” (its shape) Put it back into its original shape. Then, break it in half, hold up one of the halves, and ask, “What changed?” (its size) Break it in half again, and ask, “What changed?” (its size)
2. Fill a container with water, and have the students observe its size and shape. Pour the water into another container of a very different shape, and ask, “What changed?” (its shape) Pour half the water back into the original container, hold up the original container, and ask, “What changed?” (its size)
2. Tell students that even though the matter (clay or water) is changing in size and/or shape, it is still the same matter — clay or water. Even the smallest possible pieces, which may be too small to see with your unaided eye, are the same matter. Sometimes you need special tools, such as a magnifying glass or microscope, to see these very small pieces.

Part 2: Procedure
1. Give each student a piece of construction paper. Have the students fold, crease, and tear the paper in half. “Can you see the halves? What changed?” Have them tear one of the halves in half again, and ask the same questions. Keep going until the students have torn the paper into the smallest pieces that they can. Ask, “Can you still see the paper? What changed?” Discuss what the students observed. Have them write their observations in their journals.
2. Have the students think about salt, and ask, “Is salt easy to see?” Answers will vary. Now ask the students to think about one grain of salt: “Is that easy to see by itself?” Put a few grains of salt on each student’s desk, and let them make their observations. Ask, “Can you tell what shape each grain is with your unaided eyes?” Now give them a magnifying glass. “Can you tell now?”
3. Repeat step 2 with sugar. Discuss with the students that molecules are like the grains of salt and sugar. The very smallest particles are called atoms, which are very hard to see. However, when many, many atoms of a particular kind of matter are together, it makes the matter easy to see.
4. Have students view a grain of salt and a grain of sugar through the microscope. They will find that the salt and the sugar are different shapes. (Depending on the strength of your magnifying glasses, the students may be able to detect the grain shapes with them.)

Part 2: Observations and Conclusions
1. Have a class discussion about what the students saw with the magnifying glass and/or the microscope.
2. Have the students compare and contrast their observations of the salt and sugar.

Sample Assessment
- Have the students describe the properties of oil and those of water. Then have them try to mix oil and water and describe what happens. Do they mix? Does the matter change states?
- Give students a large and a very tiny piece of chalk, and ask them to state whether the tiny piece is still chalk, and if so, to explain why.
• Have students design an investigation to determine whether the physical properties of a material will remain the same when the material is reduced in size.

**Follow-Up/Extensions**

• Gases are hard for children to comprehend because they are invisible; children generally need several experiences that demonstrate that a gas, such as air, takes up space. Explain to students that you will do a demonstration to show how another gas, carbon dioxide, takes up space. Tell them that when you mix vinegar and baking soda, carbon dioxide gas is produced and that the gas takes up space. Fill one bottle to the top with water. Put baking soda or a seltzer tablet in a second bottle, add some vinegar, and then quickly stop up the bottle with a stopper that has a hose or straw inserted into it. Place the other end of the hose or straw in the bottle of water, and have the students observe the action of the carbon dioxide gas as it is released in the water. (The reaction lasts only a short time.) Discuss what happened, why, and what we learned about the gas.

**Resources**

• *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.

• *Jefferson Lab: Science Education Teacher Resources.* [http://education.jlab.org/indexpages/teachers.html](http://education.jlab.org/indexpages/teachers.html). Provides general physical science resources.


Sample Released SOL Test Items

Which of these will change when a piece of wood is chopped into smaller pieces?

A. The weight of each piece
B. The hardness of each piece
C. The color of each piece
D. The grain of each piece

Which of these changes the most as a balloon is being blown up?

A. The temperature of the air outside of the balloon
B. The volume of air in the balloon
C. The kind of material that makes up the balloon
D. The mass of the material that makes up the balloon

Some children are making mud balls. They cut the mud balls in half. Which of these changed when the mud balls were cut in half?

A. The softness of the mud ball
B. The size of the mud ball
C. The color of the mud ball
D. The stickiness of the mud ball

The picture shows a stick of clay. When the clay was cut into pieces, which of these was the only thing that changed?

F. Its stickiness
G. Its softness
H. Its shape
J. Its color

If you could examine a piece of cloth with a hand lens, you would see that the cloth is made of —

F. energy
G. threads
H. glue
J. minerals
Organizing Topic — Investigating Simple and Compound Machines

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.2 The student will investigate and understand simple machines and their uses. Key concepts include
   a) types of simple machines (lever, screw, pulley, wheel and axle, inclined plane, and wedge);
   b) how simple machines function;
   c) compound machines (scissors, wheelbarrow, and bicycle); and
   d) examples of simple and compound machines found in the school, home, and work environments.

Essential Understandings, Knowledge, and Skills

The students should be able to

- identify and differentiate the six types of simple machines: lever, screw, pulley, wheel and axle, inclined plane, and wedge;
- analyze the application of and explain the function of each of the six types of simple machines. An example would be that an inclined plane is a ramp to make it easier for a heavy object to be moved up or down;
- differentiate and classify specific examples of simple machines found in school and household items. These include a screwdriver, nutcracker, screw, flagpole pulley, ramp, and seesaw;
- design and construct an apparatus that contains a simple machine;
- identify and classify the simple machines that compose a compound machine, such as scissors, a wheelbarrow, and a bicycle.

Correlation to Textbooks and Other Instructional Materials
Simple and Compound Machines

Overview
Students work with and investigate simple and compound machines.

Related Standards of Learning 3.2a, b, c, d

Objectives
The students should be able to
- identify and differentiate the six types of simple machines;
- analyze the application of and explain how each of the six types of simple machines functions;
- identify and differentiate simple machines found in compound machines;
- analyze the application and purpose of the simple machines working together as a compound machine.

Activity 1: Simple Machines: Wheel and Axle

Materials needed
- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Toy cars with removable wheels
- Spring scales
- Wooden board
- Metric rulers
- “Wheel and Axle Investigation” handout (see, p. 62)
- Tape
- Stack of books

Instructional activity

Introduction
Simple machines are used to make work easier. A wheel and axle is a simple machine used to turn objects. Common examples include wheels on a car and a doorknob.

Procedure
1. Ask the students to explain how a bicycle works. Ask, “What do you have to do to make the wheels turn?” (apply force to the pedals) Ask the students, “Have you ever noticed exactly what makes it possible for a bike wheel to revolve? (A rod, called an axle, goes through the center hole of the wheel, and the wheel is free to turn around the axle.) A wheel and axle is a simple machine that makes it easier to move objects.
2. Have the students experiment to find out whether wheels and axles make it easier to move objects. Hand out the “Wheel and Axle Investigation” sheet, and have the students make their predictions about how far a toy car will go with wheels and without wheels.

3. Mark a place on the floor with tape. Put the toy car without wheels on the line. Push it from the back and measure from the tape to the back of the car with a metric ruler. Record the actual length. Have the students compare their prediction with the actual length.

4. Repeat with the toy car with wheels.

5. Discuss the results. “Which car went further? Why? What made it easier for the car to move?”

6. Have students make predictions about how much force is needed to pull each toy car up a ramp.

7. Place a stack of books on the floor, and lean the wooden board against it to make a ramp. Hook the spring scale to the car without wheels. Place the car at the bottom of the ramp. Slowly pull the car up the ramp. At the top of the ramp, read the force needed to pull the car up the ramp. Record the actual force. Have the students compare their prediction with the actual force.

8. Repeat with the toy car with wheels.

9. Discuss the results. “Which car took more force to ‘tow’ it up the ramp? Why? What made it harder to pull that car?” Have the students write their conclusions on their handout. They should conclude that wheels and axles make it easier for an object to move.

10. Have students label a page in their science journals “3.2 Simple Machine: Wheel and Axle” and staple or tape their completed handout to it.

**Observations and Conclusions**

1. Have students brainstorm as many objects they can think of that use wheels and axles. As one student names an object, ask another student to explain how its wheels and axles make work easier.

2. Complete the L section of the KWL chart as a lesson wrap-up.

Activity 2: Simple Machines: Wedge

Materials needed

- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Plastic tools such as a saw, axe, and knife

Instructional activity

Content/Teacher Notes

Simple machines are used to make work easier. A wedge is a simple machine used to split objects or pull them apart. Common examples include an axe, saw, knife, and teeth.

Introduction

1. Ask the students whether they have ever enjoyed eating cake at a birthday party, and if so, what was used to cut the cake. Explain to the students that a knife is generally used to separate cake into individual pieces. A knife is an example of a simple machine called a wedge. It is used to separate or push objects apart.
Procedure
1. Begin the lesson with a class KWL chart. Ask, “What do you know about wedges? What do you want to know about them?” Write the students’ responses in the K and W columns.

2. Show the students the plastic tools, one at a time. Ask the students to name the items and tell you what each one can do. Ask the students what the items have in common. Make sure the students understand that wedges split, cut, or separate objects.

Observations and Conclusions
1. Have the students label a page in their science journals “3.2 Simple Machine: Wedge” and draw pictures of the wedge objects that you have shown. Have them label each item and write a sentence about its function. For example, “A saw is a wedge because it cuts wood into pieces.” Have a few students share their pictures and sentences with the class.

2. Have students think again about the birthday cake. Ask, “How do you eat a piece of cake — swallow it whole or chew it? What simple machine do you carry around with you all the time that you use to cut, split, or separate things? (teeth)

3. Complete the L section of the KWL chart as a lesson wrap-up.

Activity 3: Simple Machines: Screw

Materials needed
- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Pencils
- 8½ x 11 inch construction paper
- Scissors
- Black markers
- Rulers
- One very large screw

Instructional activity

Content/Teacher Notes
Simple machines are used to make work easier. A screw is a simple machine used to squeeze objects together or to move an object in any direction. Common examples include a screw, vise, corkscrew, and faucet.

Introduction
Ask the students if they have wondered how objects in the classroom, such as desks, chairs, bookshelves, and doors, were put together. Direct the class discussion to possible answers, including glue, nails, and screws. A screw is a simple machine made of an inclined plane that has been wrapped around a rod. The spiral-shaped edge around the rod that makes the screw is primarily used to hold objects together.
Procedure
1. Begin the lesson with a class KWL chart. Ask, “What do you Know about screws? What do you Want to know about them?” Write the students’ responses in the K and W columns.
2. Have the students make their own screw. Give each student a pencil, a sheet of 8½ x 11 inch construction paper, scissors, a black marker, and a ruler.
3. Have the students fold their paper horizontally and use the marker and the ruler to draw a diagonal line from corner to corner. Then, have them cut along the black line.
4. Ask the students what simple machine one triangular section of their paper looks like. (inclined plane)
5. Have the students begin with the wide end of the triangle and slowly wrap the paper around the pencil. The black lines on the triangle represent the threads of the screw.
6. Have the students observe an actual large screw and compare their screws to it.

Observations and Conclusions
1. Complete the L section of the KWL chart as a lesson wrap-up.

Activity 4: Simple Machines: Pulley

Materials needed
- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Spring scale
- Broom
- Two chairs
- Two pieces of strong string, each about 4 feet long
- Pulley
- Two plastic shopping bags or baskets
- Weights

Instructional activity

Content/Teacher Notes
Simple machines are used to make work easier. A pulley is a simple machine used to lift heavy objects. A single pulley can be used to change direction of the force applied. This allows you to pull down in order to lift something up. Multiple pulleys can be used together to make lifting easier by trading force for distance.

Introduction
1. Ask the students if they have ever noticed how the flag on a flagpole gets to the top of the pole. Explain that the flag is raised and lowered by a simple machine called a pulley. A pulley is a rope and a wheel that work together. Pulling on the rope makes the wheel turn. This helps to move objects up, down, or across long distances without using much force.
2. Show students an example of pulleys in the classroom by raising and lowering the blinds and pointing out that there are several pulleys in the blind mechanism.
Procedure

1. Begin the lesson with a class KWL chart. Ask, “What do you Know about pulleys? What do you Want to know about them?” Write the students’ responses in the K and W columns.

2. Have the students experiment with pulleys. Set up the demonstration by placing a broom across the tops of the backs of two chairs. Hang a pulley from the broom. Tie a plastic bag to one end of each of the two pieces of string, and make a small loop in the other end. Then, put equal amounts of weight in each bag. Place the bags side by side on the floor under the broom and between the chairs. Put one of the pieces of string through the pulley, and drape the other one over the top of the broom.

3. Have the students predict which bag will be easier to lift — the one whose string goes through the pulley or the one whose string goes over the broom.

4. Have a student volunteer come up, hook the spring scale through the small loop of the string draped over the broom, and lift the weight to the top of the broom by pulling down on the string. Have the student puller read the force indicated on the scale, and have the other students record it in their journals. Then have the puller repeat the experiment with the string that goes through the pulley. Repeat the experiment with several other student pullers.

5. Have the students compare the forces required to lift two weights. Why was the force less for the weight that used the pulley?

Observations and Conclusions

1. Have the students label a page in their science journals “3.2 Simple Machine: Pulley” and draw a picture of a pulley with a wheel and a rope. Also, have them write down examples of pulleys, such as that at the top of a flagpole, the reel on a fishing rod, and those in blinds. Then, have them write a sentence about the function of a pulley.

2. Complete the L section of the KWL chart as a lesson wrap-up.

Activity 5: Simple Machines: Lever

Materials needed

- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Rulers
- Pennies
- Pencils
- Plastic hammer, shovel, and screwdriver

Instructional activity

Content/Teacher Notes

Simple machines are used to make work easier. A lever is a simple machine used to lift heavy objects. Levers turn or rotate on a fulcrum. As the fulcrum is moved toward the load (object being lifted), the work gets easier, but the distance the lever travels increases. Common examples include a see-saw, crow bar, and shovel.
Introduction

1. Ask the students whether they have been on a see-saw or teeter-totter, and ask those who have to explain how it works. Tell the students that this ride is an example of a simple machine called a lever. The bar in the middle of the see-saw (lever) is called the fulcrum. All levers have fulcrums. The object at the end that is being lifted is called the load. Levers help to lift loads.

2. Show students other examples of levers, such as a hammer, shovel, and screwdriver. Ask them what the objects are used for, and then show them how they act as levers (hammer pulling nails out of a wall, shovel lifting dirt, screwdriver lifting up a lid).

Procedure

1. Begin the lesson with a class KWL chart. Ask, “What do you Know about levers? What do you Want to know about them?” Write the students’ responses in the K and W columns.

2. Have the students experiment with levers and fulcrums to discover that the position of the fulcrum makes it easier or harder for the load to be lifted. Give each group one ruler (lever), one pencil (fulcrum), and five pennies (load). Have the students center the ruler on the pencil and put all of the pennies on one end of the ruler. Then have them draw a picture of this arrangement in their journal on a page labeled “3.2 Simple Machine: Lever.”

3. Then, have each student take a turn using his/her index finger to lift the load. Make sure the students notice how hard or easy it is to lift the load with the fulcrum in the center of the lever.

4. Next, have the students move the pencil (fulcrum) to two inches from the end of the ruler (lever) without the pennies (load). Have them draw this arrangement in their journals and then take turns lifting the load with their finger, noticing how hard or easy it is. Finally, have them move the pencil two inches from the pennies, draw this arrangement, lift the load, and notice the degree of difficulty.

5. Now, have the students rate each lift by labeling each picture “easy,” “medium,” or “hard.” (easy = fulcrum close to the load; medium = fulcrum in the middle; hard = fulcrum on the opposite end of the load)

6. In summary, have the students write sentences describing what levers do and how the fulcrum helps levers function.

Observations and Conclusions

1. Complete the L section of the KWL chart as a lesson wrap-up.

Activity 6: Simple Machines: Inclined Plane

Materials needed

- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)
- Spring scale
- Wooden board
- Chair
- Spiral notebook
- Metric ruler
- “Inclined Plane Investigation” handout (see p. 63)
Instructional activity

Content/Teacher Notes
Simple machines are used to make work easier. An inclined plane is a simple machine used to make it easier to move objects from place to place by using less work but more distance. Common examples include a ramp, sliding board, ladder, and staircase.

Introduction
1. Ask the students whether they have ever wondered how people in wheelchairs get into buildings. Direct the discussion to ramps. Ask the students whether they have ever thought of stairs as a ramp to get from one level to another. Explain that these examples are simple machines called inclined planes.

Procedure
1. Begin the lesson with a class KWL chart. Ask, “What do you Know about inclined planes? What do you Want to know about them?” Write the students’ responses in the K and W columns.
2. Have students experiment to find out whether inclined planes make it easier to move objects. Distribute the “Inclined Plane Investigation” handout, and have the students predict the distance a spiral notebook will travel from the floor to the seat of a chair. Have them record their predicted distance on their handout.
3. Place the notebook on the floor beside the chair. Then, lift the notebook so that it sits on the chair’s seat but overhangs the edge. Have one student measure the distance from the floor to the bottom of the notebook, using a metric ruler. Have the students record this actual distance and compare their predicted distance with the actual distance.
4. Have students predict how much force will be needed to pull the spiral notebook from the floor to the seat of the chair and record their predicted force on their handout.
5. Place the notebook on the floor beside the chair. Hook the spring scale to the spiral edge, and pull the notebook up until it meets the edge of the chair’s seat. Have a student read the spring scale. Have the students record the actual force needed and compare their predicted force with the actual force.
6. Discuss the data collected thus far. What do they think will happen when a ramp is used? Why?
7. Lean the wooden board against the chair to make a ramp. Have the students predict the distance the notebook will travel from the floor at the bottom of the ramp to the seat of a chair. Have them record their predicted distance on their handout.
8. Place the notebook on the floor at the foot of the ramp. Then slide the notebook up the ramp so that it rests on the chair’s seat in the same position it did in step 3. Have a student measure the distance it traveled, using a metric ruler. Have the students record this actual distance and compare their predicted distance with the actual distance.
9. Have students predict how much force will be needed to pull the spiral notebook up the ramp to the seat of the chair and record their predicted force on their handout.
10. Place the notebook on the floor at the foot of the ramp. Hook the spring scale to the spiral edge, and pull the notebook up the ramp until it meets the edge of the chair’s seat. Have a student read the spring scale. Have the students record the actual force needed and compare their predicted force with the actual force.
11. Discuss the data collected. Which way took more force to move the notebook? Why? Which way caused the notebook to travel a greater distance? Why? Have the students write their conclusions on the handout. (Ramps make it easier for an object to move from one place to another, but the object has to travel further to get there.)
12. Have each student label a page in his/her science journal “3.2 Simple Machine: Inclined Plane” and staple the handout to this page.

**Observations and Conclusions**
1. Complete the L section of the KWL chart as a lesson wrap-up.

**Activity 7: Compound Machines**

**Materials needed**
- Science journals
- KWL chart (For a description of the KWL reading strategy, see the VDOE’s *English Standards of Learning Enhanced Scope and Sequence for Grades K–5*, p. 120, at [http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml](http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml).)
- Pictures of scissors, wheelbarrow, pencil sharpener, and can opener for each student
- Glue
- Scissors

**Instructional activity**

**Content/Teacher Notes**
Compound machines are used to make work easier. A compound machine is made up of more than one type of simple machines. Common examples include scissors, wheelbarrow, pencil sharpener, and can opener.

**Introduction**
Ask the students to explain how a pair of scissors works. Discuss the simple machines that make the scissors work.

**Procedure**
1. Begin the lesson with a class KWL chart. Ask, “What do you Know about compound machines? What do you Want to know about them?” Write the students’ responses in the K and W columns.
2. Have students label a journal page “Compound Machines.” Have them cut out each picture, glue it in their journal, and label each of the compound machines with the simple machines that make it work.
3. Have volunteers share the simple machines they found for each compound machine.

**Observations and Conclusions**
1. Complete the L section of the KWL chart as a lesson wrap-up.

**Activity 8: Compound Machines**

**Materials needed**
- Science journals
- “Machine Scavenger Hunt” worksheet (see p. 64)
**Instructional activity**

**Content/Teacher Notes**

Compound machines are used to make work easier. A compound machine is made up of more than one type of simple machines. Common examples include scissors, a shovel, wheelbarrow, pencil sharpener, and can opener. Simple and compound machines help us with our daily lives. Many of them are located at school, at home, in our means of transportation, and everywhere else we go.

**Procedure**

1. Have students work in cooperative groups or teams to complete the “Machine Scavenger Hunt” worksheet. After the students locate simple and compound machines in the classroom, around the school building, and outside, have them interpret the information collected by classifying each machine as simple or compound. For each compound machine, have them name at least two simple machines that make up the compound machine.

**Observations and Conclusions**

1. Use the information collected about various compound machines to discuss with the students the importance of each simple machine working together to make a compound machine work.

**Sample Assessments**

- Assess the data sheets that go along with the students’ investigations.
- Have students create their own compound machine that will accomplish a simple task.
- Give students a writing prompt to describe five ways they use simple machines in their everyday lives.

**Follow-Up/Extensions**

- Have students create a class picture diary with pictures and descriptions of themselves using various simple and compound machines around the home — for example, using a hammer or a can opener. They should explain in each description how a simple or compound machine is being used.

**Resources**

Wheel and Axle Investigation

Name: ___________________________ Date: ___________________

If an object has a wheel and axle, then it will be easier to move.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Predicted distance it will travel</th>
<th>Actual distance it traveled</th>
<th>Predicted force it will need to get up the ramp</th>
<th>Actual force it needed to get up the ramp</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toy car without wheel and axle</td>
<td>_____ cm</td>
<td>_____ cm</td>
<td>_____ g</td>
<td>_____ g</td>
</tr>
<tr>
<td>Toy car with wheel and axle</td>
<td>_____ cm</td>
<td>_____ cm</td>
<td>_____ g</td>
<td>_____ g</td>
</tr>
</tbody>
</table>

Conclusion:

____________________________________________________________________
____________________________________________________________________
____________________________________________________________________

Virginia Department of Education

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Inclined Plane Investigation

Name: ___________________________ Date: ___________________________

If an inclined plane is used to move an object, then it will be easier to move, and the distance it travels will increase.

<table>
<thead>
<tr>
<th>OBJECT</th>
<th>Predicted distance it will travel</th>
<th>Actual distance it traveled</th>
<th>Predicted force it will need</th>
<th>Actual force it needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spiral notebook without ramp</td>
<td>_____ cm</td>
<td>_____ cm</td>
<td>_____ g</td>
<td>_____ g</td>
</tr>
<tr>
<td>Spiral notebook with ramp</td>
<td>_____ cm</td>
<td>_____ cm</td>
<td>_____ g</td>
<td>_____ g</td>
</tr>
</tbody>
</table>

Conclusion:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
Machine Scavenger Hunt

Name: ___________________________ Date: ___________________________

Directions: Locate as many machines as you can. Classify each machine as either simple or compound.

<table>
<thead>
<tr>
<th>Simple Machines</th>
<th>Compound Machines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>1.</td>
</tr>
<tr>
<td>2.</td>
<td>2.</td>
</tr>
<tr>
<td>3.</td>
<td>3.</td>
</tr>
<tr>
<td>4.</td>
<td>4.</td>
</tr>
<tr>
<td>5.</td>
<td>5.</td>
</tr>
<tr>
<td>6.</td>
<td>6.</td>
</tr>
<tr>
<td>7.</td>
<td>7.</td>
</tr>
<tr>
<td>8.</td>
<td>8.</td>
</tr>
<tr>
<td>9.</td>
<td>9.</td>
</tr>
<tr>
<td>10.</td>
<td>10.</td>
</tr>
</tbody>
</table>

Choose one compound machine from your list above. Tell where you found it. Name two or more simple machines that make it work. Explain its use.

Compound machine: ____________________________________________

Where it was found: ____________________________________________

Simple machines it uses to work: ________________________________

Its use: _________________________________________________________
Sample Released SOL Test Items

Which person is using a wedge?

A

B

C

D

Which of these best shows wheels and axles being used?

A

C

B

D

Which of these shows an inclined plane?

A

C

B

D

The picture shows a simple machine used at home and at school. Which type of simple machine is shown in the picture?

F  A pulley
G  A screw
H  A lever
J  A wedge

Which one of these would be best to use to move the box out of the truck?

F  A pulley
G  A lever
H  A wheel and axle
J  An inclined plane
Organizing Topic — Investigating Animal Adaptations

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.4 The student will investigate and understand that behavioral and physical adaptations allow
   animals to respond to life needs. Key concepts include
   a) methods of gathering and storing food, finding shelter, defending themselves, and rearing
      young; and
   b) hibernation, migration, camouflage, mimicry, instinct, and learned behavior.

3.6 The student will investigate and understand that environments support a diversity of plants and
   animals that share limited resources. Key concepts include
   a) water-related environments (pond, marshland, swamp, stream, river, and ocean
      environments);
   b) dry-land environments (desert, grassland, rain-forest, and forest environments).

Essential Understandings, Knowledge, and Skills

The students should be able to

- describe and explain the terms hibernation, migration, camouflage, mimicry, instinct, and learned behavior;
- give examples of methods that animals use to gather and store food, find shelter, defend
  themselves, and rear young;
- compare the physical characteristics of animals, and explain how the animals are adapted to
  certain environments;
- explain how an animal’s behavioral adaptations help it live in its specific habitat;
- design and construct a model of a habitat for an animal with a specific adaptation;
- distinguish between physical and behavioral adaptations of animals;
- create (model) a camouflage pattern for an animal living in a specific dry-land or water-related
  environment;
- compare and contrast instinct and learned behavior.
**Animal Adaptations: Needs**

**Overview**
Students explain the importance of the four basic needs of animals, why they have these basic needs, and how they satisfy these needs for themselves.

**Related Standards of Learning** 3.4a

**Objectives**
The students should be able to
- give examples of methods that animals use to gather and store food, find shelter, defend themselves, and rear young.

**Materials needed**
- Science journals
- Plastic sandwich bags — one per student
- Small ovals of light brown construction paper — three per student
- Small strips of light blue construction paper — three per student
- Four large circles of dark brown construction paper
- Yarn

**Instructional activity**

**Content/Teacher Notes**
The chart below shows different types of shelter and some animals that live in them:

<table>
<thead>
<tr>
<th>Homes</th>
<th>Animals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Holes in the ground</td>
<td>Prairie dogs, worms, ants, rabbits, fox, skunks, gophers</td>
</tr>
<tr>
<td>Caves or dens</td>
<td>Tigers, bears, bats</td>
</tr>
<tr>
<td>Trees</td>
<td>Birds, monkeys, squirrels</td>
</tr>
<tr>
<td>Water</td>
<td>Fish, crabs, frogs, lobsters, whales</td>
</tr>
</tbody>
</table>

**Introduction**
1. Ask students to recall the four basic needs of all animals; then, write *food, water, shelter,* and *space* on the board. Ask students why food and water are important to animals, and list the reasons offered. Ask them, “What does shelter provide for the animals?” Lead them to include the following: a protected place to rest and sleep, stay warm in winter, store food, and raise their babies.

**Procedure**
1. Tell students that today they are going to find out how hard it is to be an animal that has to find shelter and food. They are going to go to the gym or playground to play a game called “Squirrel and Hawk.”
2. Give every student a bag containing three ovals of construction paper (to represent food — nuts) and three strips of blue construction paper (to represent water).
3. Place the four dark brown circles (representing tree trunks) on the ground spread out at some distance from one another. Explain that the students are now squirrels and the “trees” are their shelter. The entire area of the four trees is the squirrels’ *habitat.*
Scene 1
Allow two squirrels to enter the habitat, and pour their food around on the ground. Ask the students if there is enough food, water, and shelter for each squirrel. (yes) Add two more squirrels, have them spread out their food and water, and ask if there is still enough food, water, and shelter? (yes) Keep adding squirrels two or three at a time, asking each time if there is enough food, water, and shelter. Once there are two squirrels per tree, there won’t be any more shelter for other squirrels. Ask students, “What will happen to the squirrels that can’t find shelter?” (They could move to another habitat, die, or steal other squirrels’ shelter when they go to find food.)

Scene 2
Divide half of the gym or playground into three parts. The first part is a shelter or safe place for the squirrels. In the middle part, place the “trees,” which are also safe places for the squirrels, and in the third part, put the “food” and “water” on the floor. Make every fourth student a hawk by taking away his/her bag and tying a piece of yarn on his/her arm. The hawks stand in the middle section containing the trees. The object of the game is for the squirrels to cross over the hawk-infested middle part to get to the food and water and bring it back to their shelter without being eaten by the hawks.

Have all of the squirrels start in the shelter side with empty stomachs (bags). They have to cross over the hawk (middle) territory, pick up only one piece of food and one water (they are too small to carry more), put them in their bag, and take them back to the shelter. The squirrels have to collect three pieces of food and three waters in order to continue living; thus they must make three trips back and forth. The hawks also have to collect three pieces of food and three waters in order to continue living. If a hawk tags a squirrel, the hawk gets the stomach, and the squirrel “dies” (has to sit down on the sidelines). The trees in hawk territory are safe places, so if a squirrel is on a tree, the hawk can’t tag it.

Stop the game at different points to announce that any hawk that doesn’t have at least three pieces of food and three waters has to fly away to another habitat and that any squirrel that doesn’t have three pieces of food and three waters has to die. At the end of the game, have the students talk about how difficult it was to get food.

Scene 3
Play the game again, but take away some of the food and water so that there is not enough for each squirrel to have three pieces of each. This should help students realize that only the fastest and smartest squirrels will be able to avoid the hawks and win out over the other squirrels.

Observations and Conclusions
1. Discuss with the students different types of shelter and various ways animals have of gathering food. Draw on the board the chart shown above under Teacher Notes, and have the students copy it into their journals.
2. Discuss the different ways animals gather and store food. Some, such as ants, squirrels, and chipmunks, will take it back to their shelter, while some, such as bears, tigers, and snakes, will eat it where they find or kill it.

Sample assessment
• Have students write in their science journals about the four basic needs of animals. Be sure the students explain the importance of shelter and getting food and what would happen if one or more of the basic needs were taken away from the habitat. Can all animals move to another habitat? What would happen if there are not enough new habitats to accommodate all the animals?
Follow-up/extension

- Have students make a poster or diorama of a habitat depicting the four basic needs of an animal. Have them label the different needs, elements of the habitat, animals, and other parts of the diorama.

Resources

- *Connections: Connecting Books to the Virginia SOLs*. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Animal Adaptations: Physical Characteristics

Overview
Students use drawings and photos of animals (or live animals, if possible) to investigate various adaptations for survival.

Related Standards of Learning
3.4a, b; 3.6a, b

Objectives
The students should be able to
• compare the physical characteristics of animals, and explain how the animals are adapted to a certain environment;
• explain how an animal’s behavioral adaptations help it live in its specific habitat;
• distinguish between physical and behavioral adaptations of animals;
• design and construct a model of a habitat for an animal with a specific adaptation.

Materials needed
• “Animal Adaptations Activity Sheet” handout (see p. 73)
• Models and/or color photos of various animals (optional)

Instructional activity

Content/Teacher Notes
An adaptation can be described as a specialized characteristic or “tool” that an animal has that enables it to survive in its habitat or environment. These tools are part of the animal’s body, not something that it can choose to use the way a human chooses to use a hammer or an axe. These tools help the animal to find or catch food, move about in search of food or a mate, escape danger, see, breathe in air or water, or protect itself. It is important to note that adaptations develop gradually over long periods of time and through many generations of the species. Individuals with the strongest or more successful traits are usually the survivors who live on to reproduce and make further generations.

Eyes enable an animal to see, but they are not really an adaptation. Eyes on stalks, for instance, help a crab to see all around itself because it does not have a head and neck that it can turn. Stalked eyes would be considered an adaptation.

Distinguish for the class between more passive protection and active defense. Most animals are more likely to flee or hide than to engage in battle. Examples of protective “devices” might be camouflage coloring, a hard outer shell, ability to flee quickly, or outer spikes or spines that would not be palatable to a gobbling predator.

In this exercise, students will inspect drawings of animals and answer questions about them. This may be done as a class, or it may be an individual activity, given some preparation. If you have models and/or color photos of animals available, you might use these instead.

Introduction
1. Begin with a class discussion of what animals need to survive — the four basic needs of animals: food, water, shelter, and space.
   • Do the things that satisfy these four needs differ for different animals?
   • Do they differ for animals that occupy different habitats?
   • Do all animals need the same type of food? Same amount of water? Same type of shelter? Same amount of space?
• Why would a rabbit not survive if it had to stay underwater? Why would a fish not survive if it had to live in a tree?

Procedure
1. Once the class has discussed the above questions, introduce the idea of adaptations, or “special tools.” Have the students analyze their own adaptations, using the following activities:
   • Have a student demonstrate walking on four limbs instead of just two feet. Ask how this would limit his/her ability to do everyday human activities.
   • Have students work with partners to tape or tie (not too tight!) their thumbs to the palms of their hands and then try picking things up, writing, or tying shoes without the use of their thumbs. Discuss the motion of the human thumb and how it “opposes” the other fingers to help them grip objects.
2. Hand out copies of the “Animal Adaptations Activity Sheet,” and have the students work in small groups to examine the animals and complete the activity questions.
3. Discuss the answers to the questions with the whole class. Make a point to differentiate between physical and behavioral adaptations for each animal.
4. Following this discussion, list several different types of habitats on the board. Be sure to include the water-related and dry-land environments listed in SOL 3.6a and b.
5. Have each student choose a habitat and create an animal that lives in that habitat. Students should draw a picture of the animal and list the types of adaptations the animal may have and why they are necessary. They should include physical and behavioral adaptations it would need to survive as well as camouflage that is necessary.

Observations and Conclusions
1. Discuss conclusions regarding the adaptations of the animals on the activity sheets.
2. Have the students share the animals they designed with the rest of the class.

Sample assessment
• Assess the completed activity sheets and animal designs.

Follow-up/extension
• Before having students share their animals with the class, have each student trade his/her animal with another student to see if each student can determine what adaptations the animal has to live in its particular environment.
• Instead of having students design an animal for a specific habitat, have them design a habitat for an animal possessing certain adaptations.

Resources
• Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
  http://www.vtea.org/ESTE/technology/Exploring_Animal_Environments.pdf. Offers a lesson on creating animals that can live in different environments.


Animal Adaptations Activity Sheet

Osprey
1. Circle the words that describe the osprey’s beak. sharp dull curved straight large small

2. Study the osprey’s feet. Describe how the osprey might use its feet.

3. The osprey lives near water. Look at the beak and feet again. What do you think it eats? little seeds twigs grass fish

4. Does this animal have any other special tools? If so, name them.

5. To protect itself, the osprey would _________ away.

Duck
1. Is the duck’s beak the same as the osprey’s? Circle the words that describe the duck’s beak. sharp dull curved straight large small

2. Why are the duck’s feet webbed?

3. When the duck wants something to eat, it can dive under the water. What might it eat?

4. If a larger animal were chasing the duck, how could the duck protect itself?
Animal Adaptations Activity Sheet continued

Blue Crab
1. Besides the mouth, what other part of the crab would help it to eat?

2. The crab has two claws. How many legs does it have? _____ Circle the two legs that are different than the rest. How do you think these are used?

3. How do you think the other legs are used?

4. What is special about the crab’s eyes?

5. What protects the body of the crab?

Fish
1. How do fish move around?

2. Look at the shape of the mouth. How does this shape help the fish pick up small bits of food from the bottom?

3. Circle the part on the fish that lets it breathe in the water.
Animal Adaptations: Defenses

Overview
Students explain the importance of protection and defense for animals and discover how various animals defend themselves.

Related Standards of Learning 3.4a

Objectives
The students should be able to
• describe how various animals defend themselves and give examples of how they defend themselves.

Materials needed
• Science journals
• Picture of an opossum
• Book about animal defense
• Construction paper
• Marker
• “Animal Defenses Research Sheet” handout (see p. 77
• Access to the Internet
• Resource materials on animals
• Sentence strips for headbands

Instructional activity

Content/Teacher Notes

<table>
<thead>
<tr>
<th>Defense</th>
<th>Animal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Venom</td>
<td>Bee, some snakes, scorpion, spiders, puffer fish, Portuguese man-of-war</td>
</tr>
<tr>
<td>Skin</td>
<td>Armadillo, rhinoceros</td>
</tr>
<tr>
<td>Weapons</td>
<td>Antlers: deer, moose, elk, caribou</td>
</tr>
<tr>
<td></td>
<td>Hooves: deer</td>
</tr>
<tr>
<td></td>
<td>Claws: cat, kangaroo</td>
</tr>
<tr>
<td></td>
<td>Teeth: raccoon, elephant, walrus, cat</td>
</tr>
<tr>
<td></td>
<td>Spines: hedgehog, porcupine, lion fish, caterpillar</td>
</tr>
<tr>
<td>Play dead</td>
<td>Opossum, hognose snake</td>
</tr>
</tbody>
</table>

Introduction

1. Hold up a picture of an opossum. Share some facts about the opossum with the students:
   • It carries its baby in pouch.
   • It is covered in hair.
   • It lives in Virginia.
   • It eats fruit, berries, plants, and sometimes snakes and eggs.
   • It has a long hairless tail useful for climbing in trees.

2. Ask the students to pretend they are opossums, and ask, “What would you do if an owl attacked you? How would you protect yourself?” Use Think-Pair-Share to allow students to share ideas: for several minutes, let students think about what they, as opossums, would do. Then pair students, and have pairs share their ideas about their defense. Finally, have the whole class share how they might defend against and escape from the owl. Have one student act out the “play dead” defense.
Procedure

1. Tell students that today you are going to talk about animal defenses and how animals protect themselves. Read a book about animal defenses.

2. Hand out the construction paper, and have students fold it in half and then in half again. Then have them use a marker to trace the creases between the four sections. Have them label the paper “Animal Defenses” and label each section with one of the four main defenses: “Venom,” “Weapons,” “Play Dead,” and “Skin.” Draw the same chart on the board, and ask students to tell examples of how specific animals defend themselves. Write student responses under the correct headings. If students are having difficulty, name an animal, and have the students think about how it could defend itself.

Observations and Conclusions

1. Have the Think-Pair-Share partners choose from the class-generated list an animal to research. Have the pairs use the Internet and printed resource materials to find facts on their animal and complete the “Animal Defenses Research Sheet.”

2. Have the partners design headbands made from sentence strips. Have one partner draw a picture of the animal’s defense (e.g., antlers) on his/her strip, and have the other partner draw a picture of the whole animal on his/hers. Have each pair wear their headbands while reporting on their animal to the class.

Follow-up/extension

- After the partners have presented their reports, have them classify themselves based on their animal’s defense. Designate each corner of the room with one of the four defenses, and have the pairs move to the appropriate corner.
- Have the students take off the headbands and mix them up. Then, have each student put one on again and ask yes/no questions of other students to decide what animal he/she is. When a student thinks he knows what defense he would use, he goes to the appropriate corner to see if he guessed correctly. After all students are in the corners, have them take off their headbands to see if they guessed the correct animal.
# Animal Defenses Research Sheet

**Name:** ___________________________  **Date:** ___________________________

<table>
<thead>
<tr>
<th>What is the name of your animal?</th>
<th>Where does it live? Describe its habitat.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What are some of the foods your animal eats? Does it eat plants or animals?</th>
<th>Who attacks your animal? Who are its predators?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How does your animal defend itself?</th>
<th>What are some interesting facts about your animal that you’d like to share?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Animal Adaptations: Mimicry

Overview
Students define mimicry, compare the mimicry of various animals, and give examples of mimicry.

Related Standards of Learning 3.4b

Objectives
The students should be able to
• describe and explain the act of mimicry;
• give examples of animals that use mimicry;
• compare animals that mimic each other;
• explain how mimicry helps animals live in a habitat.

Materials needed
• Science journals
• O-shaped cereal in various colors
• Lemon extract
• Large tray
• Venn diagram — one per group
• Poster board — one per group
• “Mimicry Recording Sheet” handout (see p. 81)
• Pictures of king and coral snakes

Instructional activity

Content/Teacher Notes
Mimicry is a physical adaptation that makes an animal look, smell, or sound like another animal in order to appear more dangerous or less appetizing to a predator, thereby improving the animal’s chances of survival.

Introduction
1. Take one student aside, and ask that student to mimic everything you say until you give him/her the signal to stop. Ask the other students what that student was doing. Many will say “copying you.” Tell the students that another word for copy is mimic and that mimicry is copying or imitating something or someone else. Mimicry is a defense that animals use. Some animals copy the appearance (colors, shape), odor, or sound of another animal in order to defend themselves.

2. Show the picture of the king and coral snakes. Have the students compare and contrast these two snakes that look like one another but are very different in several ways:

<table>
<thead>
<tr>
<th><strong>Coral Snake</strong></th>
<th><strong>Scarlet King Snake</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>burrowing snake</td>
<td>burrowing snake</td>
</tr>
<tr>
<td>grows up to 2.5 feet long</td>
<td>grows 3 to 5 feet long</td>
</tr>
<tr>
<td>red touches yellow strip</td>
<td>red touches black strip</td>
</tr>
<tr>
<td>venom can kill other living things, including humans</td>
<td>constrictor that is not harmful to humans</td>
</tr>
<tr>
<td>feeds on other snakes and lizards</td>
<td>feeds on rodents, birds, and other snakes</td>
</tr>
</tbody>
</table>
Procedure

1. Before the activity, prepare a portion of the O-shaped cereal to be similar in appearance but not in taste. Separate out all the red pieces, coat half of them with lemon extract, and let them dry. Coat the other half of the red pieces with water and let dry so that all the red pieces still appear to be the same. Mix all the cereal back together.

2. Tell the students that they are going to play a game of mimicry to show how a predator might avoid a harmless prey that mimics a dangerous prey. Have the students take on the role of predator while the cereal becomes the prey. Review the concepts of predator and prey in a class discussion.

3. Pour the cereal on a large tray. Have each student come up and choose one “prey” to take back to his/her seat. Record the number of each color taken, using tallies on the “Mimicry Recording Sheet” displayed on the board or overhead. Then allow the students to eat their prey.

4. Have students come back to the tray and repeat the process four more times. Each round fewer of the lemon-flavored cereal should be taken as more and more of the predators experience the unpleasant flavor of the red pieces and assume any of the red pieces might taste that way.

5. After all five trials, help the students analyze what happened — what type of cereal got eaten each time. Why? Have students share about the “strong” taste. Some may say that if it doesn’t taste good, they won’t eat it.

6. Give students time to write in their journals about how this might be similar to a real-life situation and to share their ideas. Tell the students that the two snakes are like this: we stay away from the coral snake because we know it is dangerous. We also stay away from the king snake because it looks like the coral snake and we don’t want to take a chance.

Observations and Conclusions

1. Shows pictures to students of examples of other animals that use mimicry, such as the yellow jacket and sand wasp, and the monarch butterfly and viceroy butterfly.

2. Have small groups of students each choose a pair of animals that use mimicry. Have each group draw a Venn diagram showing how the animals are alike and different, and have them share their observations with the class.

Follow-up/extension

- Have students pick two animals and think about how one of the animals could mimic the other. Why would one of the animals want to mimic the other? What would have to change?

Resources

- “Adaptation: Mimicry and Protective Coloration.” Center for Global Environmental Education. Hamline University Graduate School of Education. http://cgee.hamline.edu/see/questions/dp_transformation/dp_trans_adapt_mimic.htm

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Virginia Department of Education
79

Mimicry Recording Sheet

Name: __________________________ Date: __________________

**WHAT DID YOU EAT?**

<table>
<thead>
<tr>
<th></th>
<th>Color 1</th>
<th>Color 2</th>
<th>Color 3</th>
<th>Color 4</th>
<th>Color 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>3</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Look at the results for each round. What happened? Why?

Look to see if there was any pattern to which color or colors of cereal were eaten again and again, and which color or colors were avoided.
Science Enhanced Scope and Sequence – Grade 3

**Animal Adaptations: Camouflage**

**Overview**

Students define *camouflage*, create an animal that uses camouflage to protect itself, and participate in camouflage activities.

**Related Standards of Learning**

3.4b, 3.6

**Objectives**

The students should be able to

- describe and explain the term *camouflage*;
- create (model) a camouflage pattern for an animal living in a specific dry-land or water-related environment. (relates to 3.6)

**Materials needed**

- Science journals
- Sticky dots of various colors
- Outline of a small moth — one copy per student
- Newspaper
- Black construction paper
- Scissors
- Timer
- Brown paper grocery bag
- Books on animals and their habitats
- Internet access
- Art supplies
- Poster board

**Instructional activity**

*Content/Teacher Notes*

Camouflage is a physical adaptation of an animal’s body in color and/or shape so that the animal blends into its surroundings and is hard to see. Camouflaged animals are less likely to be caught by predators, and they have a better chance of catching their own prey if they are also predators.

**Introduction**

1. Before students come to class, place 10 sticky dots of various colors throughout the room in full view. Place some so that they contrast with their background and are easy to spot, and some so that they blend in with their background — i.e., are camouflaged.

2. Gather students in front of the room, and explain that today you are going to be talking about *camouflage*. Ask what this term means. Explain that it is something like a color, pattern, or shape that makes an object blend into its background or habitat so that the object is hard to see. What is our habitat at school? Guide students to describe the classroom.

3. Show the students some of the extra “Buzzy Bugs” (sticky dots), and tell them that their task is to search for 10 such bugs that are all over the room. Some have camouflaged themselves! Let each student pair take a one-minute turn to find the 10 bugs. After all the pairs have taken a turn, count how many bugs have been found. If some are still not found, show the students where they are. Ask, “What made it easy or hard to find the bugs?”
Procedure

1. Read the class a book about camouflage. Discuss the different ideas that the book presents. List some animals that use camouflage for protection.

2. Have a moth hunt. Distribute moth outlines to the students and have them trace a moth on newspaper and one on black construction paper. Then, have them cut out their two moths.

3. Spread black paper all over the room. Choose a moth catcher, and have him/her turn away while the other students place their moths on the black paper “flooring.”

4. Set the timer for 30 seconds, and have the moth catcher get as many moths as possible in that time. He/she must put each caught moth in the grocery bag before going after another one.

Observations and Conclusions

1. Record on the board how many of the two different kinds of moths were caught during each round.

2. Then, repeat the game, using newspaper spread out all over the floor. Ask, “Were the results this time different from those last time? Why?” Talk about the pattern seen in the data — that the kind of moths caught depends on the type of flooring being used. You should find that more newspaper moths were caught when they were lying on the black paper, and more black moths were caught when they were on the newspaper. Ask, “How did camouflage help the moths?”

Sample assessment

- Have students create their own “Camouflage Book.” On each page should be a picture of an animal that uses camouflage in its habitat and a paragraph about how camouflage helps the animal survive.

Follow-up/extension

- Divide students into groups. Have each group choose a habitat and research the animals that live in that habitat, using books and the Internet. Have each group build a model of their habitat by drawing, coloring, cutting out, and placing a variety of plants and trees. Then, have them draw, color, cut out, and place animals in their habitat, camouflaging these animals as much as possible without actually hiding them. Have each group share its habitat model containing the camouflaged animals. Display the models for others to play “I Spy.”

Resources

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Animal Adaptations: Migration and Hibernation

Overview
Students define migration/hibernation, cooperatively build a habitat for a hibernating animal, and participate in hibernation and migration role-playing.

Related Standards of Learning 3.4b

Objectives
The students should be able to
• describe and explain the terms hibernation, migration.

Materials needed
• Science journals
• Plastic squares or laminated 8½ x 11 inch pieces of construction paper, each labeled “Wetland”
• Chart paper and marker
• Shoebox — one per student
• Clay and other art supplies
• “Animals That...Migrate/Hibernate” chart (see p. 86)

Instructional activity
Content, Teacher Notes
Hibernation is an animal behavior in which the animal slows down its bodily functions and becomes dormant, which is like a sleeping state.

Migration is an animal behavior in which the animal travels from one place to another, usually for better food supplies but also for reproduction and/or safety.

Introduction
1. Ask the students, “How do we get ready for the winter and cold weather?” Brainstorm possible answers. (wear long sleeves, wear long pants, wear coats, stay inside, turn on the heat) “What about animals? What do they do to get ready for winter?” Brainstorm.

2. Tell students that today’s focus will be on two ways that animals prepare for winter: hibernation and migration. Some animals travel — migrate — south during the winter to find warmer climate and food. Other animals store food and then sleep/rest — hibernate — during the cold months.

Procedure
1. Read the class a book about hibernation. Talk about what happens to these animals, how they prepare for hibernation and then what happens while they are hibernating. Most animals that hibernate lower their heart rate during their period of sleep.

2. Have students put their heads on their desks and rest for two minutes. Ask them to breathe deeply, try to relax, and be very calm. Have them take their resting heart rate (pulse) for one minute and record it. Next, have students do 30 jumping jacks and then take their pulse for one minute and record it. Talk about the differences. Ask them how this is like hibernating animals. Why might the animals’ heart rates slow down? (to conserve energy and survive winter with no or little food)

3. Have the students brainstorm animals that hibernate, and display the resulting list in a wall chart similar to the “Animals That...Migrate/Hibernate” chart.
4. Ask, “What about animals that don’t hibernate?” Tell the students that some animals find it easier or better to *migrate* to a warmer climate. Read the class a book about migration. Talk about how these animals migrate. Locate on a class world map some of the places they go.

5. Have the students assume the identity of migrating birds to play the migration game. The object of the game is to migrate from Maine to Florida, traveling from wetland to wetland until you reach your winter home. Place 10 “Wetland” squares across the front of the room. Label one at one end “Maine” and the one at the other end “Florida.” The squares should not be touching but must be within a step of one another. Have students start in Maine and move toward Florida. They do not have to touch down at every square/wetland, but they cannot go off the course; those who do are the birds that die (must sit out that round). Make sure all of the birds make the journey south and back north again during the first round.

6. On the second round, pollute (mark with an “X”) some of the wetlands. Stop the game while the birds are migrating, and talk about results. Ask, “What would be the results?” (loss of birds as well as natural habitats, which causes the surviving birds to travel longer from one stop to the next) “Did all the birds make it? Why, or why not?” Continue this idea with different scenarios that would lead to loss of habitat and birds.

7. Based on the books you have shared, make a list of animals that migrate, and display the resulting list in a wall chart similar to the “Animals That...Migrate/Hibernate” chart.

**Observations and Conclusions**

1. Look over the lists that you have made of animals that hibernate or migrate. Add any more animals that students might think hibernate or migrate. Animals that do not fit can be removed after some simple research. Have students work in pairs to choose an animal, do some research, and answer the following questions:
   - Does your animal hibernate? If so, where — in what kind of habitat?
   - Does your animal migrate? If so, where does it go? How long does the journey take?
   - What prep work does your animal do to get ready for migrating or hibernating?
   - If your animal migrates, what happens to it while it is migrating? Identify its stops, diet, and risks encountered.
   - Are there any other interesting facts to share about the migration or hibernation of your animal?

**Follow-up/extension**

- Have the students whose animals hibernate use the information they found to turn a shoebox into the animal’s “Winter Hibernation Habitat” and use clay to depict the animal hibernating in it. Have the students whose animal migrates turn the shoebox into its “Winter Habitat” and use clay to depict the animal living in its winter home after migrating.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
### Animals That...

<table>
<thead>
<tr>
<th><strong>Migrate</strong></th>
<th>** Hibernate**</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bluebirds</td>
<td>Groundhogs</td>
</tr>
<tr>
<td>Orioles</td>
<td>Frogs</td>
</tr>
<tr>
<td>Monarch butterfly</td>
<td>Garter snakes</td>
</tr>
<tr>
<td>Caribou</td>
<td>Gophers</td>
</tr>
<tr>
<td>Green sea turtles</td>
<td>Bears</td>
</tr>
<tr>
<td>Sandpipers</td>
<td>Fish</td>
</tr>
<tr>
<td>Robins</td>
<td>Salamanders</td>
</tr>
<tr>
<td>Canada geese</td>
<td>Insects</td>
</tr>
<tr>
<td>Warblers</td>
<td>Bats</td>
</tr>
<tr>
<td>Hummingbirds</td>
<td></td>
</tr>
</tbody>
</table>
Sample Released SOL Test Items

What protects this animal from predators?
A Large shell
B Large mouth
C Thick legs
D Long neck

Which box shows an animal that mimics the other animal for protection?

F
Polar Bear
Panda

G
Monarch
Viceroy

H
Leaf Butterfly
Walking Stick

J
Bat
Bird

Which type of frog foot is best adapted for swimming?
A
B
C
D
Which box shows animals that depend most on camouflage for protection?

F  Monarch  Viceroy
G  Polar Bear  Panda
H  Leaf Butterfly  Walking Stick
J  Bat  Bird

Some birds fly south for the winter. Birds know when and where to fly because of —

F  camouflage
G  mimicry
H  instinct
J  hibernation
Organizing Topic — Investigating Food Chains

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.5 The student will investigate and understand relationships among organisms in aquatic and terrestrial food chains. Key concepts include
   a) producer, consumer, decomposer;
   b) herbivore, carnivore, omnivore; and
   c) predator and prey.

Essential Understandings, Knowledge, and Skills

The students should be able to

- distinguish among producers, consumers, herbivores, omnivores, carnivores, and decomposers;
- create and interpret a model of a food chain showing producers and consumers;
- explain how a change in one part of a food chain might affect the rest of the food chain;
- identify sequences of feeding relationships in a food chain;
- differentiate between predators and prey;
- infer that most food chains begin with a green plant.

Correlation to Textbooks and Other Instructional Materials

[Spaces for Correlation]
Food Chains — Producers, and Consumers

Overview
Students create and interpret food chains showing producers and consumers.

Related Standards of Learning 3.5a

Objectives
The students should be able to
• distinguish between producers and consumers;
• create and interpret a model of a food chain showing producers and consumers;
• explain how a change in one part of a food chain might affect the rest of the food chain;
• identify sequences of feeding relationships in a food chain;
• differentiate between predators and prey;
• infer that most food chains begin with a green plant.

Materials needed
• Food Chain Cards (see p. 93)
• Blank cards
• Paper for waterfall books

Instructional activity
Content/Teacher Notes
The NASA Center for Distance Learning at Langley Research Center (http://dlcenter.larc.nasa.gov/) has created video programs geared toward teaching students about science topics. Those for third through fifth graders, The NASA SCIence Files™, are excellent resources for teachers. These free programs have educator guides and activities that correspond to each episode. One episode, “The Case of the Inhabitable Habitat,” has some commendable resources and activities associated with SOL 3.5. This resource can be downloaded and viewed by going to http://scifiles.larc.nasa.gov/educators/index.html, clicking on “Episodes” at the top of the box, and clicking on “2002-2003 Season.” Correlations of each episode to the Virginia SOL, created by the NASA Center for Distance Learning, can be found under “Instructional Resources” on the VDOE Elementary Science Web page, http://www.doe.virginia.gov/VDOE/Instruction/Elem_M/Science/elementary_sci.html.

Introduction
1. Cut apart the Food Chain Cards, and give one to each of five selected students. Have those students come to the front of the room, display their cards, and share the names of the things with the class. Pose the question, “How do these things fit together?” Allow “wait time” for the class to gather their ideas.
2. Have the students discuss their ideas. Then, tell the class that these things fit together to make a food chain, which is a sequence of organisms that give energy to one another. Write on the board: “SUN→grass→mouse→owl” and instruct students to read this as “the sun gives energy to the grass, which gives energy to the mouse, which gives energy to the owl. (Alternatively, you might say: “the owl gets energy from the mouse, which gets energy from the grass, which gets energy from the sun.”) Have the class practice reading several such food chains, including some with humans.
Procedure

1. Share a book with the class about different types of food chains. Then, have each student provide one fact from the story. As general ideas emerge from this exercise, record some of them on chart paper to be used later. Some key concepts that should emerge are as follows:
   - Food chains show a transfer of energy.
   - **Producers** are plants that can make their own food.
   - **Consumers** are animals that eat producers (plants) and other consumers and get their energy from them.
   - The arrows on a food chain show who gives energy to whom, *not* who eats whom.

2. Give small groups of students a copy of the following food chains:
   - **SUN→grass→grasshopper→toad→snake→hawk**
   - **SUN→plants→insects→bat→owl**
   - **SUN→phytoplankton→shrimp→tuna→shark→human**
   - **SUN→plants→hare→weasel→great horned owl**
   - **SUN→corn→grasshopper→starling→falcon**
   - **SUN→plants→fish→weasel→bobcat**

   Have each group create a drama that shows how the food chain flows. Each student should take on the role of one of the components of the chain, showing where its energy moves. Have the groups present their dramas to the class.

3. After the dramas, pass out blank cards, and have the students draw what they were in their drama. Have them arrange the resulting cards as food chains, and glue them down on chart paper.

4. Talk about how to draw the arrows on a food chain, and stress that each arrow tells what “gives” its energy to the next member of the chain. If the students want to say “eats the…” when drawing the arrows, tell them that that is backwards. Review the correct way to read a chain: “the SUN gives its energy to the grass; the grass gives its energy to the mouse; and the mouse gives his energy to the owl.” Help each group draw the arrows and read their chain.

Observations and Conclusions

1. On chart paper, write the original food chain: **SUN→grass→mouse→owl**. Ask students to predict what might happen if the grass were to get poisoned and die off. Give them time to think. Then, collect as many answers as they can supply. Students may think that *all* the mice will die, but this is not the case. Some may die from eating poisoned grass, and some may die from lack of food, but others will leave the habitat because there is not enough food. They will find food elsewhere. That, too, will change the food chain.

Sample assessment

- Have students do some research to find several things that live together and create a food chain. Then, have them make a waterfall book (one in which the paper protrudes in increments from the sheet before) of the chain. Have them maintain proper sequence as they write the names of the chain’s elements on the protruding edges. Finally, have them glue a picture of each element on its page and write at least two facts about that element. When the book is finished and closed, it will be a perfect food chain and resemble the example shown at right.
Follow-up/extension

- Read a story to the class about a food chain in which one member goes away. Ask, “What happens to the other members of the chain when this happens? How does it affect the entire food chain?” Have the students talk about this. Then have them consider their food chain and decide what could happen if one member disappeared and how it would affect the other members.

Resources


- *I’m Starving! What’s for Dinner?: An Introduction to Food Chains.* School of Education, Loyola Marymount University. [http://www.lmu.edu/education/edcourse/ed634/spring02/foodchain/foodchain.htm](http://www.lmu.edu/education/edcourse/ed634/spring02/foodchain/foodchain.htm). Features a Webquest about food chains with links to other similar resources.

- “The Relationship between Each Successive Level of Food Chain in an Ecosystem.” *ThinkQuest for Tomorrow’s Teachers (T3).* [http://www.preservice.org/T0110500/topic4.htm](http://www.preservice.org/T0110500/topic4.htm). Shows a food chain and how its members are affected by one another.
Food Chain Cards
What’s for Dinner?

Overview

Students determine whether animals are herbivores, carnivores, or omnivores.

Related Standards of Learning

3.5b

Objectives

The students should be able to

• distinguish among herbivores, omnivores, and carnivores.

Materials needed

• Chart paper
• 11 x 17 inch paper — 1 sheet per student
• Crayons
• Poster board or large construction paper
• Bulletin board paper
• Markers and other art supplies

Instructional activity

Content/Teacher Notes

The NASA Center for Distance Learning at Langley Research Center (http://dlcenter.larc.nasa.gov/) has created video programs geared toward teaching students about science topics. Those for third through fifth graders, The NASA SCience Files™, are excellent resources for teachers. These free programs have educator guides and activities that correspond to each episode. One episode, “The Case of the Inhabitable Habitat,” has some commendable resources and activities associated with SOL 3.5. This resource can be downloaded and viewed by going to http://scifiles.larc.nasa.gov/educators/index.html, clicking on “Episodes” at the top of the box, and clicking on “2002-2003 Season.” Correlations of each episode to the Virginia SOL, created by the NASA Center for Distance Learning, can be found under “Instructional Resources” on the VDOE Elementary Science Web page, http://www.doe.virginia.gov/VDOE/Instruction/Elem_M/Science/elementary_sci.html.

Introduction

1. Ask students to tell what they had for dinner last night. As the students respond, list the different items on chart paper. Then, cut the paper apart so that each item is separate. Ask students to help you sort these items into three groups. Ask, “What could we call each group? How are some of these foods alike? How are some of them different?” Someone will most likely say that some are plants, some are animals, and some are a combo or something similar. If the students do not mention this possibility, make sure you point it out.

Procedure

1. Say to the students, “One way we sorted our dinners was by plants, animals, and both. Does anyone know the science word for living things that eat these kinds of foods?” Share the definition of herbivore (an organism whose diet consists of plants), carnivore (an organism whose diet consists of other animals), and omnivore (an organism whose diet consists of both animals and plants). Help the students understand and remember these words by taking them apart, e.g., herb means plant; omni means all.
2. Read a story about an animal that is of interest to the children — maybe a book about a desert animal or an underwater animal. Read to find out what the animal eats, and then have the students classify the animal as a herbivore, omnivore, or carnivore.

3. Have the students fold a piece of 11 x 17 inch paper to form six equal-sized boxes. In each box, have students draw an animal that they are interested in knowing more about. Have them label each animal with its name. For those having trouble, suggest the following:

<table>
<thead>
<tr>
<th>snowshoe hare</th>
<th>lion</th>
<th>chimpanzee</th>
</tr>
</thead>
<tbody>
<tr>
<td>sheep</td>
<td>wolf</td>
<td>badger</td>
</tr>
<tr>
<td>squirrel</td>
<td>cougar</td>
<td>bear</td>
</tr>
<tr>
<td>mouse</td>
<td>wolf</td>
<td>pig</td>
</tr>
<tr>
<td>rabbit</td>
<td>falcon</td>
<td>raccoon</td>
</tr>
<tr>
<td>deer</td>
<td>robin</td>
<td>chicken</td>
</tr>
<tr>
<td>insect</td>
<td>cheetah</td>
<td>fly</td>
</tr>
<tr>
<td>fish</td>
<td></td>
<td>beetle</td>
</tr>
<tr>
<td>rodent</td>
<td></td>
<td>wasp</td>
</tr>
</tbody>
</table>

4. Have groups of four students make a chart on poster board with the headings “Herbivore,” “Carnivore,” and “Omnivore.” Then have the groups cut their 6-boxes apart and place all the resulting animal cards face down in the middle of the table. Have the members of each group take turns flipping a card, deciding where it fits in the chart based on what it eats, and gluing it in the proper column. Allow the students to use the Internet and/or books for reference.

**Observations and Conclusions**

1. Hang all the posters around the room, and have students look at each category. Have them try to think how the animals in each category are alike.

2. Animals in each category have other shared traits that are indicative of their eating habits. For example, carnivores are good hunters, move quickly, and have strong limbs for grabbing and holding; they also have strong, sharp teeth for tearing. Herbivores usually have flatter teeth for chewing plants, and they don’t usually move as fast as carnivores because they don’t have to hunt. Omnivores have some traits from both plant eaters and meat eaters.

**Sample assessment**

- Have each student group choose a habitat (e.g., desert, forest, pond, ocean, wetland, prairie, mountain, forest, or other) and create a mural that shows the herbivores, carnivores, and omnivores for that habitat. Make sure each mural includes the sun as a source of energy and plenty of plants for the herbivores. Have them label all the animals and share their murals with the class.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Are You a Predator or a Prey?

Overview
Students investigate the difference between predator and prey.

Related Standards of Learning 3.5c

Objectives
The students should be able to
• differentiate between predators and prey.

Materials needed
• Acorns or other unshelled nuts
• Four large circles cut from brown paper
• Predator/Prey-Game Cards (see pp. 99–100)
• Headbands — one for each student
• Staplers
• Science journals
• Clay
• Writing paper
• Books about animals

Instructional activity
Content/Teacher Notes
The NASA Center for Distance Learning at Langley Research Center (http://dlcenter.larc.nasa.gov/) has created video programs geared toward teaching students about science topics. Those for third through fifth graders, The NASA SCIence Files™, are excellent resources for teachers. These free programs have educator guides and activities that correspond to each episode. One episode, “The Case of the Inhabitable Habitat,” has some commendable resources and activities associated with SOL 3.5. This resource can be downloaded and viewed by going to http://scifiles.larc.nasa.gov/educators/index.html, clicking on “Episodes” at the top of the box, and clicking on “2002-2003 Season.” Correlations of each episode to the Virginia SOL, created by the NASA Center for Distance Learning, can be found under “Instructional Resources” on the VDOE Elementary Science Web page, http://www.doe.virginia.gov/VDOE/Instruction/Elem_M/Science/elementary_sci.html.

Introduction
1. Have students sit in a circle to play a quick game of “Mouse, Mouse, Owl” (same as “Duck, Duck, Goose,” but with different words). Talk about what each of the two players in the game did: the owl chased or hunted, while the mouse ran and tried to stay alive. The owl is the predator, and the mouse is the prey. Have the children use their own words to define these two terms.

Procedure
Activity 1
Allow the students to play “Predator/Prey Charades,” as follows:
1. Have students choose partners and work as teams. Each team takes a turn choosing and then acting out a predator-prey combination, such as
   • baleen whale/krill
   • weasel/hare
• bat/mosquito
• woodpecker/insect
• mountain lion/deer
• shark/tuna
• fox/rabbit
• snake/tree frog
• seal/squid

2. After all teams have had their turns, review who was the predator and who was the prey for each pair of animals, and discuss the actions/behaviors of each animal. Have students record in their journals the name of each animal pair and identify which is the predator and which is the prey.

Activity 2
Have the students play the “Predator and Prey Game” on the playground or in the gym, as follows.

1. Before the game, make headbands for the class. Label one-fourth of them “P” (predator) and the remaining three-fourths “p” (prey). For the demonstration game, the predators will be hawks and the prey will be squirrels. Therefore, every fourth student will be a predator (hawk), and three-fourths will be prey (squirrels).

2. While still in the classroom, give each student a headband and a matching predator or prey card. Have students color their animal, staple it to their headband, and wear the headband.

3. Take the students to the playing field. Spread food (acorns or other unshelled nuts — about four per student) throughout the “Food Fields” area. Place three or four trees (large brown circles) in the “Hunting Forest” area.

4. Explain to the students that the object of the game is for all the animals to get enough food to eat each day. Because the squirrels are very small, they can collect only one piece of nut at a time, and they must return to the “Safe Zone” to bury it for safekeeping until the end of the day. They need to collect at least three nuts to survive. In the Hunting Forest, they may find temporary safety by standing in a tree, where hawks cannot touch them.

5. Hawks also need to eat. They eat squirrels and need to get at least two to survive. They hunt for squirrels in the Hunting Forest. To collect a squirrel, they tag one and take him/her outside the playing field.

6. After everyone is in place, start the game by yelling “hunt”! Have the students play for three to five minutes. Then, stop the game by calling “night time”! Have the students sit down where they stopped, and record the number of survivors. Talk about the results and the predator/prey relationship.

7. Have the students change roles (headbands) and play again.

Observations and Conclusions
1. Using the example of a hawk and a snake, ask the following questions to prompt discussion of the predator/prey relationship: “Who is the predator, and who is the prey? How does each react to the other? What adaptations might the prey use to survive? What natural occurrences might change
this relationship — for example, too many hawks, too many snakes, drought, flooding, disease in grass, or toads?” Have students write in their journals about the predator/prey relationship.

2. Have the students share aloud an “AHA” idea, one that they are particularly proud of thinking today.

Sample assessment

- Have the students use modeling clay to build a predator and its prey. Encourage the students to use books and the Internet to do research about their relationship. Then, have each student write a short paragraph telling about this relationship and where it takes place. Have the students share their animals and paragraph with the class.

Resources

- Animals A–Z. [http://www.oaklandzoo.org/atoz/atoz.html](http://www.oaklandzoo.org/atoz/atoz.html). Offers a long list of zoo animals and links for each that could be used for research.
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**Predator/Prey-Game Cards**

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Sample Released SOL Test Items

Why are decomposers important in any environment?

A They make food using sunlight.
B They make places for animals to live.
C They help to break down dead organisms.
D They are a big part of the water cycle.

Which of these is a decomposer?

F Mouse
G Mushroom
H Tree
J Fox

The spotted turtle is common in fresh water. It eats insects, tadpoles, dead fish, and tender aquatic plants. Which of these best describes the spotted turtle?

A A herbivore
B A carnivore
C An omnivore
D A decomposer

Raccoons eat fish, berries, nuts, and green plants. The raccoon is —

F a producer
G an omnivore
H a decomposer
J a carnivore

The snake in this food chain is a predator because it —

A eats other animals
B is eaten by the hawk
C is the largest animal
D eats only plants
Organizing Topic — Investigating Environments

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.6 The student will investigate and understand that environments support a diversity of plants and
   animals that share limited resources. Key concepts include
   a) water-related environments (pond, marshland, swamp, stream, river, and ocean
      environments);
   b) dry-land environments (desert, grassland, rain forest, and forest environments); and
   c) population and community.

Essential Understandings, Knowledge, and Skills

The students should be able to

- describe major water-related environments and give examples of animals and plants that live in each;
- describe major dry-land environments and give examples of animals and plants that live in each;
- compare and contrast water-related and dry-land environments;
- distinguish between a population and a community;
- explain how animals and plants use resources in their environment;
- analyze models or diagrams of different water-related environments in order to describe the community of organisms each contains and interpret how the organisms use the resources in that environment;
- analyze models or diagrams of different dry-land environments in order to describe the community of organisms each contains and interpret how the organisms use the resources in that environment;
- predict what would occur if a population in a specific environment were to die.

Correlation to Textbooks and Other Instructional Materials
Check It Out!

Overview
Students analyze communities and their resources.

Related Standards of Learning 3.6a, b, c

Objectives
The students should be able to
- distinguish between a population and a community;
- explain how animals and plants use resources in their environment;
- analyze models or diagrams of different water-related environments in order to describe the community of organisms each contains and interpret how the organisms use the resources in that environment;
- analyze models or diagrams of different dry-land environments in order to describe the community of organisms each contains and interpret how the organisms use the resources in that environment;
- predict what would occur if a population in a specific environment were to die.

Materials needed
Per group of students:
- A picture showing a community: a different environment for each group
- Chart paper
- Marker

Instructional activity

Content/Teacher Notes
A population is a specific group of plant or animal organisms.

A community is a collection of different populations interacting with each other and their environment.

Introduction
1. Ask the students about their community. Have them describe the people, jobs, stores, etc. found in their community. Ask them to describe in what ways all of these things are needed in order to make the community work.
2. Present the definitions of population and community to the class, and discuss. Give examples of each so that the students will understand the difference.

Procedure
1. Distribute to each group of students a picture showing a different community. Have the groups glue their picture to the top of a piece of chart paper, examine their picture, and make a chart below it listing all the organisms that they see.
2. Have the groups list on their chart the resources that each organism would use in order to stay alive (e.g., air, water, plants to eat).
3. Once their chart is complete, have the groups pretend that one of those resources or organisms dies out. Have them make a prediction about what will happen in that environment because of this event. Have them summarize their prediction on their chart in the form: “If ______________ were to die out, then _____________________________.”
4. Once all groups are finished, post the charts around the room. Give the groups time to go around, look at, and discuss each chart. Then, have the groups present their chart to the rest of the class, along with their prediction.

5. Hold a class discussion concerning the findings.

**Observations and Conclusions**

1. As the groups are working on their charts, circulate and listen to their discussions. Lead the students to conclude that all the organisms, no matter how big or small, affect and are important to their environments.

**Sample assessment**

- Use the charts, group presentations, and group discussions for assessment.

**Follow-up/extension**

- Have the students create a food chain diagram (see the lesson on food chains above) for the various animals in each environment. This may be done by drawing pictures of the animals by hand or by using the computer and Internet to find, copy, and paste pictures of the animals. The students should also write a paragraph to go with their diagram.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs*. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
**Wet and Dry**

**Overview**
Students compare and contrast water-related and dry-land environments.

**Related Standards of Learning** 3.6a, b

**Objectives**
The students should be able to
- compare and contrast water-related and dry-land environments;
- describe major water-related environments and examples of animals and plants that live in each;
- describe major dry-land environments and examples of animals and plants that live in each.

**Materials needed**
Per each group of four students:
- A set of four dry-land-environment worksheets (see pp. 108–101)
- Resource materials, such as library books, Internet sites, fact sheets, and pictures (See Resources at the end of this lesson for some helpful Web sites.)

Per student:
- Two sheets of white 8½ x 11 inch paper
- Ruler
- Scissors
- Glue
- A piece of white 8½ x 22 inch construction paper
- A piece of colored 12 x 18 inch construction paper
- Two white construction-paper circles, about the size of a regular paper plate
- A piece of colored construction paper to which to glue the two white circles, creating the Venn diagram

**Instructional activity**

**Content/Teacher Notes**
Dry-land environments include forests, deserts, grasslands, and rainforests. Water-related environments include lakes, rivers, wetlands, swamps, streams, ponds, and oceans.

**Procedure**

**Part 1 — Water-Related Environments**

1. The Virginia Department of Education has produced a teaching resource relating to watersheds and the Chesapeake Bay. Called *Lesson from the Bay* (available at [http://www.doe.virginia.gov/VDOE/LFB/index.html](http://www.doe.virginia.gov/VDOE/LFB/index.html)), this resource for third-through-sixth-grade teachers contains lesson plans, background information, action guides, planning modules, and a glossary for topics. Many of these lessons can be used to reinforce learning of several key third grade Science SOL simultaneously. Access the following lessons about water-related environments, review them, and choose one or more to offer to the class:
   - [Wetlands: Here All Year?](#) — wetlands and swamps
   - [Bay and Pond Food Webs](#) — bay and ponds
   - [Stream Creatures: Clues to Stream Health](#) — streams, rivers, ponds, and lakes
Part 2 — Dry-Land Environments
1. Divide students into groups of four. Give each group a set of the four dry-land-environment worksheets, and assign each student to investigate a different environment, using the resources you have provided.
2. Once students find the information for plants and animals in their environment, have the groups make a summary poster of each environment showing what may be found in that environment.
3. Have each group present their findings to the class.

Part 3 — “Two-in-One Environments”
1. Have students draw and color an example of a water-related environment on a sheet of white 8½ x 11 inch paper.
2. Then, have the students turn their drawing over and mark 1 inch strips across the back, making a total of 11 strips.
3. Direct the students to label the strips “1A,” “2A,” “3A,” “4A,” etc., starting at the left-hand edge, until all strips are labeled.
4. Have the students repeat steps 1–3 on another sheet of white paper, but drawing an example of a dry-land environment and using the labels “1B,” “2B,” “3B,” “4B,” etc.
5. Once both drawings are done, have the students carefully cut off strip 1A and glue it onto a piece of white 8½ x 22 inch construction paper, beginning flush with the left-hand edge. The next strip to be cut and glued is 1B; then 2A, 2B, 3A, 3B, etc., until all of the strips have been glued onto the construction paper. Let the drawings dry overnight.
6. The next step is for students to take their picture and accordion-fold it, like a fan, at the seams between the strips.
7. Have the students then glue the back of the first strip flat to a piece of colored 12 x 18 inch construction paper and then slightly stretch out the folded paper. They should not flatten out their drawing very much. Then, they should glue the last strip to the colored construction paper.
8. After this has dried, the colored construction paper can be trimmed to make an even frame around the picture. The result gives the effect of two drawings in one space, much like moving billboards. By looking from the left side, you see one environment, and by looking from the right side, you see the other environment.
9. Have the students use the white circles to create a Venn diagram about the overlaps in their environments. The circles can also be glued to the colored 12 x 18 inch construction paper.

Observations and Conclusions
• Based on prior knowledge from the class, the students should be able to compare and contrast their two environments. Have each student explain his/her Venn diagram to the class.

Sample assessment
• Use the assessments included with the water-related lesson plans for Part 1.
• Use the four worksheets, student presentations, two-in-one pictures, and Venn diagrams as the assessment for Part 2.

Follow-up/extension
• Have the students write statements concerning their Venn diagrams.
• Have the students write a descriptive paragraph about each environment, including its animals, plants, and any animal adaptations (e.g., webbed feet).
• Have students use all the materials they created in this lesson to create a large classroom display.

Resources

• *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.

• *ESpecies Fact Sheets: Electronic Fact Sheets on Over 50 Species.* Kids’ Planet. [http://www.kidsplanet.org/factsheets/map.html](http://www.kidsplanet.org/factsheets/map.html).


### Forest Environment

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# Grassland Environment

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# Desert Environment

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## Rainforest Environment

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Sample Released SOL Test Items

The roots of a desert plant are close to the surface of the ground. This helps the plant —

A stay warm
B get more air
C make food more quickly
D take in rainwater quickly

What type of animals would be found in the above environment?

A Forest animals
B Grassland animals
C Rain forest animals
D Pond animals

Which type of habitat is this animal best suited for?

F Marshlands
G Open plains
H Sandy beaches
J Freshwater ponds

Which of these would probably cause a forest habitat to become a desert?

A No rain
B Flooded rivers
C High winds
D Hot summers
Organizing Topic — Investigating the Survival of Organisms

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.10 The student will investigate and understand that natural events and human influences can affect
   the survival of species. Key concepts include
   a) the interdependency of plants and animals;
   b) the effects of human activity on the quality of air, water, and habitat;
   c) the effects of fire, flood, disease, and erosion on organisms; and
   d) conservation and resource renewal.

Essential Understandings, Knowledge, and Skills

The students should be able to

• explain how living things in an area are dependent on each other;
• compare and contrast human influences on the quality of air, water, and habitats;
• analyze the effects of fire, flood, disease, and erosion on organisms and habitat;
• describe how conservation practices can affect the survival of a species;
• describe a conservation practice in the local community.

Correlation to Textbooks and Other Instructional Materials

Virginia Department of Education
Riparian Buffers

Overview
Students investigate how riparian buffers protect streams, rivers, and wildlife.

Related Standards of Learning
3.10a, c

Objectives
The students should be able to
- analyze the effects of erosion on organisms and habitat.

Materials needed
- Internet access
Per each group of students:
- Two aluminum roasting pans
- Soil
- Grass seed
- Food coloring
- Water

Instructional activity

Content/Teacher Notes
This activity is a revision of a lesson of the same name in the VDOE Web resource Lessons from the Bay, which includes a process model, outline of the key components of the Chesapeake Bay, lesson plans geared to students in grades 3–6, a glossary of wetland terms, and a project action guide. Lessons from the Bay is on the Web at http://www.doe.virginia.gov/VDOE/LFB/index.html.

A riparian buffer is a zone of vegetation located along the bank of a waterway and serving to protect the water from harmful runoff. The roots of plants and trees in the buffer stabilize the soil and control erosion. They also slow the flow of runoff water, reducing the threat of downstream flooding after heavy precipitation. By slowing water flow, riparian buffers allow the soil to absorb more water, and thus more water enters the underground water system. This water is naturally filtered as it slowly passes through the soil to replenish the aquifers.

In addition to being a natural water filter, riparian buffers provide habitats for wildlife. Songbirds live in the trees, and waterfowl are attracted to the cover at the edge of the water. Amphibians, turtles, eagles, foxes, and many other creatures utilize the buffer closer to the shoreline. Shad, herring, alewife, perch, and striped bass utilize forested streams and rivers to spawn, preferring the shaded areas near the edge of the water. The buffer’s vegetation is a food source for wildlife in and out of the water.

Introduction

1. Conduct a class discussion of non-point source pollution in the watershed. Tell (or remind) students that non-point source pollution is pollution that is discharged from a wide land area and cannot be traced to a single specific source and location. Guide the discussion so that various sources of pollution are listed, including farms, lawns, golf courses, and roads. Also discuss the types of pollution that might come from each source.
Procedure

1. Divide the class into groups of four or five students. Instruct the groups to brainstorm and write a list of solutions to the problem of cleaning runoff and reducing the pollution that enters waterways.

2. Provide students with some of the resources listed at the end of the lesson, and allow them time to conduct research on riparian buffers. Tell groups to add to their lists of solutions any other ways they learned that toxic runoff can be prevented. Discuss as a class what the students learned from their research.

3. Assign students to groups of four or five. Give each group two aluminum roasting pans, soil, and grass seed. Provide them with the following instructions:
   - Fill two-thirds of each pan with soil, leaving the other one-third empty.
   - In one of the pans, plant grass seed in the soil in the middle portion of the pan. Do not plant grass in the other pan.
   - Carefully add water to both pans as needed to keep the soil slightly damp but not wet to a depth of one inch. Do not disturb the location of the soil. (This might best be done with a spray bottle.)

4. Allow the grass to grow to the height of one inch. You might choose to have students monitor the growth of the grass and even chart the growth on a line graph.

5. When the grass has reached the height of one inch, provide each group with two cups of water colored with food coloring. Give students the following directions:
   - Raise the soil end of each pan by placing a book underneath the pan’s edge.
   - Slowly pour one cup of colored water (representing polluted runoff) over the high end of each pan.
   - Observe the erosion and the amount of polluted water that runs down into the empty one-third of the pan representing the waterway.

6. When the groups have finished, have each student write a paragraph reporting the results of the experiment. Instruct students also to interpret the results to explain how these models illustrate the role and benefits of a riparian buffer.

Observations and Conclusions

1. Have students bring their notebooks or journals out into the schoolyard. Direct students to find places where erosion is evident. Tell them to record their observations of erosion, including things such as location, appearance, and apparent reason for the erosion.

2. Return to the classroom, and instruct students to choose one of the cases of erosion and write a paragraph about their observations about it. Tell students to answer in their paragraph the following questions:
   - What factors might contribute to erosion in these places?
   - Why should we be concerned about erosion in the schoolyard?
   - How does the water that flows over the schoolyard affect streams, rivers, and the Chesapeake Bay?
   - What might be done to stop the erosion?

3. When students have finished writing, discuss as a class some of the possible solutions for erosion.

Sample assessment

- Discussion of non-point source pollution
- List of solutions for the problem of cleaning runoff and reducing pollution
- Watershed model and written report of experiment results
Written description of erosion case in schoolyard

Follow-up/extension

- Have the students become Virginia Save Our Streams stream monitors. (See http://www.sosva.com/.)
- Have the students prepare a report about the importance of riparian buffers, supporting it with research from the Lessons from the Bay, “Riparian Buffers,” Session 1 and with results from the experiment conducted in Session 2. Have them design the report so that it might be presented to community leaders to convince them of the need for regulation requiring developers and farmers to plant riparian buffers.

Resources

A River Runs Through It

Overview
Students investigate the ways land use along a river impact it and, ultimately, the Chesapeake Bay.

Related Standards of Learning
3.10b, d

Objectives
The students should be able to
• describe how conservation practices can affect the survival of a species.

Materials needed
• Piece of drawing paper with edge cut to resemble the edge of a riverbank
• Long piece of blue bulletin board paper to represent a river
• 3 x 5 inch sticky notes
• Large piece of paper cut into the shape of a raindrop

Per each group of students:
• A scenario cut from the “Land Use Scenarios” (see p. 120)

Instructional activity
Content/Teacher Notes
This activity is a revision of a lesson of the same name in the VDOE Web resource Lessons from the Bay, which includes a process model, outline of the key components of the Chesapeake Bay, lesson plans geared to students in grades 3–6, a glossary of wetland terms, and a project action guide. Lessons from the Bay is on the Web at http://www.doe.virginia.gov/VDOE/LFB/index.html.

Rivers, creeks, and streams throughout the Chesapeake Bay watershed are lined with a wide variety of land types. The impact of the land use surrounding the upper portions of a river is felt all the way downstream, influencing the water quality of the river and, ultimately, the Bay.

Perhaps the greatest negative impact results from conditions that contribute to increased runoff, sediment, and nutrient levels in the water. Increased runoff causes erosion and flooding of waterways. The rapid water picks up and spreads pollutants. Erosion of exposed soil contributes sediment to the water. The sediment blocks the sunlight that underwater grasses need to produce the oxygen that benefits other organisms in the water. Increased nutrient levels in the water cause algal blooms that also block sunlight. Several of the scenarios in this lesson also deal with air pollution and animal waste, another source of increased nutrients.

The most effective method of reducing erosion-causing runoff, sediment, and nutrient levels in the water is the maintenance of vegetation along the riverbank. Vegetation serves as a natural filter, slowing the flow of runoff and holding the soil in place. Vegetation also shades the waterway and prevents the water from reaching unhealthy temperature levels. Farmers who practice no-till farming and/or contour plowing help to reduce runoff and erosion. Developers who maintain a vegetated buffer along waterways help to reduce the potential runoff of pollutants and sediment. Contractors who use retaining fences also reduce the level of runoff and erosion from building sites.

Introduction
1. Divide the class into 10 groups of students (or into pairs). Give each group a piece of drawing paper and one of the Land Use Scenarios. Instruct each group to draw a picture of their piece of
land, using the information given in their scenario. Impress upon them that they should include in their drawing all the details from the scenario.

Procedure
1. Give at least one 3 x 5 inch sticky note to each group. Direct each group to list on the note items from their land that could end up in the river with or without the aid of surface run-off.
2. When all groups have finished, have students place their drawings along the edge of the blue bulletin-board-paper river.
3. Beginning at the start of the river, move the paper raindrop downstream. As you pass by each land-use picture, ask the group that drew it to read their scenario to the class, describe what they have drawn, and read the list from their sticky note. Then, have the group place their sticky note on the raindrop. Proceed to the next land-use picture, and repeat the process.
4. Upon reaching the end of the river, read the sticky notes that are on the raindrop, and discuss the items. Ask students to help you list on the board the items that appear most frequently. Are some items more harmful to the water than others? Are there any that could be helpful? Discuss possible improvements to the land use in each piece of land that would decrease the negative impact on the river’s water quality.
5. Have the groups modify their drawings to reflect better stewardship of the river. Discuss the meaning of stewardship.
6. Take the “river” and “raindrop” outside. Again, give the student groups sticky notes, and tell them to imagine that the river passes through the schoolyard.
7. Direct the groups to search the schoolyard for land-use practices that could impact the river. Tell them to look for both negative and positive impacts and to record their findings on the sticky notes.
8. When students have completed their investigation of the schoolyard, have them attach their sticky notes to the raindrop.

Observations and Conclusions
1. Return to the classroom, and discuss the items listed on the raindrop. Ask students to name and list the items that appear most frequently. Are some items more harmful to the water than others? Are there any that could be helpful? Discuss possible improvements to the land use that would decrease the negative impact on the river’s water quality.

Sample assessment
- Conduct an informal assessment during the activity, determining whether or not students accurately report harmful/helpful impacts of the land area they were assigned.
- Assess students’ solutions for solving land-use problems.

Follow-up/extension
- On a field trip to a local stream, creek, or river, have the students assess the land use along the waterway and offer recommendations for improvements.
- Have the students research best practices in land management. (See “Using the Library Media Center for Project Research” and “Using the World Wide Web for Project Research” in the Project Action Guide, Part 5, of Lessons from the Bay.)
- Have the students study maps to determine land-use practices along a river in your area and then write a story about water as it flows down the river.
Have the students participate in the Chesapeake Bay Foundation’s and Maryland Department of Natural Resources’ “Bay Grasses in Classes” program. (see Resources below)

Have the class write a letter to the principal recommending improvements in land-use practices in the schoolyard. Make sure the students support their recommendations with solid scientific reasoning. Prepare the students for both eventualities: that their letter will not be acted upon, and that it will.

Resources

- “Bay Buffers.” Watershed Action for Virginia’s Environment (WAVE). Chesapeake Bay Foundation. [http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index](http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index), or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.
- “Sources of Sediment.” Watershed Action for Virginia’s Environment (WAVE). Chesapeake Bay Foundation. [http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index](http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index), or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.
A River Runs Through It
Land Use Scenarios

**Scenario 1**
You are a farmer who grows wheat, barley, and oats. Your farm is along the riverbank. In order to save money in equipment costs, you have chosen to use a no-till method of farming, which means that you do not plow the land that you farm. To keep your land free of unwanted plant growth between crops, you apply herbicides regularly.

**Scenario 2**
You are the owner of the Riverview Shopping Mall. This mall has many paved parking lots and concrete sidewalks. There is even a sidewalk along the riverbank, where shoppers can relax and eat while enjoying a lovely view of the river. There is extensive landscaping around your mall, with lush trees, shrubs, and flowers. You instruct your maintenance staff to apply fertilizers regularly to keep the landscaping lush.

**Scenario 3**
You are the owner of the Down by the Riverside golf course. Your course has 18 holes of manicured fairways and greens, all of which are kept green by the frequent application of fertilizers and herbicides. Many of the fairways slope to the river’s edge, offering golfers an extra challenge, as well as a beautiful view.

**Scenario 4**
You are the developer of the Homes on the River subdivision. This subdivision contains 25 homes owned by high-income families. Many of these families have dogs and cats that enjoy the well-manicured lawns that surround each home. Most of the homeowners apply fertilizers and herbicides regularly to their lawns to keep them beautiful. The roads and driveways in the subdivision are paved. The trees and vegetation that once lined the riverbank have been removed in order to give residents a view of the river.

**Scenario 5**
You are the owner of the Big River Marina. You have numerous concrete boat ramps that descend directly into the river, where boaters can easily gain access to the water. You also sell oil and gasoline from a dock in the river, where boaters can fill their boats with fuel without leaving the water.
Scenario 6
You are a contractor assigned to build a new subdivision of riverfront homes. You are currently in the beginning stages of construction. Your bulldozers have dug up the soil where the foundations of these homes will eventually be built. There is a tremendous area of bare, exposed soil alongside the river.

Scenario 7
You are a farmer who grows corn. Corn extracts a tremendous amount of nutrients from the soil. Since you plant corn in the same fields every year, the soil does not always have enough nutrients to support the growth of the corn. Therefore, you apply a great deal of fertilizer, containing nutrients, to the soil. One of your fields slopes down to the edge of the river. You plow this field in rows that are perpendicular to the river. Rainwater often runs very fast down the gullies created by these rows.

Scenario 8
You are the owner of a forestry company that makes its money by cutting down trees along the river and selling them to lumber companies. You bring in several bulldozers and chainsaws that plow down and cut the trees. This equipment runs on gasoline and produces large quantities of exhaust. To ensure that you will have more trees to cut in the future, you replant the land in pines after you have finished clearing it.

Scenario 9
You are the owner of a chicken farm. Chicken manure contains a very high amount of nitrogen. You have about 20 chicken coops. When it is time for you to clean them, you shovel the manure and pile it on the edges of fields that drain into the river.

Scenario 10
You are the owner of a fishing pier. Many tourists and locals use this pier for sport fishing. Your dock contains a store that sells bait, tackle, and refreshments. Many of the people who fish from your pier catch an average of 20 fish a day. Those that are too small to keep are always thrown back. There is also a spot beside your pier where guests can clean their fish. The remains of the fish are dumped back into the river. There is also a paved parking lot beside your pier that extends very close to the river's edge.
Who Killed SAV?

Overview
Students investigate what factors have contributed to the decline of submerged aquatic vegetation in the Chesapeake Bay.

Related Standards of Learning 3.10a, b

Objectives
The students should be able to
• explain how living things in an area are dependent on each other;
• compare and contrast human influences on the quality of air, water, and habitats.

Materials needed
• Internet access
Per student:
• “The Trial of SAV’s Killer” worksheets (beginning on p. 125)
• Who Killed SAV? booklet (beginning on p. 137)

Instructional activity

Content/Teacher Notes
This activity is a revision of a lesson of the same name in the VDOE Web resource Lessons from the Bay, which includes a process model, outline of the key components of the Chesapeake Bay, lesson plans geared to students in grades 3–6, a glossary of wetland terms, and a project action guide. Lessons from the Bay is on the Web at http://www.doe.virginia.gov/VDOE/LFB/index.html.

Submerged aquatic vegetation (SAV) provides an essential link in the balanced health of the Chesapeake Bay and its tributaries. Like grass on a lawn, SAV requires light, water, and nutrients to survive. In turn, these grasses produce the oxygen necessary for the survival of underwater organisms. Underwater grasses, such as wild celery, elgrass, and widgeon grass, provide shelter for fish, shellfish, and many other invertebrates. SAV provides food for the animals it shelters and for waterfowl as well. SAV helps to maintain water quality and clarity, working as a natural filter to trap sediment. SAV roots provide stability to the bottom of the bay and its tributaries, playing a vital role in preventing erosion and further sediment pollution. SAV absorbs nutrients for its own benefit, benefiting the underwater environment by helping to keep nutrient levels down.

Since the 1960s, more than half of the Bay’s SAV has disappeared. It is impossible to pinpoint one single cause of this decline, but it seems likely that the very pollutants SAV removes from the water are partly to blame. Excessive amounts of sediment cloud the water and block out the sunlight vital for the survival of underwater grasses. Likewise, excessive nutrients cause large algal blooms, which also block out the sunlight. Additionally, hurricanes and dredging have contributed to the decline. In this lesson, students will research these natural and human factors in order to defend or prosecute each “suspect.”

Introduction
1. Begin by reading aloud the story Who Killed SAV? (see p. 137). Stop after page 5 to allow students to make predictions. Ask, “What could possibly have caused SAV to disappear?”
**Procedure**

1. Continue reading, stopping after each suspect is described to summarize the ways in which that suspect harmed SAV.

2. Divide the class into groups of three or four students each, and assign each group one suspect: Hurricane Agnes, Clam Dredging, Development, or Nutrients. Designate one student in each group to be the “accused,” one to be the “defender,” and one or more to be the “prosecutor(s).” Distribute the appropriate “The Trial of SAV’s Killer” worksheets as guides for the various courtroom characters to use in preparing their cases.

3. Allow time for students to prepare and plan their cases as well as to do further research as needed. (See “Using the Library Media Center for Project Research” and “Using the World Wide Web for Project Research” in the Project Action Guide, Part 5, of Lessons from the Bay.)

4. Set up the classroom as a “courtroom,” and call one group to the front of the courtroom to act out their suspect’s trial before you, the judge. Give the prosecutor(s) time to present the case against the accused; then, allow the accused and defender to defend the charges. Direct the rest of the class to serve as members of the jury and take notes. Repeat this step for each suspect.

**Observations and Conclusions**

1. When all groups have presented, lead the class in a discussion of who is guilty among the four suspects. Alternatively, you may choose to have the class determine which suspect is least guilty, since it is impossible to blame only one factor for the demise of SAV. It is important for students to realize that land-use practices and other factors contributing to the decline of SAV levels can be prevented or reversed. Nevertheless, students should recognize that there are two sides to every argument. For example, watermen who dredge for clams, though they are killing SAV, also have the right to earn a living.

**Sample assessment**

- Assess the students’ Trial Worksheets.
- Assess the students’ group presentations.
- Assess students during the class discussion of guilty suspects.

**Follow-up/extension**

- Have students survey the schoolyard to identify land-use practices that contribute to increased sediment and nutrient runoff, and develop an action plan for addressing the problem.
- Have the students participate in the Chesapeake Bay Foundation’s and Maryland Department of Natural Resources’ “Bay Grasses in Classes” program. (see Resources below).
- Have students write persuasive letters to clam dredgers, developers, farmers, homeowners, and others, encouraging them to use the land more wisely in an effort to save underwater grasses.

**Resources**

- *Watershed Action for Virginia’s Environment (WAVE)*. Chesapeake Bay Foundation. [http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index](http://www.cbf.org/site/PageServer?pagename=edu_educators_curriculum_va_index), or contact the Virginia Office: Capitol Place, 1108 E. Main Street, Suite 1600, Richmond, VA 23219; phone 804-780-1392.
- “Bay Grasses: Bay Grass Restoration.” *Chesapeake Bay*. Maryland Department of Natural Resources. [http://www.dnr.state.md.us/bay/sav/](http://www.dnr.state.md.us/bay/sav/).
Science Enhanced Scope and Sequence – Grade 3

- “Bay Grasses (SAV).” Chesapeake Bay Program. http://www.chesapeakebay.net/baybio.htm. Go to this site and then click on Bay Grasses (SAV).
The Trial of SAV’s Killer

You are Clam Dredging!

How do you affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Accused, it is your job to
- work with the defender to prove that you are not guilty or that you killed SAV in self-defense;
- explain why some other causes are to blame.
The Trial of SAV’s Killer

Name: ___________________________ Date: ______________________

You are the Defender of Clam Dredging!

How does Clam Dredging affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Defender, it is your job to
• prove Clam Dredging is not the only one responsible for SAV’s decline;
• prove Clam Dredging killed SAV in self-defense;
• convince the jury to allow Clam Dredging to continue.
You are the Prosecutor against Clam Dredging!

How did Clam Dredging affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Prosecutor, it is your job to
• prove the decline of SAV is mostly the fault of Clam Dredging;
• prove Clam Dredging could have avoided killing SAV;
• explain why Clam Dredging should be punished or prevented from committing the same crime in the future.
The Trial of SAV’s Killer

Name: ___________________________ Date: ________________

You are Hurricane Agnes!

How do you affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Accused, it is your job to
• work with the defender to prove that you are not guilty or that you killed SAV in self-defense;
• explain why some other causes are to blame.
You are the Defender of Hurricane Agnes!

How does Hurricane Agnes affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Defender, it is your job to
- prove Hurricane Agnes is not the only one responsible for SAV’s decline;
- prove Hurricane Agnes killed SAV in self-defense;
- convince the jury to allow Hurricane Agnes to continue.
You are the Prosecutor against Hurricane Agnes!

How did Hurricane Agnes affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Prosecutor, it is your job to
- prove the decline of SAV is mostly the fault of Hurricane Agnes;
- prove Hurricane Agnes could have avoided killing SAV;
- explain why Hurricane Agnes should be punished or prevented from committing the same crime in the future.
The Trial of SAV’s Killer

Name: ____________________________ Date: ________________

You are Development!

How do you affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Accused, it is your job to
• work with the defender to prove that you are not guilty or that you killed SAV in self-defense;
• explain why some other causes are to blame.
The Trial of SAV’s Killer

Name: ___________________________ Date: __________________

You are the Defender of Development!

How does Development affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Defender, it is your job to

• prove Development is not the only one responsible for SAV’s decline;
• prove Development killed SAV in self-defense;
• convince the jury to allow Development to continue.
The Trial of SAV’s Killer

Name: _____________________________ Date: ______________________

You are the Prosecutor against Development!

How did Development affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Prosecutor, it is your job to
• prove the decline of SAV is mostly the fault of Development;
• prove Development could have avoided killing SAV;
• explain why Development should be punished or prevented from committing the same crime in the future.
You are Nutrients!

How do you affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Accused, it is your job to
- work with the defender to prove that you are not guilty or that you killed SAV in self-defense;
- explain why some other causes are to blame.
The Trial of SAV’s Killer

You are the Defender of Nutrients!

How does Nutrients affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the Defender, it is your job to
• prove Nutrients is not the only one responsible for SAV’s decline;
• prove Nutrients killed SAV in self-defense;
• convince the jury to allow Nutrients to continue.
The Trial of SAV’s Killer

Name: ___________________________ Date: __________________

You are the Prosecutor against Nutrients!

How did Nutrients affect Bay grasses, or Submerged Aquatic Vegetation (SAV)?

What are some other causes of Bay grass decline?

As the prosecutor, it is your job to
• prove the decline of SAV is mostly the fault of Nutrients;
• prove Nutrients could have avoided killing SAV;
• explain why Nutrients should be punished or prevented from committing the same crime in the future.
Who Killed SAV?

written by
Jelita P. Hopkins

adapted from the Chesapeake Bay Foundation’s “Bay Grasses in the Classes” curriculum
Once upon a time, Submerged Aquatic Vegetation or SAV (also known as Underwater Grasses) lived happily in the Chesapeake Bay and its tributaries. She grew tall and thick throughout the entire Bay and even in the rivers that flowed into the Bay.
She waved back and forth in the tides, soaking up sunlight from above, nutrients from the sandy soil below her, and water from all around.

So, who killed SAV? Was it Hurricane Agnes, Clam Dredging, Development, or Nutrients? You decide.
These extra Nutrients flowed into the creeks, streams, and rivers that flowed into the Bay. They caused algae to grow very fast and thick on the water. The algae was like a blanket on the water. It blocked out the sunlight that SAV needed to survive.

She breathed out oxygen for the fish and other underwater organisms to breathe in.
She provided food and shelter for water birds, crabs, baby fish, and tiny invertebrates in her thick leaves. She hid them from predators while they grew.

Nutrients started out as a pretty innocent guy. He helped plants to grow, including SAV. But then the people who lived in the Bay’s watershed started to add lots of Nutrients to the soil. They put fertilizers and chemicals on their grass and crops to make them grow faster.
Development also caused more pollution and poisons to get into the water. With their factories, farms, cars, and lawns, the people put chemicals onto the land that washed into the rivers and streams when it rained. This poison killed lots of animals in the rivers and the Bay, and it also hurt SAV.

She filtered the water that flowed through her, catching tiny bits of dirt and pollution. She was able to help keep the water that flowed into the Bay clean and healthy. She was proud of all that she did.

But then something bad started to happen. SAV started to disappear!
A big hurricane blew across the Chesapeake Bay. The Hurricane’s name was Agnes. Hurricane Agnes caused the salty ocean water at the mouth of the Bay to flow much further up into the Bay. SAV could not live with so much salt in the water around her.

Development caused trees to be chopped down and caused a lot more soil to erode into the rivers and streams that flowed into the Bay. The extra soil in the water blocked out the sunlight that SAV needed to live.
The people who lived around the Bay also wanted to build houses for themselves. Later they decided to build lots and lots of houses and other buildings, too. They used these buildings for homes, businesses, and ways to make money to help feed their families. But all of this Development was causing some very bad things to happen in the Bay.

Hurricane Agnes also caused the rivers that flowed into the Bay to flood. They tore through land and picked up lots of extra sediment and nutrients. The sediment blocked out the sunlight that SAV needed to grow and survive.
One day, the people who lived around the Bay found out that the clams and oysters that lived in SAV’s shelter were delicious to eat. They decided to take lots and lots of clams and oysters out of the Bay by dredging. This means they would drag a large rake from their boats to scrape the oysters and clams off the bottom of the Bay and into their boats.

Clam Dredging did not scrape just the clams and oysters, though. SAV got caught in the rakes as well. When Clam Dredging scraped for oysters and clams, he also ripped up lots and lots of SAV.
**Sample Released SOL Test Items**

One reason people build tall buildings in cities is that there is too little —

A  land  
B  air  
C  minerals  
D  water  

Which of these probably causes the most air pollution?

A  Trees  
B  Cars  
C  Wind  
D  Rain  

What natural event most likely caused the damage to this forest habitat?

F  A flood  
G  A fire  
H  A hurricane  
J  An earthquake
Organizing Topic — Investigating Natural Cycles

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.8 The student will investigate and understand basic patterns and cycles occurring in nature. Key concepts include
   a) patterns of natural events (day and night, seasonal changes, phases of the moon, and tides);
   b) animal and plant life cycles.

The students should be able to

- explain how some events in nature, such as the seasons, day and night, phases of the moon, tides, and life cycles, occur in a pattern or cycle;
- recognize that the relationships that exist between and among the Earth, sun, and moon result in day and night, seasonal changes, phases of the moon, and the tides;
- model and describe how Earth’s rotation causes day and night;
- model and describe how the sun’s rays striking Earth at various angles cause seasons;
- observe, chart, and illustrate phases of the moon, and describe the changing pattern of the moon as it revolves around Earth;
- analyze data from simple tide tables to determine a pattern of high and low tides;
- explain the pattern of growth and change that organisms, such as the butterfly and frog, undergo during their life cycle.
Time and Tide

Overview
Students investigate the rise and fall of daily tides and learn to read a tide table.

Related Standards of Learning 3.8a

Objectives
The students should be able to
- explain how some events in nature, such as tides, occur in a pattern or cycle;
- recognize that the relationships that exist between and among the Earth, sun, and moon result in the tides;
- analyze data from simple tide tables to determine a pattern of high and low tides.

Materials needed
- A yardstick (or meter stick) (This will help you and the class measure the difference between high tides and low tides. Tides are always measured in feet, but you may want to measure the water level in both English and metric units.)

Per student:
- “Tide Card” copied on blue 8½ x 11 inch paper (see p. 153)

Instructional activity

Content/Teacher Notes
This lesson is an adaptation of an activity from the Science Museum of Virginia’s, “Earth in Space” teaching module. This activity, “EIS Workshop 6: Time and Tide — How Do the Tides Work?,” as well as others that cover the Earth/Space Systems and Cycles strand, can be found at http://www.smv.org/pubs/EarthInSpaceMenu.htm.

The moon orbits around Earth. The moon’s gravity pulls at Earth’s oceans and makes the water a little bit higher in some places, which in turn makes the water a little lower in other places. This phenomenon produces tides. Tides are daily changes in the elevation of the waters on our planet caused by the gravity of the moon and the sun.

Earth rotates once every day and the tides appear to go up and down about twice in one 24-hour day. This accounts for the approximately six-hour interval between a high tide and the following low tide. Because the moon is also moving in an orbit around Earth as Earth rotates, the moon rises almost an hour later every night. This means that it actually takes the tides almost 25 hours to repeat the full pattern. This extra time means that on some days, there might not be both two high tides and two low tides. The tide in some places causes the water to rise only a few feet, as it does in the Chesapeake Bay; in other places, it causes a much greater rise, as it does in the Bay of Fundy in Canada.

Tide tables are easy-to-read charts that list the times of the low and high tides for each day. Tide tables appear in many daily newspapers because knowing the times of the tides is important to people who live and work along the coasts.

There are actually two tidal “bulges” caused by the moon’s gravity and the motion of Earth. The second bulge on the side of Earth facing away from the moon is produced by a combination of the pull of gravity and the motion of Earth. (Think of a pan of water sloshing as you move it in a circle: you’ll see a bulge and a trough in the pan.)
Introduction
1. To get your students in a “tidal” frame of mind, read them a book about the beach. Sharing such a story with your students can also be an excellent way of reviewing with them the relationship between the moon and Earth.

Procedure
This activity involves only 12 students at a time, so you may have to repeat it to give all of your students an opportunity to participate.

1. Copy the simplified tide table included at the end of this activity onto the chalkboard or make a transparency to use on your overhead projector.
2. Explain to students that they will be making a “living graph” of the low tides and high tides that occur over a three-day period. Ask students to describe tides by drawing on their own experiences or by thinking of the books that were read to them in the “Getting Started” section.
3. Distribute to each student a copy of the Tide Card that you have copied onto blue paper.
4. Show the students how to read the Tide Table, pointing out the days, times, and low and high tides.
5. Assign each student a day, tide, and time. For example, your first student would be assigned “Monday, Low Tide at 3:30 a.m.” Two or more students will be assigned the same day, tide and time if you choose to do this activity more than once so that each child may participate.
6. Once students have their assignments, instruct them to write their day on the card, circle the correct tide, write in the time, and circle “a.m.” or “p.m.” on their Tide Cards.
7. Students are now ready to form their “living graph!” Ask the students to line up in the front of the room in chronological order beginning with “Monday, Low Tide at 3:30 a.m.”
8. Instruct students who are “high tides” to hold their cards above their heads. Students who are “low tides” should hold their cards waist high. The difference created between “high and low tide” should be about two and a half feet — which is the actual difference in high and low tides in the Chesapeake Bay! Use your yardstick to show the usual height difference between high and low tide in Virginia tidal waters.

Observations and Conclusions
1. Lead a class discussion, using the following prompts:
   • How many high tides usually occur in one day? (2)
   • How many low tides usually occur in one day? (2)
   • What is the approximate time interval between one high tide and the following low tide? (6 hours)
   • Would you describe tides as occurring in a cycle that follows a natural pattern? Why, or why not? (Yes, tides occur in a pattern; a high tide is always followed by a low tide and they are approximately six hours apart.)
   • Name some other cycles or patterns found in nature. (moon phases, seasons, birds flying south for the winter and north for the summer, day and night)
   • Name some people who need to know where to find and how to read tide tables. (beach vacationers, fishermen, lighthouse keepers, lifeguards, boaters, swimmers, and surfers — anyone who works or lives near coastal waters)

Sample assessment
• Informally assess students’ answers to the conclusion questions.
• Give the students a tide table, and assess their reading of it.
Follow-up/extension

- Have the students who are not participating in the activity graph the results at their desk; then have the students switch roles.
- Have students research tide tables on the Web for different areas of Earth.

Resources

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Offers a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
# Tide Table

<table>
<thead>
<tr>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low Tide: 3:30 a.m.</td>
<td>Low Tide: 4:25 a.m.</td>
<td>Low Tide: 5:20 a.m.</td>
</tr>
<tr>
<td>High Tide: 9:44 a.m.</td>
<td>High Tide: 10:39 a.m.</td>
<td>High Tide: 11:34 a.m.</td>
</tr>
<tr>
<td>Low Tide: 3:58 p.m.</td>
<td>Low Tide: 4:53 p.m.</td>
<td>Low Tide: 5:48 p.m.</td>
</tr>
<tr>
<td>High Tide: 10:11 p.m.</td>
<td>High Tide: 11:06 p.m.</td>
<td>High Tide: 11:59 p.m.</td>
</tr>
</tbody>
</table>
Tide Card

Directions:
• Write in the correct day;
• Circle the correct tide;
• Write in the correct time;
• Circle a.m. or p.m.

Day: ____________________

Tide: High      Low

Time: _____________   a.m.   p.m.
The Phases of the Moon

Overview
Students investigate the phases of the moon.

Related Standards of Learning 3.8a

Objectives
The students should be able to
• explain how some events in nature occur in a pattern or cycle, such as phases of the moon;
• observe, chart, and illustrate phases of the moon and describe the changing pattern of the moon as it revolves around Earth.

Materials needed
• Soccer ball
• Flashlight
• Black paper
• Chalk
• Calendar grid

Instructional activity

Content/Teacher Notes
(Note: The following is background information for the teacher. At this level, the focus is not to have the students know the names of each phase of the moon, but rather to have them understand what causes the phases.)

The moon generates no light of its own. It shines because it reflects the light coming from the sun. Though it does not always appear so from Earth, half of the moon is always illuminated; that is, the sun always shines on one side of the moon, while the other side is in darkness. However, as the moon orbits (revolves around) Earth, its position in relation to the Earth and the sun changes, and more or less of the illuminated side can be seen from Earth. These different views of the illuminated portions of the moon are called “phases of the moon.”

When the moon is directly between the sun and the Earth, the side of the moon facing Earth is in darkness, and therefore the moon is not visible in the sky. The intensity of the sun is so great that the moon is visibly lost in the sun’s glare. This phase is called a “new moon.”

As the moon continues to move in its orbit around the Earth, a sliver of the illuminated side of the moon becomes visible. This phase is called the “waxing crescent.” (To wax is to increase.)

When the moon has completed one quarter of its orbit around the Earth, it makes a right angle with the Earth and the sun. One side of the moon is still illuminated by the sun, and the other side is still in darkness. From Earth, however, the moon now appears to be a half circle. This phase is called the “first quarter.”

As the moon continues in its orbit, the portion of the illuminated side of the moon visible from Earth continues to increase. When the moon appears to be more than a half moon but less than a full moon, it is called a “gibbous moon.” At this point in its orbit, the moon appears to be growing, so this phase is called a “waxing gibbous.”

When the moon has completed one half of its orbit around the Earth, it is almost in a straight line with the Earth and the sun. The entire side of the moon that faces Earth is illuminated. This phase is called a “full moon.”
The darkened side of the moon begins to reappear to observers after the full moon. This phase is called a “waning gibbous.” (To wane is to decrease.) The moon is described as waning when it appears to grow smaller.

When the moon has completed three-quarters of its orbit around the Earth, it again makes a right angle with the Earth and the sun. This phase is called the “third quarter” or “last quarter.”

As the moon continues in its orbit, it appears as a crescent shape once again. Since it appears to grow smaller, this phase is called a “waning crescent.”

The darkened area continues to grow larger until no portion of the illuminated moon can be seen. The moon has returned to the new moon phase.

Activity 1
1. Explain to students that for the next month, they are going to be making nightly observations of the moon.
2. Give each student a copy of a calendar grid with the dates of the month on it. Have them take the moon calendars home to use every evening, but have them bring them back to class every day. Give them instructions to look at the moon each evening and draw in the appropriate box on the calendar the shape of the moon that they see.
3. During calendar time at school each day, have students share the shape of the moon that they drew the night before. Discuss the change from the previous shape, if any.

Activity 2
1. When the month is over and the moon calendars are complete, ask the students if they have any ideas about the changes in the shape of the moon that they have been observing. Lead the discussion toward the fact that the moon is always round but that we see different shapes because of where it is in the sky. To emphasize this point, do the following activity:
2. Place a soccer ball or other round object up at eye level in the middle of the room to represent the moon. Shine a flashlight on the “moon.”
3. Give each student a black piece of paper and a piece of chalk. Have them form a circle around the “moon.”
4. Turn out the room lights, and have students observe the “moon.” Have them draw how the moon looks to them — the dark part and the illuminated part. (If it is too dark to draw, give them time to look, and then turn the lights back on for the drawing process.) Then, discuss whether they all saw the same thing.
5. Begin with the student who could not see any part of the illuminated “moon,” and have him/her place his/her picture on the board. Go around the circle in order, with each student placing his/her picture on the board in order.
6. Ask the students why all of the pictures do not look the same. “Why didn’t you all see the same thing? Is there a pattern to what you observed? How does it compare with the chart you made when you observed the real moon?”
7. Have students write a short explanation of why they all did not see the same thing when they looked at the “moon” while standing in the circle around it.

Activity 3
1. Review with students the previous activity. Lead the discussion toward the fact that the sun is the source of the light that lights up the moon.
2. Review with students how Earth rotates on its axis, and relate this to the rotation of the moon on its axis as well. Be sure students understand the difference between rotate/rotation and revolve/revolution (orbit). (This topic is addressed in the next lesson, “As the World Turns, Rotates, and Revolves.”)

3. Have students use models to show the relative locations of the sun, moon, and Earth during each phase of the moon depicted on their moon calendars from Activity 1. Be sure to include a discussion about the orbit (revolution) of the moon around Earth.

**Observations and Conclusions**

1. Students will make observations and answer questions throughout activity.

**Sample assessment**

- Have students draw the positions of the sun, moon, and Earth when there is a full moon, new moon, and the quarter moons. Remember that at this level, the focus is not to have the students know the names of each phase of the moon, but rather to have them understand what causes the phases.

**Follow-up/extension**

- Have students demonstrate the positions of the sun, moon, and Earth that cause the crescent moons.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Offers a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


As the World Turns, Rotates, and Revolves

Overview
Students investigate the rotation and revolution of Earth.

Related Standards of Learning 3.8a

Objectives
The students should be able to
• explain how some events in nature occur in a pattern or cycle, such as the seasons and day and night;
• recognize that the relationships that exist between and among the Earth, sun, and moon result in day and night and seasonal changes;
• model and describe how Earth’s rotation causes day and night;
• model and describe how the sun’s rays striking Earth at various angles cause seasons.

Materials needed
• Globe of the Earth (See Optional Globe Preparation below.)
• Clear 100-watt light bulb
• Lamp
• “Rotate” and “revolve” signs (see pp. 161 and 162)
• Tiny piece of a sticky note
• A room that can be darkened

Instructional activity

Content/Teacher Notes
This lesson is an adaptation of an activity from the Science Museum of Virginia’s, “Earth in Space” teaching module. This activity, “EIS Workshop 2: As the World Turns,” as well as others that cover the Earth/Space Systems and Cycles strand, can be found at http://www.smv.org/pubs/EarthInSpaceMenu.htm.

Optional Globe Preparation: You can use a regular globe for this demonstration, but a white globe creates a much more dramatic effect. The colors on a regular globe have different abilities to absorb and reflect light, which makes it hard to see and understand how the light is hitting the globe’s surface. You can make a “white globe” in a couple of ways. If possible, find an old, out-of-date globe that you can paint. Outline the continents and the equator with the kind of puff paint that children use for decorating T-shirts. Let the puff paint dry for about 24 hours. Next, paint the surface of the globe with several coats of white acrylic paint. Once the globe is dry, experiment with shining a strong light on the surface of the globe, aiming the light at the equator. This setup should provide a very dramatic division between “night” and “day.”

Introduction
1. Position your light source so that you can move the globe around it during the discussion. Draw a human figure on the tiny portion of a sticky note. Dim the lights in the room for the demonstration. Use your own version of the following conversation to get the class ready for the “As the World Turns” demonstration.
2. “Let’s look at this globe. What things do you notice about this globe? (It’s a special kind of map. It shows us where the oceans and landmasses are on the Earth’s surface.) Let’s find where we live on
this globe. (Point out Virginia on the globe. Attach the tiny sticky note with the figure drawn on it to Virginia. Make sure that the little figure is looking toward the North Pole.)

3. “This little figure is going to represent us as we talk about the globe. Why do you think the North Pole is at the top of the globe? There is actually no reason that we couldn’t put the South Pole at the top. If the first mapmakers had lived in Australia, we might be studying a globe that had the South Pole at the top! However, most of the early explorers and mapmakers came from the top half of the Earth, so globes have north at the top.

4. “As we talk about the movements of the sun and Earth, we will pretend that we are standing in Virginia and facing the North Pole. This is our ‘point of view’ or ‘frame of reference.’”

Procedure

Rotation of the Earth Demonstration

1. Ask the students, “Can anybody tell me what the word rotate means?” (To spin around an imaginary line called an axis.) Ask all of the students to rotate, and have one student be the “rotate” sign holder, holding up the sign every time you say the word rotate. Turn the globe slowly counterclockwise, and explain that Earth rotates in a counterclockwise direction.

2. Ask, “What do we mean by the term counterclockwise?” Ask the students to make circles with an arm in the direction in which the hands on a clock move — clockwise. Then, have them make circles in the opposite direction — counterclockwise. “When we say that Earth turns in a counterclockwise direction, remember that we are looking at Earth from above the North Pole. Ask all of the students to rotate in a counterclockwise direction, using their arms to represent their axis of rotation. Have the “rotate” sign holder hold up the sign.)

3. Say, “This light we have set up represents the sun. As you rotate, imagine that your nose is you and the top of your head is the North Pole. Notice that your nose goes through a repeating cycle — night (away from light) – day (facing light) – night – day – night – day, and so on. Also, the sun seems to rise in the east and set in the west, but it’s really you who is moving, not the light (sun).” Let the students sit down for a few minutes, as you don’t want “dizzy” planets!

4. Demonstrate the same phenomenon — the sequence of night and day — using the globe. Be sure to point out the little figure that represents “us.” Follow the little figure through several cycles of night and day. “Where is the sun when the little figure sees the dawn start?” (Just appearing in the east) “Where is the sun when the little figure is ready for lunch around noon?” (Close to overhead in the sky) “Where is the little figure when it’s sunset?” (Just disappearing in the west) “Where is the little figure when it’s night?” (On the far side of Earth, which is in shadow) Depending on the ability level of your students, you may want to add that this is why the stars, moon, and planets also appear to rise and set. Emphasize that these objects aren’t really moving across our sky from east to west, but that Earth’s rotation in the opposite direction, west to east, makes all of these objects look like they are moving — rising and setting.

5. The diagram below shows why the sun appears to move across the sky because of Earth’s rotation. (The Earth and sun are not drawn to scale.) “Can anyone tell how long it takes Earth to rotate once on its axis, from noon to noon?” (One day, or 24 hours)
Revolution of the Earth Demonstration
1. Say, “Now, we’re going to learn about another movement that Earth makes. It has a special word too. At the same time that Earth is rotating on its axis, it’s making a circle — or revolution — around the sun. We say that Earth revolves around the sun.” Have a student be the “revolve” sign holder, holding up the sign every time you say the word *revolve*. Make sure everyone gets the idea of revolving.

2. The diagram below is designed to show the movement of Earth around the sun. (The sizes of the sun and the Earth and the distances between them are not drawn to a single scale. Also, Earth’s orbit is viewed from the side. This orbit is actually fairly close to a circle.)

![Earth's Revolution Diagram](image)

3. Say, “Let’s do one last movement around the sun! I want everyone to make one revolution around the sun and rotate on your axis at the same time. Go slowly so that you don’t get too dizzy! Can anyone tell me how long it takes for Earth to revolve around the sun one time? (One year)

Observations and Conclusions
1. Have students make observations and answer questions throughout activity.

Sample assessment
- Have students draw diagrams to depict the seasons and day and night with respect to the position of the sun and Earth.
- Ask students to describe in their own words the difference between rotation and revolution, including which one causes the seasons and which one causes day and night.

Follow-up/extension
- See the “Earth in Space” teaching module for more lessons regarding the seasons.
- Ask students to make a drawing that shows the early morning or late afternoon sun in the sky. East should be on the right side of the picture and west on the left side of the picture. (This activity puts east on the right because the students will associate east and west with standard map orientations. Astronomers in the Northern Hemisphere usually view the sky while facing south, but younger students may have trouble understanding the reversal of viewpoint. Noon is omitted from the student options because at our latitude, the sun would be behind the student high in the sky, and
objects would cast their shadows toward the north, which would be directly behind the objects from the students’ point of view.) Remind students to include the shadows that the objects in the drawing cast on the ground and to write the time of day in the lower right hand corner of the drawing.

Resources

- **Connections: Connecting Books to the Virginia SOLs.** Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.

- **Earth in Space: Teacher Training Module.** [http://www.smv.org/pubs/EarthInSpaceMenu.htm](http://www.smv.org/pubs/EarthInSpaceMenu.htm). This module is a professional development resource of the Virginia Department of Education that was developed by the Science Museum of Virginia for astronomy in grades 1 through 6.

- **The NASA SCIENCE Files™.** NASA Center for Distance Learning at Langley. [http://scifiles.larc.nasa.gov/educators/index.html](http://scifiles.larc.nasa.gov/educators/index.html).


revolve
Sample Released SOL Test Items

When the moon is seen from the Earth as a whole circle, it is called a —

A  full moon  
B  crescent moon  
C  new moon  
D  half moon

These pictures show the seasons changing from —

A  spring to summer  
B  summer to fall  
C  fall to winter  
D  winter to spring
Organizing Topic — Investigating the Water Cycle

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.9 The student will investigate and understand the water cycle and its relationship to life on Earth. Key concepts include
   a) the energy from the sun drives the water cycle;
   b) processes involved in the water cycle (evaporation, condensation, precipitation);
   c) water is essential for living things; and
   d) water supply and water conservation.

Essential Understandings, Knowledge, and Skills

The students should be able to
- identify the sun as the origin of energy that drives the water cycle;
- describe the processes of evaporation, condensation, and precipitation as they relate to the water cycle;
- construct and interpret a model of the water cycle;
- identify major water sources for a community, including rivers, reservoirs, and wells, and describe the major water sources for the local community;
- explain methods of water conservation in the home and school;
- analyze possible sources of water pollution in their neighborhoods, at school, and in the local community, including runoff from over-fertilized lawns and fields, oil from parking lots, eroding soil, and animal waste;
- appraise the importance of water to people and to other living things;
- realize living things get water from the environment in different ways.
**Aquatic Words**

**Overview**
Students describe a variety of ways and reasons that water is important to people and wildlife.

**Related Standards of Learning** 3.9c

**Objectives**
The students should be able to
- appraise the importance of water to people and other living things;
- realize living things get water from the environment in different ways.

**Materials needed**
- Writing materials
- Magazine photographs
- Construction paper in various shades of blue, aqua, gray, white, and green

**Instructional activity**

*Content/Teacher Notes*
This lesson is adapted from the Project Wild aquatic lesson, “Aquatic Words.” Information concerning Project Wild and workshops in Virginia can be found at [http://www.dgif.state.va.us/education/wildlife_education.html](http://www.dgif.state.va.us/education/wildlife_education.html).

Water is central to all life and life activities. Plants and animals must have water to survive. Almost all plants and animals and all humans need clean water to live healthy lives. To stay healthy, humans need about one liter of water each day. Water helps blood and its components transport oxygen and nutrients and removes waste through our circulatory systems. Water represents about 75% of a person’s body weight. Some animals and plants contain even more water. A jellyfish is 95% water, and a watermelon is 97% water. Most fish and other aquatic animals can live only when they are completely covered with water.

Water covers nearly 75% of Earth’s surface. Nearly everything on Earth has a direct or indirect connection with water. Rocks channel water into streams, and streams and rivers carry water across the land. Ponds, lakes, marshes, and swamps often hold water in place. Trees draw water from the soil and transport it into the leaves and out again into the air. Clouds are airborne carriers of water across the sky.

Humans use water for many purposes other than drinking. We use water for power generation, for industry, and for irrigating crops and lawns. Water is also a source of beauty and recreation. It is the basis of a massive planetary transportation system. Even the driest desert has water, and there are about 320,000,000 cubic miles of water in the oceans. Water grows our food, cools our cars, and is one of the most important substances astronauts take into space.

**Introduction**
1. Have students bring in photographs from magazines and other sources that show water habitats. Ask them to look especially for pictures that show how organisms depend on water. Display these photographs, and use them as a basis for a discussion about the dependence of living things on water.
Procedure
1. Ask students to think about some of the ways they have used water today. Use applicable pictures they have collected to prompt their thinking. Emphasize how all organisms are ultimately connected to water.

2. Ask students to think of at least 50 words that have something to do with water, including how it is important to people and wildlife, and list them on chart paper or the chalkboard. Lead students to stretch into new areas by suggesting examples and categories of ideas.

3. Using the list of words, ask the students to create word trees of water-related words. Begin with a simple word tree like this:

   ![Word Tree Example]

   Then, have students create more complex word trees as well.

4. When students have finished several word trees, have them use the trees to write one or two poetic definitions of water or water-related concepts. For example, using the word tree composed of the words condensation, cloud, rain, and storm, they might say: “Water is gray clouds condensing into a loud summer rain storm.” Alternatively, students could create sentences about water.

5. When the students have completed their poetic definitions/sentences, have them write their sentences onto pieces of construction paper in various shades of blue, aqua, gray, white, and green.

6. Have the students cut their papers to fit into a graphic representation of their feelings about their ideas. For example, the papers could be cut and arranged into the shape of a stream, river, pond, the water cycle, etc.

7. Have students share their statements with the class. As they share, discuss with the class how the water in that particular situation helps plants and animals.

Sample assessment
- Have students describe water usage, such as
  - explaining three ways people use water
  - explaining how plants use water
  - explaining how animals use water
  - explaining why water is important.
- Have students use visual vocabulary techniques to demonstrate understanding of concepts and relationships from the activity.

Follow-up/extension
- Create a class book about water by having each student write his/her poetic definition at the bottom of a sheet of 8½ x 11 inch paper and then illustrate his/her idea at the top of the page. Bind the pages together to form the book. Have the students give the book a title and design and make a cover.
- Have students write and illustrate a short story about the importance of water.
Resources

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


**Around and Around It Goes**

**Overview**  
Students simulate the path of a water molecule through the water cycle to understand how water moves through the cycle.

**Related Standards of Learning**  
3.9 a, b

**Objectives**  
The students should be able to:  
- identify the sun as the origin of energy that drives the water cycle;  
- describe the processes of evaporation, condensation, and precipitation as they relate to the water cycle;  
- construct and interpret a model of the water cycle.

**Materials needed**  
Per student:  
- “Water Cycle Journey Record” handout (see p. 170)  
- Eight cups  
- Water cycle scenario strips (see p. 171)

**Instructional activity**

**Content/Teacher Notes**  

**Introduction**  
1. Read page 15 in the Educator’s Guide, and then show the students the video for Segment 1 of *The Case of the Wacky Water Cycle* before starting this activity.  
2. Have a class discussion about the meanings of the word *cycle*, including examples of common cycles.

**Procedure**  
1. Set up eight water-cycle stations (see p. 171) throughout the classroom by making a sign for each station that displays the station name and number. Cut each station’s scenario strips apart and place them in a cup at the station. Give a copy of the “Water Cycle Journey Record” to each student.  
2. Explain to students that each of them is a water molecule. Divide the class into eight groups and send each group to a station to begin. Have students remove a strip from the cup at their station to find out about the molecule’s (their) journey through the water cycle. Have them write the information on their journey record and then put the strip back into the cup.  
3. Say the word *cycle* when you are ready for them to move to the next station, as directed by the strip, and repeat the process.  
4. Repeat steps 2 and 3 until most of the students have cycled through most of the stations. Remind them that they may be at the same station more than once.
5. After finishing the stations, have the students go back to their seats and use their “Water Cycle Journey Record” to make a diagram of the path they took. For example, their journey might have taken them from the Cloud to the Mountain to the Cloud to the Lake to the Animal to the Lake.

**Observations and Conclusions**

1. Use questions such as the following to stimulate class discussion of what the students have learned:
   - Even though each water molecule (each of you) took a different path, was anything similar about the journeys you took?
   - Could you classify each part of your journey as either evaporation, condensation, or precipitation?
   - Can you think of other parts of the water cycle that were not included in the game?
   - What makes water move through the water cycle?
   - What would happen if all of Earth’s water stayed in the oceans?
   - Why did the tree house detectives need to understand the water cycle to help solve their problem?

**Sample assessment**

- Assess the diagrams students made of their path through the water cycle. Have students label each section as to whether it is condensation, precipitation, or evaporation.

**Follow-up/extension**

- Have students write a story about the journey they took or make a comic book illustrating the journey.
- Have students choose two locations on a map and write a story about how they, as a water droplet, would go from one place to the other. Encourage them to be creative.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary.
  [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
- *Search for Literature: Literature for Science and Mathematics.* California Department of Education.
### Water Cycle Journey Record

I am a molecule of water. Here is a record of my journey through the water cycle:

<table>
<thead>
<tr>
<th>WHERE I AM</th>
<th>WHAT I DO</th>
<th>WHERE I GO</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ex: cloud</td>
<td>fall as rain</td>
<td>mountain</td>
<td>precipitation</td>
</tr>
<tr>
<td>1.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3.</td>
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<td>4.</td>
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<td>5.</td>
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<td>8.</td>
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<tr>
<td>9.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
# Water Cycle Scenario Strips

## STATION 1 - CLOUD
- You fall as rain onto a mountain. Go to the mountain.
- You fall as snow onto a mountain. Go to the mountain.
- You fall as rain onto a stream. Go to the stream.
- You fall as rain on a farmer’s field. Go to the plant.
- You fall as rain onto a parking lot. Go to the stream.
- You fall as snow onto a lake. Go to the lake.

## STATION 2 - MOUNTAIN
- You evaporate into the air. Go to the cloud.
- You soak into the ground and become part of the groundwater. Go to the groundwater.
- You soak into the ground and are absorbed by a plant’s roots. Go to the plant.
- You roll downhill and become part of a lake. Go to the lake.
- You become frozen and stay there. Stay at the mountain.
- You drip off the rocks and join other molecules in a small stream. Go to the stream.

## STATION 3 - STREAM
- You evaporate into the air. Go to the cloud.
- You continue rolling across the land and become part of the ocean. Go to the ocean.
- You are pulled down into the soil on the bank. Go to the groundwater.
- An animal drinks you. Go to the animal.
- You flow into a lake. Go to the lake.
- While flowing down the mountain, you freeze and stay there. Go to the mountain.

## STATION 4 - LAKE
- An animal drinks you. Go to the animal.
- You flow into a stream. Go to the stream.
- You remain in the lake. Stay in the lake.
- You are absorbed by the leaves of a plant. Go to the plant.
- You evaporate into the air. Go to the cloud.
### STATION 5 - GROUNDWATER

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Next Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>You become part of an underground river that flows to the ocean.</td>
<td>Go to the ocean</td>
</tr>
<tr>
<td>You are absorbed by the roots of a plant.</td>
<td>Go to the plant</td>
</tr>
<tr>
<td>You are pumped out of a well for a person to drink.</td>
<td>Go to the person (animal)</td>
</tr>
<tr>
<td>You are pumped out of a well for a person to wash dishes.</td>
<td>Go to the stream</td>
</tr>
<tr>
<td>You are pumped out of a well for a farmer to irrigate his field.</td>
<td>Go to the plant</td>
</tr>
<tr>
<td>You become part of an underground river that flows to the ocean.</td>
<td>Go to the ocean</td>
</tr>
<tr>
<td>You stay in the aquifer.</td>
<td>Stay at the groundwater</td>
</tr>
</tbody>
</table>

### STATION 6 - ANIMAL

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Next Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are breathed out of a person’s lungs into the air as water vapor.</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>A person uses you for brushing his or her teeth.</td>
<td>Go to the stream</td>
</tr>
<tr>
<td>After using you to process food, the animal urinates, and you end up</td>
<td>Go to the mountain</td>
</tr>
<tr>
<td>on the ground.</td>
<td></td>
</tr>
<tr>
<td>You are excreted as sweat and evaporate into the air.</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>A person takes a drink of water and spits you out onto the ground.</td>
<td>Go to the groundwater</td>
</tr>
<tr>
<td>You seep into the soil and become part of the groundwater.</td>
<td></td>
</tr>
</tbody>
</table>

### STATION 7 - PLANT

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Next Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>The plant transpires you through its leaves, and you evaporate into the</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>air.</td>
<td></td>
</tr>
<tr>
<td>The plant stores you in its fruit, and you are eaten.</td>
<td>Go to the animal</td>
</tr>
<tr>
<td>The plant uses you to grow.</td>
<td>Stay at the plant</td>
</tr>
<tr>
<td>The plant transpires you through its leaves, and you evaporate into the</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>air.</td>
<td></td>
</tr>
<tr>
<td>The plant stores you in a root, and you are eaten.</td>
<td>Go to the animal</td>
</tr>
</tbody>
</table>

### STATION 8 - OCEAN

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Next Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>You are one of the many water molecules in the ocean, and you stay there.</td>
<td>Stay at the ocean</td>
</tr>
<tr>
<td>You evaporate into the air.</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>A kelp plant takes you in, releases you through its leaf, and transpires</td>
<td>Go to the cloud</td>
</tr>
<tr>
<td>you into the air.</td>
<td></td>
</tr>
<tr>
<td>You are swallowed by a fish.</td>
<td>Go to the animal</td>
</tr>
</tbody>
</table>
“A-Reservoiring” We Will Go

Overview
Students investigate how a reservoir works and build a model of a water delivery system.

Related Standards of Learning 3.9 c

Objectives
The students should be able to
• identify major water sources for a community, including rivers, reservoirs, and wells;
• describe the major water sources for the local community.

Materials needed
Per student or group of students:
• Clear plastic box
• Pebbles
• Soil
• Sand
• Leaves
• Spray bottle with water
• Two paper towel tubes
• Two toilet tissue tubes
• Straws
• Toothpicks
• Wooden skewers
• Small milk carton
• Scissors
• Glue
• Markers
• Tape

Instructional activity

Content/Teacher Notes

Introduction
1. Read page 53 in the Educator’s Guide, and then show the students the video for Segment 3 of *The Case of the Wacky Water Cycle* before starting this activity.
**Procedure**

Have each student or group of students follow the directions below:

1. Line the bottom of the clear plastic box with small pebbles. Slope the pebbles so that they are higher on the sides (4–5 cm deep) and lower in the middle (1–2 cm deep). This middle area will become the new reservoir.

2. Add a layer of sand, following the same sloping pattern created in step 1.

3. Repeat step 2 with soil.

4. On top of the soil, place leaves around the outer edges (Diagram 1).

5. Using a spray bottle, carefully spray water on the four corners of the model until the soil mixture is saturated and the water has seeped through to the reservoir.

6. In your group, discuss how a reservoir is formed, and write a brief paragraph describing the process.

7. On a flat surface, place the reservoir at one end of the large piece of paper or cardboard.

8. To create a water treatment plant, turn a milk carton on its side, and stand a small toilet tissue tube on end so as to trace its circumference on the side of the milk carton.

9. Use scissors to cut out the circle.

10. Repeat steps 8 and 9 on the opposite side of the milk carton (Diagram 2).

11. Connect the water treatment plant to the reservoir by using a small toilet tissue tube in each of the cutout holes (Diagram 3).

12. Brainstorm ideas on how a pipe system works to get water from the reservoir to the water treatment system and finally to the homes and businesses in a community. Remember that there are four different sizes of pipes to use in the system.

13. After reaching a consensus, draw a design for the pipe system in your science journal. Be sure to consider which size pipe should be used for each level of the pipe system, and explain why.

14. Following your design, use cardboard tubes, straws, wooden skewers, and toothpicks to create your pipe system for a community of homes. If necessary, use scissors to cut pipes to length.

15. Use glue to secure the system together and in place.

16. Connect your system to the reservoir.

17. If using game pieces for houses, place them at the end of the pipe system for each branch, or draw houses and businesses on the cardboard.
18. Discuss how water gets into the reservoir and then to your house. Trace its path, and record the path in your science journal. Illustrate the path.

**Observations and Conclusions**

1. Use questions such as the following to stimulate class discussion of what the students have learned:
   - What are sources of water for a reservoir?
   - How does water get into a reservoir?
   - In a real reservoir, what holds the water in?
   - In your pipe system, how did the size of the pipe get larger or smaller as it left the water treatment plant? Explain why.

**Sample assessment**

- Assess the models and the explanations students wrote in their science journals.

**Follow-up/extension**

- Have students conduct research on water towers and give a report on their importance to a water system. Add a water tower to the system.
- Have the students do the desalination activity, “To Still Water,” found on p. 62 in Segment 3 of *The Case of the Wacky Water Cycle*.

**Resources**

- *Connections: Connecting Books to the Virginia SOLs*. Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
Every Drop Counts

Overview
Students identify and implement water conservation habits to learn how this essential resource can be shared with other water users of today and tomorrow.

Related Standards of Learning 3.9d

Objectives
The students should be able to
• explain methods of water conservation in the home and school.

Materials needed
Per student:
• “Water Conservation Primer” handout (see p. 181)
Per group of students:
• “Constructing a Water-Flow Cup” instruction sheet (see p. 180)
• Two large paper cups
• Pin
• 1/16-inch-diameter nail
• Heavy tape
• Bowl
• Stopwatch

Instructional activity
Content/Teacher Notes
This lesson is adapted from the Project Wet lesson, “Every Drop Counts.” Information concerning Project Wet and workshops in Virginia can be found at http://www.deq.virginia.gov/education/wetinfo.html.

The topic of resource conservation is becoming more common in schools and in other facets of our society. Television and other media often present water-conservation practices. Students appreciate the need for water conservation if they or someone they know has experienced a water shortage. By participating in simple water-saving measures, students experience ways they can contribute to the conservation of water.

Earth has a finite amount of fresh, usable water. Fortunately, water is naturally recycled (collected, cleansed, and distributed) through the hydrologic cycle. Humans have developed the technology to speed this process. However, because of diverse factors, such as drought, flood, population growth, and contamination, a community’s water supply may become inadequate. Conservation of water can help ensure that supplies of fresh water will be available for everyone, today and tomorrow.

People can become active in conserving water by starting simply, then gradually taking more advanced steps to reduce water consumption. The simplest habits involve turning off water whenever it is not being used. When water is needed for rinsing dishes, it can be held in a sink rather than allowing it to flow unused down the drain. An individual may simply use less water. For example, some people use a hose to sweep sidewalks, when a broom works just as well. People can shorten their shower time or reduce the amount of water they use when taking a bath.
Introduction

1. Have students list the many ways they use water and then describe or draw pictures of situations in which they believe water is being wasted. Have them share their pictures and discuss ways that they could use this water more efficiently. Finally, have them list ways water can be conserved and not be wasted.

Procedure

1. Ask students to keep track in a journal of the water they use over a one-week period. Have them design a chart to record the number of liters used, using the information in the chart at right. As they monitor their water use, ask them to think: “Am I using this water wisely? Am I ever wasting it?”

   **Water Conservation Chart**

<table>
<thead>
<tr>
<th>Use Category</th>
<th>Water Used*</th>
<th>Amount in liters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking</td>
<td>Daily requirement</td>
<td>3</td>
</tr>
<tr>
<td>Toilet device</td>
<td>Per flush</td>
<td>20</td>
</tr>
<tr>
<td>Brushing teeth</td>
<td>Leave water on for 2 minutes</td>
<td>40</td>
</tr>
<tr>
<td>Washing hands</td>
<td>Leave water on for 1 minute</td>
<td>20</td>
</tr>
<tr>
<td>Shower</td>
<td>5-minute shower</td>
<td>100</td>
</tr>
<tr>
<td>Washing clothes</td>
<td>1 load</td>
<td>120</td>
</tr>
<tr>
<td>Washing dishes</td>
<td>1 load, automatic dishwasher</td>
<td>100</td>
</tr>
<tr>
<td>Washing car</td>
<td>5 minutes to complete</td>
<td>100</td>
</tr>
<tr>
<td>Lawn Watering</td>
<td>Apply 2.5 centimeters to 10 square meters</td>
<td>250</td>
</tr>
</tbody>
</table>

   *Source: Denver Water Department, Colorado River Water Conservation District.

2. Discuss reasons water should not be wasted. Students should consider such things as saving water for future use, sharing of a limited resource, sustaining a limited resource, and the fact that clean water costs money.

3. Have students research water conservation strategies and develop a set of behaviors they can use to conserve water at school and home. Supplement their research with the “Water Conservation Primer” provided.

4. Have students identify three-to-five water conservation habits they can individually adopt. Ask them to write these down, and challenge them to practice these habits during the next week. Instruct students to record results in their charts. Remind them that forming new habits takes time and effort.

5. Have students participate in one or more of the Conservation Capers presented on the next page.

Observations and Conclusions

1. At the end of the week, ask students whether their conservation practices made any difference in the amount of water used. Have students refer to their charts and compare the amounts of water used before and after conservation practices were implemented. Which practices were easy to adopt? Which were more difficult? Do they hope to adopt any other conservation habits?

2. Have students design posters advertising the benefits of conserving water. The posters might include a list of things people can do to save water.

Sample assessment

- Have students list and illustrate ways water can be conserved.
- Have students demonstrate how water-efficient products reduce the amount of water used.
- Have students compare amounts of water used before and after water conservation strategies are implemented.
- Have students write a paragraph or develop a “TV news spot” that reflects their views on the importance of water conservation.
Follow-up/extension

- Have students encourage their families or the school to adopt water conservation procedures.
- Have the students examine some water conservation products from a local hardware store, comparing the cost of each product to the amount and cost of the water saved. Have them figure how long it would take for the product to “pay for itself.”
- Have the students contact a municipality or industry to learn what measures they take to conserve water.

Resources

- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.

Conservation Capers

**Conservation Caper 1**

Have students present a “Wasteful Water Charade.” Refer to the list of wasteful water habits generated by the class in the Introduction, e.g., leaving an unattended faucet running, flushing toilets unnecessarily, using a hose to sweep the sidewalk, allowing a faucet to leak, taking long showers. Write these on slips of paper. Divide the class into groups, and have each group draw one of these habits. Each group must create and perform a pantomime to display the behavior written on the paper. The group that identifies the behavior must then create a response pantomime to demonstrate correction of the wasteful habit.

**Conservation Caper 2**

Ask students whether they know ways they can reduce the amount of water flowing out of their homes’ faucets. Some students may be familiar with low-flow showerheads. To demonstrate how low-flow showerheads save water, have students make water-flow cups (see p. 180) and compare the effect of flow restrictors on water quantity.

**Conservation Caper 3**

Have students demonstrate the difference in amounts of water used by a toilet with a weighted bottle in the tank (tank A) versus one with no bottle (tank B). For this activity, tank A uses three gallons (11.4 liters) of water per flush while, like most standard toilets, tank B uses approximately five gallons (19 liters).

Ask all students to stand in the back of the room to represent a common pool of water such as a city reservoir or ground water source. Each student represents one gallon (3.8 liters) of water. Have two other students stand at either side of the room to represent water meters and count the number of gallons (students) that pass by.

Indicate that the left half of the room represents a household with tank A and the right half represents one with tank B. The front of the room represents a wastewater treatment plant.
Tell students that both toilets have been flushed. Three students should move to the left and then to the front, while five move to the right and then to the front. Continue the “flushing” process until all students have moved to the front.

Have students compare the number of gallons (liters) needed by each toilet. If a household was limited to a specific amount of water during a bad drought, which toilet would make that supply last longer? Which toilet would contribute to a higher water bill? Which would produce less wastewater?
Constructing a Water-Flow Cup

How could you easily save water when taking a shower? Cooperate with other members of your group to find out how!

1. Using a nail, punch five holes in the bottom of a large paper cup. Using a pin, punch five holes in the bottom of a second cup. The location of the holes should be the same for each cup.

2. Cover the holes of each cup with a piece of tape placed on the outside of the bottom.

3. Fill the large-holes cup with water.

4. Have one member of your group hold the cup above a bowl. Then, have another member remove the tape and a third member use a stopwatch to time how long it takes for the water to drain out of the cup. Be careful not to squeeze the cup. Repeat the procedure two more times, making sure the starting water level is exactly the same each time. Use the three trial times to calculate the average time.

4. Fill the small-holes cup with water, and repeat the procedure in step 4.

5. Now, compare the flow rates of the two cups:
   - What is the difference in the drainage times of the two cups?
   - How do the streams of water coming out of the two cups compare?
   - Would one cup make a better showerhead than the other? If so, which one?
   - How could you use the flow-restrictor data from this activity to help your family save water?
Water Conservation Primer

- Turn off the water when it’s not in use. Don’t leave it running when brushing your teeth. Turn it off between soaping and rinsing your hands.

- Run the dishwasher or washing machine only when it has a full load.

- Keep a bottle of cold drinking water in the refrigerator instead of running the tap water until it gets cold.

- Limit your shower time to 10 minutes or less.

- Take showers instead of baths. (When taking baths, limit the amount of water you use.)

- Put one or more capped bottles of rocks or marbles in the toilet tank to reduce the amount of water it takes to fill it up. Don’t use the toilet for a trash can.

- When washing dishes by hand, use a sink full of rinse water rather than letting the water run.

- Use a broom instead of a hose to sweep sidewalks and driveways.

- When washing the car, use a hose with an on/off nozzle or use buckets of rinse water.

- Water lawns in the mornings or evenings when the water will not evaporate as quickly. Make sure the water lands on vegetation and not on streets or sidewalks. If possible, save rainwater for watering lawns.

- If you need to run the water before it becomes hot, store the cool running water in a bottle for future use. Unheated water can be used for rinsing dishes and washing vegetables and hands.

- Fix leaking faucets!

- Install a low-flow showerhead.
Pollution Perils

Overview
Students describe and identify land use activities within a watershed by analyzing water quality.

Related Standards of Learning 3.9 d

Objectives
The students should be able to
• analyze possible sources of water pollution in their neighborhoods, at school, and in the local community, including runoff from over-fertilized lawns and fields, oil from parking lots, eroding soil, and animal waste.

Materials needed
Per student or group of students:
• 30 pieces of wrapped candy in at least six different colors
• Small, plastic bags
• Graph paper
• Colored pencils
• “Land Use Table” handout (see p. 185)
• Index cards

Instructional activity

Content/Teacher Notes
This activity is adapted from the Educator’s Guide for The Case of the Wacky Water Cycle, Segment 4, pp. 74–75, which is part of the 2003–2004 NASA SCI Files™ series of video programs. It is used by permission. This video episode can be accessed free of charge at http://scifiles.larc.nasa.gov/educators/index.html?p=episodes/guides. It is recommended that teachers review the full Educator’s Guide for Segment 4, which is available at http://scifiles.larc.nasa.gov/docs/guides/Water_Cycle_seg4.pdf.

A watershed (drainage basin) is an area of land where all the water drains to the same location. Watersheds may be large, such as the Mississippi River drainage basin, or small, such as the 40 acres that drain into a farm pond. Nonpoint source pollution has many different sources, usually associated with rainfall and snowmelt runoff moving over and through the ground, carrying natural and human-made pollutants into lakes, river, streams, wetlands, and groundwater. Pollutants accumulate in watersheds as a result of various practices and natural events. If we can determine the type of pollutant, then we cannot only classify the source of the pollutant, but also take preventive measures to stop further contamination.

Introduction
1. Read page 68 in the Educator’s Guide, and then show the students the video for Segment 4 of The Case of the Wacky Water Cycle before starting this activity.

Procedure
1. Have the students complete this activity individually or in small groups. Divide the candy so that each student or group will get about 30 pieces in three to six different colors. Place the candy sets
in small, plastic bags. Make Pollutant Cards by copying, cutting apart, and gluing to index cards the five sets of pollutants listed on the Land Use Table. Put one card in each bag.

2. Tell the students that each bag of candy represents a watershed and that the candies represent different kinds of pollutants associated with various land uses that may be found in the watershed.

3. Have the students open their bags of candy and separate the candies by color. Then have them use the list of pollutants on the card in their bag to assign a pollutant to each color of candy. If they have more colors than pollutants, tell them to make the extra colors “harmless” bacteria.

4. Have the students create in their science journals a key indicating what pollutant each color represents.

5. Instruct the students to use graph paper to create a bar graph of the pollutants found in their watershed, labeling the x-axis with the names of the pollutants and the y-axis with numbers. Have them title their graphs and add the pollutant color key from step 4.

6. Give the students copies of the “Land Use Table,” and have them determine what activities are occurring in their watershed. Have them classify their watershed land use as agriculture, construction and/or forestry, urban, mining and/or industry, or wastewater disposal.

Observations and Conclusions

1. Prompt the students for observations and conclusion by asking questions similar to the following:
   - How are the various watersheds different from one another?
   - What can a scientist learn from studying the kinds of pollutants found in a watershed?
   - How might these pollutants change an ecosystem?

Sample assessment

- Assess the students’ science journals.

Follow-up/extension

- Have the students contact the state geological survey office or local zoning office to obtain a land-use map for the area. Then have them determine how the land in the area is used. What kinds of pollutant might be a problem?
- Allow the students to visit the Web site of the United States Geological Survey’s (USGS) at http://www.usgs.gov/ to learn about water use, land use, and much more about Virginia. Just click on the U.S. Map. and then scroll down and click on Virginia.
- Read the class a story about pioneer times, and have the students draw a picture of the land as it might have looked 100 years ago. Have them write a short story about how the land was used at that time and how the land’s use has changed through the years until the present day.

Resources

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.
### Land Use Table

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Activities</th>
<th>Pollutants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>cultivation, pest control, fertilization, animal waste management, weed control</td>
<td>sediments, nitrates, ammonia, phosphate, pesticides, bacteria</td>
</tr>
<tr>
<td>Construction and forestry</td>
<td>land clearing, land grading, timber harvesting, road construction, fire control, weed control</td>
<td>sediment, pesticides, ash</td>
</tr>
<tr>
<td>Wastewater disposal</td>
<td>septic systems, laundry, personal hygiene, dishwashing, restaurant waste</td>
<td>bacteria, nitrates, phosphates, chlorine, organic waste</td>
</tr>
<tr>
<td>Mining and industry</td>
<td>dirt, gravel, mineral excavation, chemical cooling, waste products, manufacturing</td>
<td>sediment, heavy metals, acid, nutrients</td>
</tr>
<tr>
<td>Urban storm runoff</td>
<td>automobile maintenance, lawn and garden care, painting, rain runoff from blacktop</td>
<td>oil, gas, antifreeze, nutrients, pesticides, paint</td>
</tr>
</tbody>
</table>
Sample Released SOL Test Items

The picture shows the water cycle. At which point in the cycle does most evaporation occur?

A 1  
B 2  
C 3  
D 4

The energy that drives the water cycle comes from —

F tides  
G wind  
H sunlight  
J plants
Organizing Topic — Investigating Soil

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.7 The student will investigate and understand the major components of soil, its origin, and
   importance to plants and animals including humans. Key concepts include
   a) soil provides the support and nutrients necessary for plant growth;
   b) topsoil is a natural product of subsoil and bedrock;
   c) rock, clay, silt, sand, and humus are components of soils; and
   d) soil is a natural resource and should be conserved.

Essential Understandings, Knowledge, and Skills

The students should be able to

- observe and recognize that soil, as a natural resource, provides the support and nutrients necessary for plant growth;
- explain how soil forms over time;
- analyze and describe the different components of soil, including rock fragments, clay, silt, sand, and humus;
- comprehend the key terminology related to soil, including humus, nutrients, topsoil, and bedrock;
- interpret and illustrate a basic diagram showing major soil layers, including bedrock, subsoil, and topsoil;
- design an investigation to compare how different types of soil affect plant growth. This includes organizing data in tables and constructing simple graphs;
- collect, chart, and analyze data on soil conservation on the school grounds;
- evaluate the importance of soil to people;
- describe how soil can be conserved.

Correlation to Textbooks and Other Instructional Materials

Virginia Department of Education
**Digging In**

**Overview** Students investigate the layers of soil.

**Related Standards of Learning** 3.1; 3.7

**Objectives**
The students should be able to
- analyze and describe the different components of soil;
- comprehend the key terminology related to soil;
- see, interpret, and illustrate the major soil layers.

**Materials needed**
Per student:
- One spoonful of soil
- Clear plastic cup
- Water
- Wooden popsicle stick or other stirrer
- “Layers of Soil” handout (see p. 191)

**Instructional activity**

**Content/Teacher Notes**
Soil covers much of the land on Earth. It is made up of minerals (rock, sand, clay, silt), air, water, and organic (plant and animal) material.

**Soil Formation:** Soil is formed slowly as the parent material, rock, erodes into tiny pieces near Earth’s surface. Organic matter decays and mixes with inorganic material (rock particles, minerals, and water) to form soil.

**Soil Layers:** Soil is made up of distinct horizontal layers called *horizons*. These range from the rich, organic upper layers (humus and topsoil) to the underlying rocky layers (subsoil, regolith, and bedrock). To best match the diagram that the students will fill out, it is best to describe these layers as follows:
1. humus: leaf litter and other decomposing organic material, such as dead animals and plant material
2. topsoil: humus mixed with mineral particles (This is where plant roots grow.)
3. subsoil: mostly sand/silt and clay near the bottom
4. bedrock: parent material for soil once it reaches the surface.

**Introduction**
1. Lead the students in creating a KWL chart on what they know about soil. (For a description of the KWL reading strategy, see the VDOE’s *English Standards of Learning Enhanced Scope and Sequence for Grades K–5*, p. 120, at [http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml](http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml).)

**Procedure**
1. Have each student bring in a spoonful of soil from his/her yard. They may not bring potting soil.
2. Have the students pour their soil sample into a clear plastic cup, add water to fill the cup about three-fourths full, and stir the soil and water mixture thoroughly. Then have them set the mixtures aside so they can settle without being disturbed.
3. Have the students observe and draw diagrams of their soil samples at various times throughout the day and finally the next morning. Instruct them to label each drawing with the time it was drawn and the interval of time since the last drawing was made. The students should be able to see different layers forming in their cups.

4. Discuss that the floating debris on top is humus, i.e., leaf litter and decomposing organic matter. The next layer is a sand/silt mixture. There may sometimes be a third layer, which is heavier particles of soil. These layers help to show how natural soil is layered.

5. Review with students the four layers of soil as listed under the Teacher Notes above. Make sure that they understand each layer.

**Observations and Conclusions**

1. Help the students conclude from their drawings of their soil samples that when soil is deposited by storms, flooding, etc., it will layer depending on the different weights of the various particles. Lead them to understand that the layering of soil is a continuing process.

**Sample assessment**

- Have the students label the “Layers of Soil” diagram.

**Follow-up/extension**

- Have the students create a folded-layered book about the layers of the soil by drawing a diagram of each layer and giving an explanation of it and what makes it up.

- Have the students create “edible soil” representing the four layers of the soil. Have them describe each layer in their “soil sample,” write about it, and finally eat it. The recipe is shown below.

### Edible Soil

**Ingredients per student**

- Small container of chocolate pudding
- Clear plastic cup
- Two vanilla wafers
- Plastic baggie
- Spoon
- Spoonful of chocolate chips
- Two gummy worms
- Two chocolate wafer cookies

**Directions**

1. Place one vanilla wafer on the bottom of the cup. (bedrock)
2. Place the chocolate chips on the wafer. (boulders in the upper portion of the bedrock)
3. Put a very small amount of chocolate pudding over the chips.
4. Place the second vanilla wafer in the baggie, crush the wafer as fine as possible, and pour the crushed wafer on top of the pudding. (silt and sand)
5. Pour the remaining chocolate pudding on top.
6. Place the gummy worms in the pudding with one sticking out of the top.
7. Finally, place the chocolate wafers in the baggie, crush them as fine as possible, and pour the crushed wafers on top. (topsoil)

You should be able to see and identify the layers through the cup.

Enjoy!

**Resources**


• Soil Science Education Home Page. http://soil.gsfc.nasa.gov/. This NASA site offers good background information for the teacher and some for the students.
Layers of Soil

Name: ___________________________ Date: ___________________

Label the soil layers in the diagram, using the following terms:

subsoil
humus
bedrock
topsoil

A Soil Profile
From Rock to Soil

Overview
Students investigate how soil is formed.

Related Standards of Learning 3.7d

Objectives
The students should be able to
• explain how soil forms over time.

Materials needed
Per student:
• Plastic egg
• Sugar cube

Instructional activity

Content/Teacher Notes
Soil covers much of the land on Earth. It is made up of minerals (rock, sand, clay, silt), air, water, and organic (plant and animal) material.

Soil Formation: Soil is formed slowly as the parent material, rock, erodes into tiny pieces near Earth’s surface. Organic matter decays and mixes with inorganic material (rock particles, minerals, and water) to form soil.

Introduction
1. Ask the students how they think soil forms, and list their responses on the board. Lead a class discussion on the topic, prompting them to mention the various components of soil.

Procedure
1. Give each student a plastic egg and a sugar cube, and have him/her place the cube (representing a rock) inside the egg.
2. Explain to the students that they will be shaking the egg to simulate weathering and erosion of the “rock” by the action of wind, water, and plant roots over time.
3. Let the students shake the eggs for several minutes.
4. Have the students open the eggs, pour out the “soil,” and draw a picture of their observations. Then, have them place the larger portions of the sugar cube back into the egg and repeat the process.

Observations and Conclusions
1. Have the students examine their particles of “soil” to identify each small grain as a soil particle and the larger pieces as pebbles, rocks, etc. Explain that the results of the “erosion” or “weathering” that they are seeing are very similar to what happens to rocks over time. Have the students draw or write about what their parent “rock” looks like after each shaking.

Sample assessment
• Assess the students’ writings and drawings.
Follow-up/extension

- Have the students create a “Flow Chart” showing the parent material, each weathering or erosion event, and the final product, “soil.”

Resources


- “The Dirt on Soil: What’s Really Going on under the Ground.” *DiscoverySchool.com.*

- *The Great Plant Escape.* University of Illinois Extension.
  [http://www.urbanext.uiuc.edu/gpe/index.html](http://www.urbanext.uiuc.edu/gpe/index.html). Offers information on plant life and soil in a cute mystery format with Detective LaPlant.

**Drain This!**

**Overview**
Students investigate how the different soil types allow for water and nutrients to drain and ultimately affect plant growth.

**Related Standards of Learning** 3.7a, c

**Objectives**
The students should be able to
- observe how the particle sizes of the different soils allow water and nutrients to drain;
- see that drainage is an important function for the health and strength of plants;
- organize data in tables and construct simple graphs;
- evaluate the importance of soil to people.

**Materials needed**
Per group of students:
- Three funnels
- Three clear containers to hold the funnels
- Three coffee filters
- Sand
- Silt
- Clay
- Pitcher of water
- Graduated cylinder
- Stopwatch
- Quarter-cup measuring cup
- “Drain This! Data Sheet” handout (see p. 197)
- “Create a Soil Sample” worksheet handout (see p. 198)
- Five identical pots
- Five “identical” plants (plants of the same kind and size as closely alike as possible)
- Metric ruler
- “Plant Growth Data Sheet” handout (see p. 199)

**Instructional activity**

**Content/Teacher Notes**

Soil is described by how much sand, silt, and clay are present in a soil sample. These are the inorganic parts of soil. There are also organic parts of soil, such as decaying plant and animal matter. This lesson will focus on the sand, silt and clay present in soil. **Sand** can have particles ranging from 2 mm to 0.05 mm in diameter. The particles of sand create many spaces among them, causing water and nutrients to drain quickly and thus making it not ideal for plant (crop) growth. **Silt** has particles ranging from 0.05 mm to 0.002 mm in diameter, and is good for crop growth. The particles are of such a size as to allow both for water and nutrient movement and for some air in the soil as well as for some water and nutrient retention, which in turn aids water and nutrient absorption by crops. The last type is **clay**, which has particles that are less than 0.002 mm in diameter, causing them to be very close. This closeness does not allow for much water and nutrient movement. When clay gets wet, it gets sticky and packs down. When it gets hot from the sun, it bakes and turns quite hard, hindering root growth. Therefore, it is not good for crop growth.
Most soil is a combination of the sand, silt, and clay. The amounts of each component in the soil will make a major difference to how crops will grow in that soil.

**Introduction**

1. Tell students that they are going to investigate how fast water and nutrients move through certain soil samples. They will then investigate how these same soil samples affect plant growth.
2. Discuss with the students how certain soil types are, or are not, beneficial to crops and ultimately to animals and humans.

**Procedure**

1. Make the funnels and containers needed in this activity by using empty, clear 2 liter soda bottles. Mark the bottles 4 in. from the opening, and cut the bottles on this line. The top part of the bottle becomes the funnel, and the bottom of the bottle can be used as the container to hold the funnel. Label the three containers for each group “Sand,” “Silt,” and “Clay.”
2. Divide the students into groups of three or four each, and pass out the materials needed by each group.
3. Have the students place a funnel in each container, put a coffee filter in each funnel, and put exactly ¼ cup of the specified soil type for each container into its filter.
4. Have each group choose and record on its “Drain This! Data Sheet” a specific amount of water (mL) to use to measure the drainage speeds of the three soil samples. The group must use this exact amount for all three samples.
5. Have one student in each group measure the chosen amount of water (mL) into the graduated cylinder. When given the signal to pour, the student will pour the water immediately into the funnel containing sand.
6. Give the pour signal, and have another student in each group use a stopwatch to measure the time it takes for the water to drain through the soil and filter into the container. Have the groups record this time on their data sheets.
7. Have the groups repeat steps 5 and 6 for each of the other two soil samples.
8. Finally, have one of the students in each group measure the amount of water (mL) in each of the three containers and record the three amounts on the group’s data sheet. Instruct each group to use this data to calculate and record the amount of water (mL) retained in each soil sample. (Subtract the amount in the container from the original ¼ cup.)

**Observations and Conclusions**

1. Have the class discuss and compare how the water drained through each sample. Which sample had the worst drainage? Why do you think that was? Have the groups share their times and amounts of water retained.
2. Discuss how the drainage characteristics of each sample might affect plant growth.
3. Ask the students whether they could create a good soil sample that would encourage plant growth, using all three types of soil. If so, how?

**Sample assessment**

- Have the groups create a soil mixture from the three types of soil that they think will grow strong and healthy plants. They must use all three soil types and must measure and record the amount of each soil type they used. They must also record whether they layered the mixture or mixed it up.
Then, have them test their sample by repeating steps 5 and 6 above. Have the students share their time results.

**Follow-up/Extension (class activity)**

**Procedure**

1. Have the students use what they know about soil drainage affecting plant growth to make hypotheses about how well plants will grow in the following soils:
   - sand
   - silt
   - clay
   - the student-made soil that drained the worst
   - the student-made soil that drained the best.

2. Fill each of five identical pots with the same amount of one of the five soils listed above. Label each pot according to the soil it contains. Give each student a “Plant Growth Data Sheet” (p. 199).

3. Have the students plant the same type of plant in each soil. The plants and planting methods should be as identical as possible.

4. Have the students give the plants identical amounts of water and light over a specified period of time, e.g., 3–4 weeks. Have them use the metric ruler to measure and record the growth of each plant every other day during this time. Also, have them make observations on the general health of each plant.

5. At the end of the specified time, have the students create a graph, give results, discuss their observations, and make a final conclusion.

**Observations and Conclusions**

1. Based on the two investigations, have a class discussion about why soil should be considered important to people.

**Resources**


- *The Great Plant Escape.* University of Illinois Extension.
  [http://www.urbanext.uiuc.edu/gpe/index.html](http://www.urbanext.uiuc.edu/gpe/index.html). Offers information on plant life and soil in a cute mystery format with Detective LaPlant.

# Drain This! Data Sheet

**Group Names:**

________________________________________

________________________________________

**Date:** ______________

<table>
<thead>
<tr>
<th>Soil Ingredient</th>
<th>Amount of water used</th>
<th>Time to drain (min. &amp; sec.)</th>
<th>Amount of water drained</th>
<th>Amount of water retained</th>
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</thead>
<tbody>
<tr>
<td>Sand</td>
<td>mL</td>
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<tr>
<td>Silt</td>
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<td>Clay</td>
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</table>

**Conclusion:**

________________________________________

________________________________________

________________________________________
Create a Soil Sample

Name: ____________________________ Date: __________________

Decide how much of each type of soil you will add to make your soil sample, and list the amounts below. Decide whether you want to mix the soils together or layer the soils. If you layer, tell the order of your layers.

- Sand amount: ____________
- Silt amount: ____________
- Clay amount: ____________

Mixed together: YES   NO (circle one)
Layered: YES   NO (circle one)

  top layer: ____________
  middle layer: ____________
  bottom layer: ____________

Test your sample for drainage time.

Amount of water used: ______ mL   Amount of water drained: ______ mL
Time to drain: ______ min., ______ sec.   Amount of water retained: ______ mL

Based on what you have learned, would this sample make a good soil for plants to grow in? Why, or why not?

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________
### Plant Growth Data Sheet

**Name:** ___________________________  **Date:** ______________________

**Hypotheses about plant growth in 5 types of soil:**

---

<table>
<thead>
<tr>
<th>Date</th>
<th>Growth of plant in sand</th>
<th>Growth of plant in silt</th>
<th>Growth of plant in clay</th>
<th>Growth of plant in worst draining sample</th>
<th>Growth of plant in best draining sample</th>
<th>Comments on general health of the five plants</th>
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**Conclusion:** ____________________________________________________________

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*Virginia Department of Education*

199
S.O.S. (Save Our Soil)

Overview
Students investigate conservation of soil.

Related Standards of Learning 3.7d

Objectives
The students should be able to
- collect, chart, and analyze data on soil conservation on the school grounds;
- describe how soil can be conserved;
- evaluate the importance of soil to people.

Materials needed
- Science journals
- Paper
- Pencil

Instructional activity

Content/Teacher Notes
Soil conservation is the best way to make sure that we will continue to have the land we need to live on. Soil saving is going on right now. People use grass and other plants to hold the soil down. Farmers employ ways to keep their soil on the land so they can continue to grow food. One way is with windbreaks — rows of trees that are planted beside fields to keep the soil from blowing away.

Introduction
1. Prompt thinking about the importance of soil and the conservation of soil by asking the students the following questions:
   - What do you think would happen if all the soil were to disappear?
   - What are some ways to help keep or save our soil?

Procedure
1. Have the students investigate soil conservation, using the library and the Internet. Instruct them to look for the meaning of soil conservation and what is being done or can be done to make it happen. Have them write their findings in their science journals.
2. Take the students on a schoolyard fieldtrip during which they will look for areas that may need soil-conservation help. If necessary, point them to areas of erosion and runoff.
3. Have the students draw and label a map of the schoolyard, giving a detailed description of the area(s) needing conservation help. For example, they might draw and label
   - areas needing retaining walls to hold loose rocks and soil
   - areas needing drainage pipes to direct flowing water to appropriate areas
   - areas needing grass and/or other plants to hold loose soil in place
   - areas needing fences, walls, and/or windbreaks to help prevent movement of soil.
4. Have the students work in small groups to discuss the best ways to conserve the identified schoolyard areas. Also, have them come up with reasons why soil is important to people and why it should be conserved.
Observations and Conclusions

1. Lead a class discussion in which students use their data to make conclusions concerning the conservation project that they may complete (see Follow-up/extension below). Once the project is complete, have the students reanalyze that area, and have groups share their results with the class.

Sample assessment

- Assess the students’ soil-conservation research, which they recorded in their journals, as well as their schoolyard diagrams.

Follow-up/extension

- If possible, have the students take the information they collected and diagrams they made and implement them. Have them maintain data about the conservation area over a period of several months as well as keep a photographic journal of the project. Finally, have them graph the results of their data collection and draw conclusions.
- Have a guest speaker from the soil/water district in your community speak to the class about soil-conservation measures being taken and being planned.

Resources

- “The Dirt on Soil: What’s Really Going on under the Ground.” *DiscoverySchool.com.*
- *The Great Plant Escape.* University of Illinois Extension.
  [http://www.urbanext.uiuc.edu/gpe/index.html](http://www.urbanext.uiuc.edu/gpe/index.html). Offers information on plant life and soil in a cute mystery format with Detective LaPlant.
Sample Released SOL Test Items

Humus, silt, clay, and sand are all parts of —
A. soil  
B. fungi  
C. rocks  
D. plants

Which of these is a natural part of soil?
F. Paper  
G. Plastic  
H. Silt  
J. Tires

This experiment shows that —
A. clay and humus do not hold water  
B. humus holds water better than clay  
C. clay holds water better than humus  
D. clay and humus hold the same amount of water

Soil is important for plant growth because it —
A. makes the Earth's surface hard  
B. moves easily from one place to another  
C. does not let plant roots grow too deeply  
D. contains nutrients to help plants grow

Soil helps trees because soil —
F. makes food for the trees  
G. gives nutrients to the trees  
H. turns the roots into new trees  
J. moves the tree seeds to new places

In which Earth layer do most grasses grow?
F. Solid rock  
G. Topsoil  
H. Subsoil  
J. Bedrock
Organizing Topic — Investigating Energy Resources

Standards of Learning

3.1 The student will plan and conduct investigations in which
   a) predictions and observations are made;
   b) objects with similar characteristics are classified into at least two sets and two subsets;
   c) questions are developed to formulate hypotheses;
   g) data are gathered, charted, and graphed (line plot, picture graph, and bar graph);
   j) inferences are made and conclusions are drawn; and
   k) natural events are sequenced chronologically.

3.11 The student will investigate and understand different sources of energy. Key concepts include
   a) the sun’s ability to produce light and heat energy;
   b) sources of energy (sunlight, water, wind);
   c) fossil fuels (coal, oil, natural gas) and wood; and
   d) renewable and nonrenewable energy resources.

Essential Understandings, Knowledge, and Skills

The students should be able to

- explain that the sun is the major source of energy for the Earth;
- analyze the advantages and disadvantages of using different naturally occurring energy sources;
- identify sources of energy and their uses;
- describe how solar energy, wind, and moving water can be used to produce electricity;
- describe how fossil fuels are used as an energy source;
- design a basic investigation to determine the effect of sunlight in warming various objects and materials, including water;
- compare and contrast renewable and nonrenewable energy sources.
Is It Hotter?

Overview
Students investigate the heat of the sun.

Related Standards of Learning 3.11a, b

Objectives
The students should be able to
• explain that the sun is the major source of energy for the Earth;
• design a basic investigation to determine the effect of sunlight in warming various objects and materials, including water.

Materials needed
Per group of students:
• Two Celsius thermometers
• Stopwatch or timer
• Pencil and paper
• “Scientific Investigations” handout (see p. 206)

Instructional activity

Content/Teacher Notes
This lesson is best done outside on a fairly sunny day. Be sure to spend some time discussing appropriate behavior while outside, emphasizing that during this activity the outside area is a science laboratory, not a playground.

Introduction
1. Draw the students into the activity by carrying an umbrella around quite obviously as you explain that part of the science lesson will be done outside. Ask students why they think you might need an umbrella today, since it’s sunny. Lead the students to suggest that umbrellas can be used to provide shade on sunny days, as well as protection from the rain on rainy days. Include the following points in the discussion:
   • The sun provides heat.
   • Heat is a form of energy.
2. Ask the students, “How can you prove that the sun provides heat?” Guide the discussion to using a thermometer to measure temperatures in shade and direct sunlight.

Procedure
1. Before going outside, have students make a data sheet by making a Temperature graph, labeling one side “Sunny” and the other “Shady.” Then divide the class into about five groups of students, and equip each group with two thermometers, a stopwatch, and pencil and paper.
2. Take the class outside, and have each group choose a sunny and a shady area to place the thermometers. Have the groups wait about five minutes for the thermometers to register, and then have them read and record the temperatures on their data sheets. Encourage them to write descriptions of each area on their data sheets in addition to recording the temperature reading. Check to make sure the students are reading the thermometers correctly.
3. Have each group repeat the place-wait-read-record process twice so that each group collects data from three trials.
4. Have the groups observe how the temperature feels in the sun and in the shade. Encourage them to describe the difference in feel between the two areas. Have the students make observation about the sun without looking directly at it. (Safety Note: Caution students against ever looking directly at the sun, as they may permanently damage their eyes.) Have students record these observations as well.

5. Return to the classroom, and have students graph the data they collected on a line graph.

Observations and Conclusions

1. After students complete their graphs, ask them to make some conclusions and discuss their conclusions as a class.

Sample assessment

- Have students first design and then conduct their own investigation to determine the effect of sunlight in warming two different objects. Distribute the “Scientific Investigations” handout (see next page) to aid their design work. After individually designing their investigations, they might work in groups and pick one investigation to conduct.

Follow-up/extension

- Have students determine the effect of sunlight in warming different colored examples of the same object. They should discover that sunlight more readily warms the dark colored example than it does the light colored one.

Resources

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Scientific Investigations

Before Experimenting

Title of my experiment:

“The effect of _________________ on _________________”

Independent (changed or manipulated) variable  Dependent (responding) variable

My experiment is about: ____________________________________________

My hypothesis (prediction) is: ______________________________________

My procedures (what I will do): ______________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

_________________________________________________________________

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During Experimenting

My data that I collected:

After Experimenting

The result (what happened) was: ________________________________

___________________________________________________________

My conclusion was (Be sure your conclusion is based on the evidence and the data, not just on your opinion.):

___________________________________________________________

___________________________________________________________

___________________________________________________________
Fossil Fuels

Overview

Students investigate how fossil fuels are used as an energy source.

Related Standards of Learning

3.11c, d

Objectives

The students should be able to

• describe how fossil fuels are used as an energy source.

Materials needed

• Thick raisin cookies
• Paperclips
• Napkins
• Pencil and paper
• “Coal Deposits in Virginia” maps (see p. 211)

Instructional activity

Content/Teacher Notes

Coal, oil, and natural gas are called fossil fuels because they come from plants and animals that have been buried for millions of years. The weight of mud and rock over millions of years created pressure and heat that changed the plants and animals into fossil fuels. These energy sources are considered nonrenewable because once they are consumed, they are gone for our lifetimes: it will take millions of years to produce more.

Coal: Relate this energy source to charcoal used to produce heat on a grill in order to cook hamburgers. Ask students whether they have felt the heat energy released during charcoal-grill cooking. Point out that charcoal is like coal, which is a nonrenewable energy source: once all the coal is used up from the place it was found, no more can be mined there or made.

Oil: Some students may have experience with an oil furnace, but another way to illustrate oil as a source of energy is through the use of an oil lamp. Have students describe how they know this is an energy source (i.e., heat and light are produced during the burning process). Oil is also refined to produce gasoline. Point out that oil is a nonrenewable energy source because once all the oil is used up from the place it was found, no more can be found there or made.

Natural Gas: Natural gas is formed, under similar conditions as oil, from dead and decaying plant and animal life that lived millions of years ago in swampy, warm conditions. When drilling in the Earth, gas is usually found in layers above oil since gas is lighter. Natural gas is piped to homes and is used to light stoves, heat water, and run furnaces. Some students may have gas logs in fireplaces in their homes. Natural gas is odorless; explain that the odor additive, Mercaptan, alerts people to the presence of natural gas, which can be dangerous. Again, point out that gas is a nonrenewable energy source because once all the gas is used up from the place it was found, no more can be found there or made.

Introduction

1. Facilitate a discussion about energy and its sources. Have students name energy sources, and list them on the board. Lead them to include the fossil fuels: coal, oil, and natural gas. Once the list is complete, focus on the fossil fuels. Describe to students how fossil fuels are formed and where they are found, and introduce the idea that they are nonrenewable resources. Emphasize how they...
are used as sources of energy. Lead students into the activity by telling them that they will be discovering how fossil fuels are retrieved from under the ground.

**Procedure**
1. Give each student a cookie, paperclip, and napkin. Tell them that the cookie represents the state of Virginia. The tan area represents the Earth’s crust, and the raisins represent coal deposits. They are going to “mine” the cookie.
2. Instruct students to count the number of visible chunks of coal in Virginia, counting only the coal deposits visible from the top. Have them record this number.
3. Have students make a prediction and record how many coal deposits (raisins) will actually exist in Virginia if they look for them below the surface. Have them record this number, and record the class information on the board as well.
4. Have students use their paper clip to begin “mining” their coal deposits. Place the coal deposits in one pile and the Earth’s crust in another pile. Have students count the coal deposits and record the data.
5. Have the students compare and contrast the number of coal deposits visible on the surface with the number of those actually in existence. Ask them to compare the actual number of coal deposits with their predications.

**Observations and Conclusions**
1. Point out that there were more “coal deposits” than could be seen on the surface.
2. Discuss the fact that mining the deeper coal took more time and energy and was more trouble than mining the coal near the surface. This means that it often takes energy to get a source of usable energy. Explain to students that the trucks and other machinery used to mine coal use gasoline or diesel fuel to operate. We must use energy to get energy!
3. Discuss the fact that mining the coal disturbs the Earth’s crust. This means mining coal has a destructive environmental impact. To illustrate this point, have students describe the mess of crumbs on their napkin as if it were a huge heap of rocks and soil. Ask them whether they think this “land” could be made to be “natural” and attractive again so that it would grow trees and other plants. If so, how?
4. Stress that the “coal deposits” were unevenly distributed, which meant that some students had more coal deposits than others had. Display a map of Virginia that shows where real coal deposits can be found.

**Sample assessment**
- Have students describe why it takes energy to get energy from fossil fuels.

**Follow-up/extension**
- Have the students research oil and natural gas and present a class discussion on how they are obtained from beneath the Earth’s surface.

**Resources**
- *Connections: Connecting Books to the Virginia SOLs.* Fairfax County Public Schools and The College of William and Mary. [http://www.fcps.edu/cpsapps/connections](http://www.fcps.edu/cpsapps/connections). Presents a database of more than 1,000 works of children’s literature and their connection to the Virginia Standards of Learning.


Coal Deposits in Virginia

Total Area of State:
40,817 square miles

Area Underlain by Coal:
1,940 square miles
Naturally Occurring Sources of Energy

Overview
Students research information about use of naturally occurring energy sources, including ways each is used to make electricity.

Related Standards of Learning
3.11b

Objectives
The students should be able to
- analyze the advantages and disadvantages of using different naturally occurring energy sources;
- identify sources of energy and their uses;
- describe how solar energy, wind, and moving water can be used to produce electricity.

Materials needed
Per student:
- Encyclopedias
- Books with information about naturally occurring sources of energy
- Materials for making posters
- Pictures from old magazines

Per group of students:
- Internet access

Instructional activity

Content/Teacher Notes
Sunlight, moving water, and wind are naturally occurring sources of energy. Solar energy is captured directly from the sun by plants to make food. Solar energy can also be converted to electricity by solar cells. The force of moving water and moving air (wind) can also be used to generate electricity. See NEED Energy Infobooks at http://www.need.org/infobooks.htm for more information about the various naturally occurring sources of energy. These booklets can be downloaded and printed for students to use as resources. The secondary resources may be helpful for teacher background information.

Introduction
1. Use a KWL chart to find out what students already know about sources of energy, specifically, sun, water, and wind. (For a description of the KWL reading strategy, see the VDOE’s English Standards of Learning Enhanced Scope and Sequence for Grades K–5, p. 120, at http://www.doe.virginia.gov/VDOE/EnhancedSandS/english.shtml.)

Procedure
1. Have students identify the three naturally occurring sources of energy — sunlight, moving water, and wind. Write these terms on the board, overhead, or a large chart. Explain that energy from the sun is also referred to as “solar energy.” Write this term below “sunlight.” Continue this discussion with water and wind energy.
2. Divide students into three groups, and assign each group one of the three naturally occurring energy sources. Explain that each group will do research about uses of its assigned, naturally occurring energy source and then make a poster to present their finding.
3. Have each group collaboratively research ways the energy source is used, including how it is used to produce electricity. Allow time for each team to brainstorm what its task is, how to go about
performing the task, and how to present what is learned. Have the groups meet together to share
their plans, and make plan modifications as necessary. Make encyclopedias, other books, and the
Internet available to the students, and assist with identifying key terms to use to access
information.

4. After finishing their research, have the groups prepare their poster showing three to five ways the
energy source is used. They should include how it is used to produce electricity, as well as any
other important information they found. The posters should be neatly and clearly titled and should
be illustrated with pictures. Encourage the groups to be creative.

5. Have the groups present the posters to the class. In a class discussion, have the students compare
the information presented to determine which sources of energy are used in the same ways and
which are used in different ways.

Observations and Conclusions

1. Discuss reasons why one naturally occurring energy source is used instead of the others in specific
places and for specific purposes. For instance, waterpower is more frequently used to produce
electricity in the Pacific Northwest because there are many lakes and rivers there.

Sample assessment

- Name a way that a source of energy is used, and the students identify the energy source. Use
  examples from the presentations. Examples might include “growing crops” (sunlight), “moving a
  paddleboat” (water), and “moving a sailboat” (wind).
- Have students make a four-column chart by folding paper in half lengthwise, and then in half
  lengthwise again. Have them open the paper and use the fold lines to draw pencil lines. Label the
  Energy.” Have them then write in the Use column at least seven uses, based on the group
  presentations, and put check marks in the energy-source column(s) that provide this use. For
  instance, the use “Produce electricity” would get checks in all energy-source columns.

Follow-up/extension

- Have each group design and create a model to demonstrate how its energy source is used to make
electricity.
- Have the groups research other natural sources of energy.

Resources

- Connections: Connecting Books to the Virginia SOLs. Fairfax County Public Schools and The
  College of William and Mary. http://www.fcps.edu/cpsapps/connections. Presents a database of
  more than 1,000 works of children’s literature and their connection to the Virginia Standards of
  Learning.
- NEED Energy Infobooks: Curriculum Guides and Activities: National Energy Education
- Search for Literature: Literature for Science and Mathematics. California Department of
Sample Released SOL Test Items

Turning off lights when you leave a room is a way to —

F recycle materials
G save energy
H reuse natural resources
J reduce trash

Which of these models might help show how a windmill works?

A

B

C

D