ELEM

Engineering By Design

Advancing Technological Literacy

A Standards-Based Program Series

Moon Munchies

Human Exploration Project
Engineering Design Challenge

A Standards-Based Elementary School Model Unit Guide

Moon Munchies

Design, Build and Evaluate (Lessons 1-6)

International Technology Education Association
Center to Advance the Teaching of Technology & Science

Inspiration + Innovation + Discovery = Future

Preface

Moon Munchies

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The ITEA-CATTS Human Exploration Project (HEP)
People, Education and Technology

In May 2005, ITEA was funded by the National Aeronautics and Space Administration (NASA) to develop curricular units for Grades K-12 on Space Exploration. The units focus on aspects of the themes that NASA Engineers and Scientists—as well as future generations of explorers—must consider, such as Energy and Power, Transportation and Lunar Plant Growth Chambers (the STS-118 Design Challenges). Moreover, the units are embedded within a larger Model Program for technology education known as Engineering byDesign™.

The Human Exploration Project (HEP) units have several common characteristics. All units:

- Are based upon the Technological Literacy standards (ITEA, 2000/2002).
- Coordinate with Science (AAAS, 1993) and Mathematics standards (NCTM, 2000).
- Utilize a standards-based development approach (ITEA, 2005).
- Stand alone and coordinate with ITEA-CATTS Engineering byDesign™ curricular offerings.
- Reflect a unique partnership between NASA scientists and engineers and education professionals.

These unit guides are designed to be practical and user-friendly. ITEA welcomes feedback from users in the field as we continually refine these curricular products, ensuring that the content remains as dynamic as the technological world in which we live. Please email ebd@iteaconnect.org or call 703-860-2100.

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Photographic Overview of Unit

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Unit Overview

Design is a creative problem-solving process. In this unit, students will design and build a lunar plant growth chamber using the Engineering Design Process.

> ***Big Idea***
> *The design process helps humans to solve the problems of growing plants for food on the moon.*

Standards

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the characteristics and scope of technology. (ITEA/*STL* – 1)
- Students will develop an understanding of the core concepts of technology. (ITEA/*STL* 2)
- Students will develop an understanding of the attributes of design. (ITEA/*STL* 8)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving. (ITEA/*STL* 10)
- Students will develop the abilities to apply the design process. (ITEA/*STL* 11)
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/*STL* 12)
- Students will develop an understanding of and be able to select and use energy and power technologies. (ITEA/*STL* 16)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- The Nature of Technology/Technology and Science (AAAS 3A)
- The Nature of Technology/Issues in Technology (AAAS 3C)
- The Living Environment/Diversity of Life (AAAS 5A)
- The Living Environment/Cells (AAAS 5C)
- The Living Environment/Flow of Matter and Energy (AAAS 5E)
- The Human Organism/Human Identity (AAAS 6A)
- The Human Organism/Physical Health (AAAS 6E)
- The Designed World/Materials and Manufacturing (AAAS 8B)
- Common Themes/Systems (AAAS 11A)
- Common Themes/Models (AAAS 11B)
- Habits of Mind/Values and Attitudes (AAAS 12A)
- Habits of Mind/Manipulation and Observation (AAAS 12C)
- Habits of Mind/Communication Skills (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Number and Operations
- Geometry
- Measurement
- Data Analysis and Probability

Science: National Science Education Standards *(NRC, 1996)*

- Physical Sciences/Students should develop an understanding of light, heat, electricity and magnetism. (NRC B)

- Earth and Space Science/All students should develop an understanding of properties of earth materials. (NCR D)
- Earth and Space Science/All students should develop an understanding of objects in the sky. (NCR D)

Social Studies: Expectations of Excellence *(NCSS, 1994)*

- Social studies programs should include experiences that provide for the study of people, places and environments, so that the learner can consider existing uses and propose and evaluate alternative uses of resources and land in home, school, community, the region and beyond.

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- The natural world and human-made world are different. (ITEA/*STL* 1A)
- Systems have parts or components that work together to accomplish a goal. (ITEA/*STL* 2B)
- Everyone can design solutions to a problem. (ITEA/*STL* 8A)
- Design is a creative process. (ITEA/*STL* 8B)
- The engineering design process includes identifying a problem, looking for ideas, developing solutions and sharing solutions with others. (ITEA/*STL* 9A)
- Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL* 9B)
- Asking questions and making observations helps a person to figure out how things work. (ITEA/*STL* 10A)
- Build or construct an object using the design process. (ITEA/*STL* 11B)
- Use hand tools correctly and safely and be able to name them correctly. (ITEA/*STL* 12B)
- Energy comes in many forms. (ITEA/*STL* 16A)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure and make things. (AAAS 3A)

- The tools and ways of doing things that people have invented affect all aspects of life. (AAAS 3C)
- When a group of people wants to build something or try something new, they should try to figure out ahead of time how it might affect other people. (AAAS 3C)
- Plants and animals have features that help them live in different environments. (AAAS 5A)
- Most living things need water, food and air. (AAAS 5C)
- Magnifiers help people see things they could not see without them. (AAAS 5C)
- Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light. (AAAS 5E)
- People need water, food, air, waste removal and a particular range of temperatures in their environment, just as other animals do. (AAAS 6A)
- Eating a variety of healthful foods and getting enough exercise and rest help people to stay healthy. (AAAS 6E)
- Several steps are usually involved in making things. (AAAS 8B)
- Some kinds of materials are better than others for making any particular thing. Materials that are better in some ways (such as stronger or cheaper) may be worse in other ways (heavier or harder to cut). (AAAS 8B)
- People, alone or in groups, are always inventing new ways to solve problems and get work Most things are made of parts. (AAAS 11A)
- Something may not work if some of its parts are missing. (AAAS 11A)
- When parts are put together, they can do things that they couldn't do by themselves. (AAAS 11A)
- A model of something is different from the real thing but can be used to learn something about the real thing. (AAAS 11B)
- Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out. (AAAS 12A)
- Tools are used to help make things and some things cannot be made at all without tools. Each kind of tool has a special purpose. (AAAS 12C)
- Use hammers, screwdrivers, clamps, rulers, scissors and hand lenses and operate ordinary audio equipment. (AAAS 12C)
- Make something out of paper, cardboard, wood, plastic, metal or existing objects that can actually be used to perform a task. (AAAS 12C)
- Measure the length in whole units of objects having straight edges. (AAAS 12C)
- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Understand the effects of adding and subtracting whole numbers. (NCTM Number and Operations)
- Recognize, name, build, draw, compare and sort two- and three-dimensional shapes. (NCTM Geometry)
- Describe attributes and parts of two- and three-dimensional shapes. (NCTM Geometry)
- Recognize the attributes of length, volume, weight, area and time. (NCTM Measurement)
- Understand how to measure using nonstandard and standard units. (NCTM Measurement)
- Select an appropriate unit and tool for the attribute being measured. (NCTM Measurement)
- Use tools to measure. (NCTM Measurement)
- Represent data using concrete objects, pictures and graphs. (NCTM Data Analysis and Probability)

Science: National Science Education Standards *(NRC, 1996)*

- Electricity in circuits can produce light, heat, sound and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass.
- Earth materials are solid rocks and soils, water and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel or for growing the plants we use as food. Earth materials provide many of the resources that humans use.
- The sun, moon, stars, clouds, birds and airplanes all have properties, locations and movements that can be observed and described.
- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air, water and soil; some are produced from basic resources, such as food, fuel and building materials; and some resources are nonmaterial, such as quiet places, beauty, security and safety.

Purpose of Unit

To understand and apply the design process as it relates to plant growth on the moon.

Unit Objectives

Lesson 1: Natural Resources on Earth

Students will:

- Identify natural resources on Earth.
- Identify the natural resources that help seeds/plants grow.
- Identify plants that provide food for people.

Lesson 2: Exploring the Moon

Students will:

- Identify and describe properties of the moon.
- Compare and contrast the properties of the moon and Earth.
- Determine a growth chamber is needed to grow plants on the moon.

Lesson 3: Providing Light for Your Plants

Students will:

- Identify and describe two sources of electricity. (electrical outlets and batteries)
- Identify and describe parts that are needed to create an electrical circuit.
- Express their ideas by sketching a diagram of an electrical circuit.

Lesson 4: Watering Your Plants

Students will:

- Identify and describe a system.
- Identify and describe parts that are needed to create a watering system.
- Express their ideas by sketching a diagram of a watering system.

Lesson 5: Designing the Growth Chamber

Students will:

- Sketch a diagram of their lunar plant growth chamber.
- Verbally explain their design to others.

Lesson 6: Building a Lunar Plant Growth Chamber

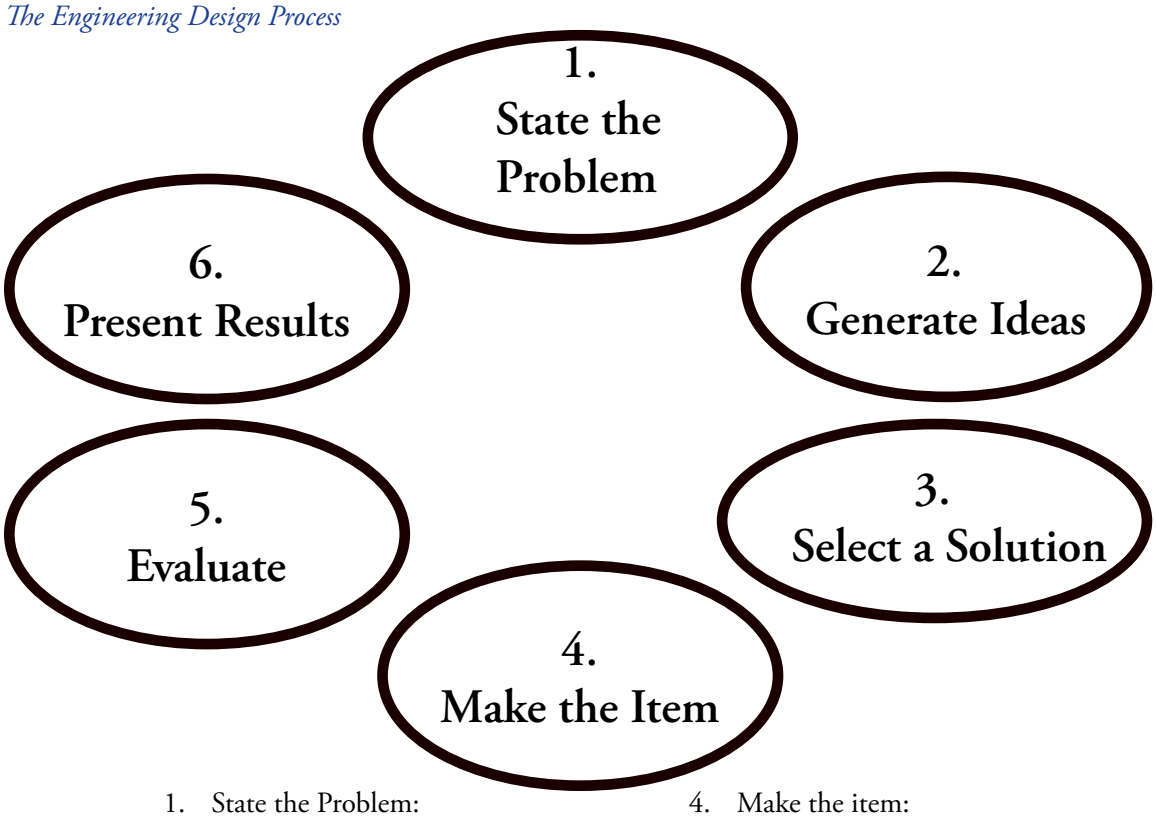
Students will:

- Understand the building process.
- Understand how to measure using standard units.
- Use an inch ruler.
- Use tools correctly and safely.
- Write about the building process.
- Explain and demonstrate the role of money in everyday life.

Teacher Preparation and Resources

As children look up at the night sky, they are certain that the lunar "ball" changes its shape. Educators can teach children about the moon using exciting, hands-on activities. This unit is designed to help children understand the design process as well as engage them in activities that will help them learn more about our Earth and moon.

The Engineering Design Process



1. State the Problem:
   - Explain the problem
   - Explain the guidelines
   - Set goals or desired results (teacher explanation)
2. Generate Ideas:
   - Brainstorm with others
   - Read books
   - Search the Internet
3. Select a Solution:
   - Sketches
   - Trial and error
4. Make the item:
   - Use resources
5. Evaluate:
   - Test, Revise; Test, Revise
   - Make adjustments/Changes
   - Improve
6. Present Results:
   - Verbal explanations
   - Share models

Engineering Portfolio and Journal

An Engineering Portfolio and Journal or EPJ, is provided so students can document their creative work, such as sketches. Student efforts can be recorded as they acquire their materials and design and build their lunar plant growth chamber.

The EPJ provides a wonderful opportunity for the teacher to model writing and language skills. The daily journal, which is part of the EPJ, should be used to help students write about their daily experiences. This approach will enhance their writing and language skills by permitting them to

connect language skills to relevant and meaningful daily activities. Detailed records of the materials students purchase at the store should be recorded. Teachers should allow students to record as many informational details as possible. Students should also be encouraged to review their writing and reflect on what they have accomplished as they complete their lunar plant growth chamber. Reading time could be enhanced by having students read their journals aloud.

One helpful management strategy might be to place all engineering worksheets and journal pages in a folder or notebook for each student.

Teachers should tell the students that many jobs require that employees document their work.

Journal suggestions:

- Write about each day's building session.
- Write about changes they made in their designs.
- Write about new discoveries.
- Write about materials they purchased and their purpose.

Tip: Be sure to provide at least ten pages (front to back) per student.

Materials Store

It is highly recommended that a store be set up for students to purchase their materials during the building process. Students will apply and improve their basic computation skills. This is also a way to have students understand the role money plays in everyday life. A list of materials and their suggested costs has been provided within the EPJ. Teachers may change these items and prices if they desire to do so. A graph has been included in the engineering portfolio for students to document the materials they purchase at the store.

Teachers should schedule specific times for students to visit the store and purchase materials they need to build their systems and chamber. Small plastic containers and large plastic bags can be used to hold the various materials and money. (Pages of the coins and dollar bills are provided for the teacher to duplicate on construction paper. Each person or team should receive approximately $16.00.)

Students should be expected to count out the amount of money they need. Each visit to the store to obtain engineering materials should include a discussion of the items they want or need and the associated costs. Students should calculate exact change and report aloud to the teacher.

Suggestion: Replenish the students' bank accounts by paying them for being safe, correctly computing their total at the store or cleaning up when asked. Older students may be used to verify the correct totals.

Safety and Tools

Students have the opportunity to use tools during this unit. The teacher should discuss and demonstrate the tools that will be used. The teacher may want to have students brainstorm a list of safety rules to follow while using tools and display a copy of the safety rules in the tool area. Science education in the elementary school is crucial to the education of children. Hands-on science activities encourage students to become active participants in learning about the world around them. The materials contained in this unit may be too advanced for your students to use. Furthermore, there may be local or state regulations that prohibit the use of some of these items in your classroom. Safety in the classroom is very important, and science is safe as long as teachers and students are aware of potential hazards and take necessary and appropriate precautions and safety measures. Parts of this unit may have to be modified in order to meet safety regulations in your system

- As students use tools to cut and fasten the materials together, students must wear proper safety items.
- Students must wear safety goggles when cutting parts with saws or using other tools.
- Gloves are recommended to prevent cuts when using saws or burns from glue guns.

Safety Rules

1. Wear safety goggles at all times.
2. Be careful when using tools.
3. Make sure vises, clamps and miter boxes are fastened securely.
4. Do not use broken tools. Check to make sure all tools are safe.

Lesson 1: Natural Resources on Earth

Lesson Snapshot

Overview

Big Idea: Earth offers many natural resources that help us to live.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson introduces students to the natural resources that help plants grow.

Lesson Duration: A total of three hours, which may be spread over several days.

Activity Highlights

Engagement: Students work in small groups to explore natural resource items. Groups list the items on a worksheet and record their importance to humans. The teacher leads a discussion to determine the importance of these items to humans.

Exploration: The teacher guides students through a booklet about the natural environment. Students read, discuss and illustrate. Students observe and answer questions about seeds. Students also read, discuss and illustrate a booklet about seeds. Students observe and answer questions about plants. Students also read, discuss and illustrate a booklet about plants.

Explanation: Students verbally identify natural resources that help seeds and plants grow. Students identify plants that provide food for humans.

Extension: Students can also create a shoebox scene, short play, song, story or factual cartoon.

Evaluation: Rubrics guide and assess:

- Poster/mobile
- Assessment

Lesson 1: Overview

Lesson Duration

- Three hours.

Standards/Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the characteristics and scope of technology. (ITEA/*STL* 1)
  - The natural world and human-made world are different. (ITEA/*STL* 1A)

Science: Benchmarks for Science Literacy (AAAS, 1993)

- Plants and animals have features that help them live in different environments. (AAAS 5A)
- Magnifiers help people see things they could not see without them. (AAAS 5C)
- Most living things need water, food and air. (AAAS 5C)
- Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light. (AAAS 5E)
- People need water, food, air, waste removal and a particular range of temperatures in their environment, just as other animals do. (AAAS 6A)
- Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out. (AAAS 12A)

Science: National Science Education Standards *(NRC, 1996)*

- All students should develop an understanding of properties of earth materials. (NSES – Earth and Space Science)
- All students should develop understanding of personal health and types of resources.
- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population.
- Some resources are basic materials, such as air, water and soil; some are produced from basic resources, such as food, fuel and building materials; and some resources are nonmaterial, such as quiet places, beauty, security and safety.
- Earth materials are solid rocks and soils, water and the gases of the atmosphere. The varied materials have different physical and chemical properties, which make them useful in different ways, for example, as building materials, as sources of fuel or for growing the plants we use as food. Earth materials provide many of the resources that humans use.

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- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Learning Objectives

Students will learn to:

1. Identify natural resources on Earth.
2. Identify the natural resources that help seeds/plants grow.
3. Identify plants that provide food for humans.

Student Assessment Tools and/or Methods

1. Rubric for Natural Environment Booklet

Category	Below Target – 0	At Target – 1	Above Target – 2
Illustrations	Illustrations are incorrect.	Illustrations are correct.	Illustrations are correct with many details.
Labels	Labels are incorrect.	Most labels are correct.	All labels are correct.
Application –Question 1	Student did not apply what he/she knows about natural resources to answer the question.	Student partly applied what he/she knows about natural resources to partially answer the question.	Student applied what he/she knows about natural resources to correctly answer the question.
Organization	Explanation is incomplete, unorganized and not logical.	Explanation is somewhat complete, well-organized and/or logical.	Explanation is complete, well-organized and logical.
Conventions	Many errors interfere with the meaning and confuse the reader.	Some errors, some of which interfere with the meaning and confuse the reader.	No errors; the reader can read easily.
Application –Question 2	Student did not apply what he/she knows about natural resources to answer the question.	Student partly applied what he/she knows about natural resources to partially answer the question.	Student applied what he/she knows about natural resources to correctly answer the question.
Organization	Explanation is incomplete, unorganized and not logical.	Explanation is somewhat complete, well-organized and/or logical.	Explanation is complete, well-organized and logical.
Conventions	Many errors interfere with the meaning and confuse the reader.	Some errors, some of which interfere with the meaning and confuse the reader.	No errors; the reader can read easily.
Teacher Comment			

2. Rubric for Poster/Mobile

Requirements	Requirement Achieved
Title/Heading	1
Name	1
Four or more facts	1
Words spelled correctly	1
Neat	1
Colorful	1
Score:	6

Above Target	6
On Target	4-5
Below target	0-3

3. Rubric for Assessment

Requirements	Requirement Achieved
Question 1	3
Question 2	4
Question 3	4
Score:	11

Above Target	10-11
On Target	7-9
Below target	0-6

Resource Materials

Print Materials

1. Berger, M. (1992). *All about seeds*. New York: Scholastic.
2. Berger, M and Berger, G. (2004). *Seed to plant*. New York: Scholastic.
3. Royston, A. (2003). *My world of science, natural and man-made*. Chicago: Heinemann Library.
4. Spilsbury, L. (2006). *How do plants grow?* Chicago: Heinemann Library.
5. Spilsbury, L. (2006). *What is a plant?* Chicago: Heinemann Library.
6. Spilsbury, L. (2006). *Where do plants grow?* Chicago: Heinemann Library.

Audiovisual Materials

1. Burrud, J. & Soto, R. (Producers), & Burrud, J. and Josephson, D. (Directors). (2005). *All about natural resources* (Video). Wynnewood, PA: Schlessinger Media.
2. Commisso, V. (Producer), & Bastien, C. E. (Director). (2001). *The magic school bus gets planted* (Video). New York: Kid Vision.
3. Giakoumis, H. (Producer), & Jacobs, L.. (Director). (1995). *The magic school bus goes to seed* (Video). New York: Kid Vision.

Internet Sites

1. Sample, S. (NASA Official). (December 1, 2004). *Fun and games: The earth*. Retrieved April 14, 2007, from http://science.hq.nasa.gov/kids/earth.html

Lesson 1: 5-E Lesson Plan

Engagement

1. The teacher organizes the students into groups of two to four and gives each group the following items: cup of water, bag of air (the students should focus on what is inside the bag, not the bag itself), cup of soil, rock, picture of an animal or a jar with a worm or bug in it and a plant.
2. Each team receives ***Natural Resources on Earth 1***. Students complete this worksheet.
3. Groups discuss their answers. The teacher asks students: *Where can we find all of these items*?

Exploration

1. Each student receives the booklet, Natural Environment (***Natural Resources on Earth 2***). (Students only complete Pages 1–11 at this time.) The teacher explains to the students that they are going to explore natural resources that are on Earth. The students read page 1, discuss the information on the page and draw pictures. The teacher guides the students through each page in the same manner, allowing time for the students to cut their pages in half and staple the booklets.

   The teacher asks the following questions:
   - What are natural resources?
   - How do people use natural resources?
   - Could we survive without natural resources?
   - Which resource do you think is the most important? Why?
   - Who can recall the objects we looked at before reading the booklet?
   - What are all of those objects called?

2. The teacher shows the students a packet of seeds. The teacher asks the following questions:
   - What are these?
   - What can these seeds produce?
   - Do you think seeds are important to people? Why or why not?
   - Are seeds a natural resource?

3. Each student receives the booklet, Seeds on Our Earth (***Natural Resources on Earth 3***). The students read page 1, discuss the information on the page and draw a picture. The teacher guides the students through each page in the same manner, allowing time for students to cut their books out and staple them.

   The teacher asks the following questions:
   - Where can we find seeds?
   - Why are they important to people?
   - What do seeds need in order to grow?
   - What would happen to a seed if we didn't give it water, air or warmth?

4. The teacher shows students a lima bean seed and the tiny plant inside of it. *Suggestion*: Allow the students to use magnifying glasses.

   The teacher asks the following questions:
   - What do we need to do to this seed to help it grow?
   - How is this baby plant getting its food?
   - What will this seed become?

5. The teacher gathers the students in a circle and places a variety of plants in front of them.

   The teacher asks the following questions:
   - What is the same about these plants?
   - What is different about these plants?
   - Are all plants the same?
   - Where can you find plants?
   - Why do you think there are plants on Earth?
   - Are plants important to people?
   - How do people use plants?
   - What do you think plants need in order to grow?

6. Each student receives the booklet, Plants (***Natural Resources on Earth 4***). The students read page 1, discuss the information on the page and draw a picture. The teacher guides the students through each page in the same manner, allowing time for students to cut their pages out and staple them.

   The teacher asks the following questions:
   - What natural resources do plants need in order to grow?
   - Why are plants important to people?
   - What do people get from plants?
   - Why do most plants need soil?
   - Why do most plants need light?
   - Why do plants need water?

7. The teacher asks the students to close their eyes and picture all the plants that provide food for them to eat. Students complete Food From Plants (***Natural Resources on Earth 5)***. Students share their answers. The teacher writes all responses on a piece of chart paper.

   The teacher asks the following questions:
   - How do people benefit from plants?
   - What would happen if Earth did not have plants?

8. Students explore new terms and concepts by reading selected books or listening to the teacher read.
9. Students explore new terms and concepts by viewing selected videos.
10. Students explore new terms and concepts by viewing selected Internet sites.

Explanation

1. Students verbally name the natural resources we have on Earth that help plants and humans.
2. Students identify natural resources needed for seeds and plants to grow.
3. Students verbally contribute to a list that identifies plants that provide food for humans.

Extension

1. Students may create a poster, mobile, shoebox scene, short play, song or story pertaining to Earth's natural resources.
2. Students respond to questions on a written assessment, Seeds and Plants on Earth. (***Natural Resources on Earth 6***).

Evaluation

Rubrics guide and assess:

1. Student poster/mobile of Earth, containing all the natural resources.
2. Students written assessment to Seeds and Plants on Earth. (***Natural Resources on Earth 6***).

Teacher Note: Remember a seed only needs warmth, water and air to begin its growing process. It does not need light in order to germinate. Plants have different needs than seeds do in order to grow. They need more natural resources to survive (soil, sunlight [light], water, air).

Enrichment

1. Students can write a report about Earth.
2. Students can create a skit about the natural resources and the importance of them.
3. Students can make an ABC book about seeds and plants that provide foods for people. They can read it to younger children.
4. Students can research which seeds germinate quickly and/or slowly.
5. Students can research the plants that produce foods that are very nutritious.

Lesson 1: Lesson Preparation

Teacher Planning

1. Gather all the items listed in the "Tools/Materials/Equipment" section so that there is enough for four to five groups of students.
2. Make copies of the worksheets/assessments:
   a. Natural Resources on Earth ***(Natural Resources on Earth 1)***
   b. Food From Plants ***(Natural Resources on Earth 5)***
   c. Seed and Plants on Earth ***(Natural Resources on Earth 6)***
3. Make copies of the booklets:
   a. Natural Environment ***(Natural Resources on Earth 2)***
   b. Seeds on Our Earth ***(Natural Resources on Earth 3)***
   c. Plants ***(Natural Resources on Earth 4)***

Tools/Materials/Equipment

Group work:

- Cups of water
- Bags of air
- Cups of soil
- Rocks
- Pictures of animals or worms/bugs in jars
- Variety of plants or pictures of plants
- ***Natural Resources on Earth 1***

Other work:

- Variety of Seeds
- Dry lima beans
- Magnifying glasses
- Chart paper
- Marker
- Natural Resources on Earth ***(Natural Resources on Earth 1)***
- Natural Environment ***(Natural Resources on Earth 2)***
- Seeds on Our Earth ***(Natural Resources on Earth 3)***
- Plants ***(Natural Resources on Earth 4)***

- Food From Plants ***(Natural Resources on Earth 5)***
- Seeds and Plants on Earth ***(Natural Resources on Earth 6)***

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Lesson 2: Exploring the Moon

Lesson Snapshot

Overview

Big Idea: The moon does not provide natural resources that would allow plants to grow, but astronauts can provide an environment to grow plants.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson introduces students to the characteristics of the moon.

Lesson Duration: Two hours.

Activity Highlights

Engagement: The teacher places lava rocks and "moon dust" (crushed lava rocks) around the room. The students enter a dark room and are asked to "leap" around the room. The students determine where they are for the day. The KWL worksheet is used to obtain some understanding of student knowledge about the moon.

Exploration: The teacher reads a book about the moon. Using their prior and acquired knowledge, students work in small groups to draw pictures of the moon and are asked to write facts. Each group shares their illustrations and facts. The teacher shows students a picture of the moon and Earth. During a discussion led by the teacher, students complete a Venn diagram comparing the moon and Earth. The teacher shows students a packet of seeds. Each student responds to the following on a worksheet: *If we planted seeds on the moon, do you think they would grow? Use information from what we have read to explain your answer*. Students discuss their responses. The teacher asks questions and guides a conversation about what seeds would be best for astronauts to take to the moon to provide food. Students complete a worksheet determining what would need to be in a lunar plant growth chamber.

Explanation: Students verbally identify and describe characteristics of the moon and how the moon and Earth differ. Students verbally explain why plants couldn't grow on the moon; what seeds and plants would be best to grow on the moon; what astronauts would need to take to the moon so that plants could grow and what should be included in a lunar plant growth chamber.

Extension: Students complete a KWL chart, make a model of the moon and complete pages in booklets.

Evaluation: Rubrics guide and assess:

- KWL chart
- Model of the moon
- Natural Environment Booklet (***Natural Resources on Earth 2***)

Lesson 2: Overview

Lesson Duration

- Two hours.

Standards/Benchmarks

Science: Benchmarks for Science Literacy (*AAAS, 1993*)

- People, alone or in groups, are always inventing new ways to solve problems and get work done. The tools and ways of doing things that people have invented affect all aspects of life. (AAAS 3C)
- When a group of people wants to build something or try something new, they should try to figure out ahead of time how it might affect other people. (AAAS 3C)
- Eating a variety of healthful foods and getting enough exercise and rest help people to stay healthy. (AAAS 6E)

Mathematics: Principles and Standards for School Mathematics (NCTM, 2000)

- Represent data using concrete objects, pictures and graphs. (NCTM Data Analysis and Probability)

Science: National Science Education Standards *(NRC, 1996)*

- All students should develop an understanding of objects in the sky.
  - The sun, moon, stars, clouds, birds and airplanes all have properties, locations and movements that can be observed and described.

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Learning Objectives

Students will learn to:

1. Identify and describe properties of the moon.
2. Compare and contrast the properties of the moon and Earth.
3. Determine that a growth chamber is needed to grow plants on the moon.

Student Assessment Tools and/or Methods

1. Rubric for KWL Chart

Category	Below Target – 0	At Target – 1	Above Target – 2
Completeness	Some sections are not complete. Many sentences do not have a lot of details. The "L" section offers little information about what student learned.	All sections are complete. A few sentences do not have a lot of details. The "L" section offers some information about what student learned.	All sections are complete with a lot of details. The "L" section offers exceptional information about what student learned.
Teacher Comment			

2. Rubric for Model of the Moon

Category	Below Target – 0	At Target – 1	Above Target – 2
Color	Color is incorrect.	Color is somewhat correct.	Color is correct.
Surface	No surface has been represented. It is smooth.	Surface includes several landforms.	Surface includes all landforms discussed in class.
Teacher Comment			

Resource Materials

Print Materials

1. Branley, F. M. (1987). *The moon seems to change*. New York: HarperCollins Publisher.
2. Carle, E. (1986). *Papa, please get the moon for me*. New York: Scholastic, Inc.
3. Fowler, A. (1994). *When you look up at the moon*. Chicago, Illinois: Children's Press
4. Gibbons, G. (1997). *The moon book*. New York: Holiday House.
5. Lassieur, A. (2000). *A true book: The moon*. New York: Children's Press.
6. McNulty, F. (2005). *If you decide to go to the moon*. New York: Scholastic Press.
7. Rustad, M. E. H. (2002). *The moon*. Minnesota: Pebble Books.
8. Sorensen, L. (1993). *Moon*. Florida: The Rourke Corporation, Inc.
9. Willis, S. (1999). *Whiz kids tell me why the moon changes shape*. New York: Franklin Watts.

Audiovisual Materials

1. Gross, M. & Kriegman, M. (Directors). (1993). *Bill Nye the science guy: Outer space way out there* (Video). Buena Vista Home Video.
2. Schlessinger A. & Mitchell, T. (Executive Producers). (1999). *All about the moon: Space science for children* (Video). Wynnewood, PA: Schlessinger Media.

Internet Sites

1. Canright, S. (Editor) & Dunbar, B. (NASA Official). (March 28, 2007). Kids' main page. Retrieved April 14, 2007 from http://www.nasa.gov/audience/forkids/home/
2. Fisher, Diane. (August 25, 2006). *What do we know about our moon*? Retrieved April 14, 2007, from http://spaceplace.nasa.gov/en/kids/phonedrmarc/2002_august.shtml
3. Grayzeck, E. (NASA Official) & William, D. K. (Curator). (October 31, 2006). The moon. Retrieved April 14, 2007 from http://nssdc.gsfc.nasa.gov/planetary/planets/moon-page.html
4. Keating, S. (Curator) & Gabrys, B. (NASA Official). (October 7, 2004). *Moon links*. Retrieved April 14, 2007 from http://learners.gsfc.nasa.gov/challenge/moonlinks.html
5. Lee, J. (NASA Official) & Varros, G. (Curator). (March 29, 2000). *Our moon*. Retrieved April 14, 2007 from http://spacekids.hq.nasa.gov/osskids/animate/moon.html
6. Whitlock, L. (Project Leader) & Newman, P. (NASA Official). *The moon: Earth's satellite*. Retrieved April 14, 2007 from http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/moon.html

Required Knowledge and Skills

1. Students should be able to identify and describe properties of Earth.
2. Students should know what seeds and plants need in order to grow.
3. Students should understand how to complete a Venn diagram.

Lesson 2: 5-E Lesson Plan

Engagement

1. The teacher places lava rocks and small piles of crushed lava rock ("moon dust/soil") on plastic sheeting around the room and turns the lights out before the students enter the room. The teacher asks students to take "leaps" instead of steps as they move around the room to look at the lava rocks and moon dust/soil. The students are given time to feel the lava rocks and moon dust/soil. The lights are turned out because the sky on the moon is always black. There is no atmosphere on the moon to scatter the Sun's light and create the blue sky we see on Earth.

   The teacher asks the following questions:
   - Where do you think we are today?
   - Why?

2. Students complete the first two columns of the Moon KWL Worksheet (***Exploring the Moon 1***). After students complete their columns, they share information. As the students share their information, the teacher writes responses on a piece of chart paper.

Exploration

1. The teacher reads a book about the moon to the students.

2. Place students in groups of two to four. Each group receives a large piece of white paper and large round pattern pieces, if needed.

   The Task:
   - Students draw a moon and include the various characteristics that were discussed in the book—landforms (craters, hills, mountains, rocks, plains, "seas"), dark spots and natural resources (rocks and soil).
   - Students write facts they learned about the moon on index cards.
   - Students share their drawings and facts.

3. Each student receives the worksheet Venn Diagram (***Exploring the Moon 2***). The teacher shows students a picture of the moon and Earth.

   The teacher asks the following questions:
   - What is the same about the moon and Earth?
   - How is the moon different from Earth?
   - How is Earth different from the moon?

4. Students fill in their Venn diagram during the discussion.

5. The teacher shows students various packets of seeds. Include packets of fruits, vegetables and flowering plants. Students complete the worksheet Seeds on the Moon (***Exploring the Moon 3***). The teacher leads a discussion of student responses.

   The teacher asks the following questions:
   - Why can't seeds and plants grow on the moon?
   - What do we have on Earth that allows seeds/plants to grow?
   - If astronauts wanted to grow seeds/plants on the moon, what would they need to take with them? (The teacher lists the responses on chart paper.)

- Which type of seeds/plants would be the most beneficial for astronauts? Why? (The teacher points out the ones that provide food.)
- What kinds of food seeds/plants would be the best to grow on the moon? Why? (Plants that provide a lot of nutritional value would be the best to grow. Tomatoes provide a lot of Vitamin C. Plants that provide little food and a lot of "debris" would not be the best [e.g., wheat].)
- Which of these packets of seeds do you think would be most beneficial to astronauts? Why? (The teacher should make sure students are looking at the packets in the room.)
- If you were to go to the moon, which seeds would you want to plant? Why? (The teacher may graph student responses.)
- Did you choose your favorite food that you had recorded on the worksheet Food From Plants (***Natural Resources on Earth 5***)? Why or why not?

6. The teacher directs student attention to the chart paper that lists what astronauts should take to the moon to grow seeds/plants.

   The teacher asks the following questions:
   - Why are these items important?
   - What could astronauts build to give seeds/plants the best environment so they can grow on the moon?
   - What would you call this "building?"

7. Students complete the worksheet Plant Growth Chamber Engineer (***Exploring the Moon 4***). Students share their answers. The teacher lists student answers on chart paper.
8. Students explore new terms and concepts by reading selected books or listening to the teacher read.
9. Students explore new terms and concepts by viewing selected videos.
10. Students explore new terms and concepts by viewing selected Internet sites.

Explanation

1. Students verbally identify and describe characteristics of the moon.
2. Students verbally identify and describe how the moon and Earth differ.
3. Students verbally explain why plants couldn't grow on the moon.
4. Students verbally explain what seeds and plants would be the best to grow on the moon.
5. Students verbally explain what astronauts would need to take to the moon so that plants could grow.
6. Students verbally explain what should be included in a lunar plant growth chamber so that plants can grow.

Extension

1. KWL chart.
2. Students make a model of the moon (i.e., papier machè).
3. Students pages 12 and 13 in ***Natural Resources on Earth 2***.

4. Student booklet, Our Moon (***Exploring the Moon 5***).

Evaluation

Rubrics guide and assess:

1. Students complete their KWL chart (***Exploring the Moon 1***).
2. Students make a model of the moon.

3. Students' answers to the questions in the booklet, Natural Environment (***Natural Resources on Earth 2***).

Enrichment

1. Students can write stories about the moon and read to younger children.
2. Students can write a letter to NASA asking for information about the moon and/or asking for someone to be a guest speaker.

Lesson 2: Lesson Preparation

Teacher Planning

1. Crush lava rocks.
2. Prepare a chart with a bar graph for Exploration 5, Bullet 7.
3. Make copies of the following worksheets:
   a. Moon KWL Chart ***(Exploring the Moon 1)***
   b. Venn Diagram ***(Exploring the Moon 2)***
   c. Seeds on the Moon ***(Exploring the Moon 3)***
   d. Plant Growth Chamber ***(Exploring the Moon 4)***
4. Make copies of the Moon booklet (***Exploring the Moon 5***).
5. Prepare flour and water for the papier machè moons.
6. Cut newspaper pieces.

Tools/Materials/Equipment

- Lava rocks (Can be purchased at a garden center)
- Plastic sheeting (Can be purchased at hardware stores)
- Chart paper
- Large white pieces of construction paper
- Crayons/colored pencils/markers/construction paper
- Index cards
- Moon and Earth pictures
- Variety of seed packets
- Suggestion: NASA has done experiments with the following seeds: lettuce, tomato, bell pepper, spinach, strawberries and dried beans.
- Newspaper
- Flour
- Bowls
- Round balloons (inflated)
- Spoons
- Paints for papier machè moon

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Lesson 3: Providing Light for Your Plants

Lesson Snapshot

Overview

Big Idea: Electricity is a form of energy that can provide light.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson requires students to create and illustrate a diagram of an electrical circuit that will provide light to their lunar plant growth chamber.

Lesson Duration: Two hours.

Activity Highlights

Engagement: The teacher leads a discussion about lights/electricity with students as they enter the room with the lights off. As the teacher turns a flashlight on and off, students answer questions. The students answer a question as the teacher turns a radio/television on and off. The teacher unplugs an object and students discuss why it is not able to work.

Exploration: Students observe objects that complete an electrical circuit. As they observe these objects, they write a response and definition on a worksheet. The teacher leads a discussion about each object. The correct spelling and definition are written on a chart. As a whole group, students connect parts to create an electrical circuit. The teacher guides students through a booklet about electricity. Students read, discuss and illustrate.

Explanation: Students discuss whether their circuit and switch works properly and why a switch is important. Students discuss how lights help plants, why an electrical circuit is needed in a lunar plant growth chamber and what source of electricity astronauts would take to the moon.

Extension: Students draw a sketch of an electrical circuit. Students build an electrical circuit.

Evaluation: Rubrics guide and assess:

- Student diagrams of electrical circuit
- Assessment
- Student electrical circuits

Lesson 3: Overview

Lesson Duration

- Two hours.

Standards/Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the core concepts of technology. (ITEA/*STL* 2)
  - Systems have parts or components that work together to accomplish a goal. (ITEA/*STL* 2B)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
  - Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL* 9B)
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/*STL* 12)
  - Use hand tools correctly and safely and be able to name them correctly. (ITEA/*STL* 12B)
- Students will develop an understanding of and be able to select and use energy and power technologies. (ITEA/*STL* 16)
  - Energy comes in many forms. (ITEA/*STL* 16A)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure and make things. (AAAS 3A)
- Several steps are usually involved in making things. (AAAS 8B)
- Tools are used to help make things, and some things cannot be made at all without tools. Each kind of tool has a special purpose. (AAAS 8B)
- Most things are made of parts. (AAAS 11A)
- Something may not work if some of its parts are missing. (AAAS 11A)
- When parts are put together, they can do things that they couldn't do by themselves. (AAAS 11A)
- Make something out of paper, cardboard, wood, plastic, metal or existing objects that can actually be used to perform a task. (AAAS 12C)
- Use hammers, screwdrivers, clamps, rulers, scissors and hand lenses and operate ordinary audio equipment. (AAAS 12C)
- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

Science: National Science Education Standards *(NRC, 1996)*

- Students should develop an understanding of light, heat, electricity and magnetism. (NSES – Physical Science – Content Standard B)
  - Electricity in circuits can produce light, heat, sound and magnetic effects. Electrical circuits require a complete loop through which an electrical current can pass. (NSES)

Learning Objectives

Students will learn to:

1. Identify and describe two sources of electricity (electrical outlets and batteries).
2. Identify and describe components that are needed to create an electrical circuit.
3. Express their ideas by sketching a diagram of an electrical circuit.

Student Assessment Tools and/or Methods

1. Rubric for Diagram of Electrical Circuit

Category	Below Target – 0	At Target – 1	Above Target – 2
Diagram	Few pictures are accurately drawn, with few or no details.	Most pictures are accurately drawn, with some details.	All pictures are accurately drawn, with many details.
Sequence	Most parts are connected out of sequence.	Most parts are connected in the correct sequence.	All parts are connected in the correct order.
Labels	Few labels are correct, with few or no details.	Most labels are correct, with some details.	All labels are correct, with many details.
Neatness	Diagram is not neat. A small amount of text is neat. There are many visible stray marks and/or smears.	Diagram is neat. Most text is neat. There are few visible stray marks and/or smears.	Diagram is neat. All text is neat. There are no visible stray marks and/or smears.
Spelling	Many words are misspelled.	Most words are spelled correctly.	All words are spelled correctly.
Teacher Comment			

2. Rubric for Assessment

Requirements	Requirement Achieved
Question 1	3
Question 2	4
Question 3	4
Question 4	12
Question 5	3
Score:	24

Above Target	21-24
On Target	17-20
Below target	0-16

3. Rubric for Assessment Question 5

Category	Below Target – 0	At Target – 1	Above Target – 2
Application	Student did not apply what he or she learned about electricity to answer the question.	Student mostly applied what he or she learned about electricity to partially answer the question.	Student applied what he or she learned about electricity to correctly answer the question.
Organization	The explanation is incomplete, unorganized and not logical.	The explanation is somewhat complete, well organized and/or logical.	The explanation is complete, well organized and logical.
Vocabulary	No science vocabulary used to explain the answer.	Some science vocabulary to used explain the answer.	A good deal of science vocabulary used to clearly explain the answer.
Conventions (Capitalization, Usage, Punctuation, Spelling)	Many errors interfere with the meaning and confuse the reader.	Few errors, some of which interfere with the meaning and confuse the reader.	No errors interfere with the meaning or confuse the reader.
Teacher Comment			

4. Rubric for Electrical Circuit

Category	Below Target – 0	At Target – 1	Above Target – 2
Parts	Some parts are missing. Parts are not securely attached.	Most parts are included. Most parts are attached securely.	All parts are included. Everything is securely fastened.
System	Circuit does not work; bulb does not light	System is working, but occasionally the light goes out.	System is working properly.
Neatness	Few wires fit neatly within the system. Lots of glue is showing. Tape is not wound neatly and tightly.	Most wires fit neatly within the system. Some glue is showing. Most tape is wound neatly and tightly.	All wires fit neatly within the system. No glue is showing. All tape is wound neatly and tightly.
Teacher Comment			

Resource Materials

Print Materials

1. Mayes, S. (1989). *Where does electricity come from?* London: Usborne.
2. Olien, B. (2003). *Electricity*. Mankato, Minn.: Bridgestone Books.
3. Royston, A. (2002). *My world of science, using electricity.* Chicago: Heinemann Library.
4. Tocci, S. (2001). *A true book: Experiments with electricity*. New York: Children's Press.
5. Trumbauer, L. (2004). *What is electricity?* New York: Children's Press

Audiovisual Materials

1. Hoard, D. C. (Producer), & Gluck, D. H. (Director). (2000). *All about the uses of energy* (Video). Wynnewood, PA: Schlessinger Media.
2. Martin, K. L. (Producer), & Jacobs, L. (Director). (1997). *The magic school bus getting energized* (Video). New York: Kid Vision.
3. Palacio, O. (Producer). (2000). *All about electricity* (Video). Wynneswood, PA: Schlessinger Media.
4. Schlessinger A., Mitchell, T. & Gluck, D. (Executive Producers). (2000). *All about the conservation of energy* (Video). Wynnewood, PA: Schlessinger Media.
5. Schlessinger A., Mitchell, Tr. & Gluck, D. (Executive Producers). (2000). *What is energy?* (Video). Wynnewood, PA: Schlessinger Media.

Internet Sites

1. Beaty, W. J. (1996). *What is electricity?* Retrieved April 14, 2007 from http://amasci.com/miscon/whatis.html
2. Nick and S. (March 31, 1999). *The shocking truth about electricity*. Retrieved April 14, 2007 from http://library.thinkquest.org/6064/main.html
3. *Electricity and magnetism*. (n.d.). Retrieved April 14, 2007 from http://www.galaxy.net/~k12/electric/
4. Energy Information Administration. (n.d.). *Electricity basics 101*. Retrieved April 14, 2007 from http://www.eia.doe.gov/basics/electricity_basics.html

Required Knowledge and Skills

Students should be able to identify and describe how we use electricity in our daily lives (homes, schools, car).

Lesson 3: 5-E Lesson Plan

Engagement

1. The teacher has the lights turned off when students enter the room.

   The teacher asks the following questions:
   - How do we turn the lights on in our room?
   - Why is there a switch?
   - What is electricity?
   - Where does electricity come from?
   - Why is light important?

2. The teacher turns a flashlight on and off.

   The teacher asks the following questions:
   - What do you see when this switch is flipped up and down?
   - What allows the lightbulb to light up?
   - What is the source of electricity? (battery)

3. The teacher turns a radio/television on and off.

   The teacher asks the following question:
   - What allows this piece of equipment to turn on and off?

4. The teacher unplugs the radio/television.

   The teacher asks the following questions:
   - Why isn't it working?
   - What is the source of electricity? (electrical outlet)

Exploration

1. The teacher shows students a lightblub, light socket, wire, battery, battery holder and wire strippers. As they see each object, the students illustrate, label and describe what each object does on the worksheet Parts of an Electrical Circuit (***Providing Light for Your Plants 1***).
2. The teacher holds up one object at a time again and has students share their responses. As students respond, the teacher writes an accurate spelling of each word and definition on a chart.
   - A lightblub provides light.
   - A light socket is a device that holds a lightblub
   - A battery stores electricity.
   - A battery holder is a device that holds batteries.
   - A wire is a metal piece that allows electricity to flow through it.
   - A wire stripper is a device that strips the plastic covering off of a wire so that metal wire can be seen.

3. The teacher asks students the following questions:
   - If we put all these parts together, what do you think it will create?
   - What would we need to do to get the lightblub to light up?
   - What form of energy do you think we are using?

4. The teacher gathers students in a large circle on the floor. The teacher places a light bulb, light socket, batteries, battery holders and wires that have been stripped of a ½ inch of plastic at both ends in the middle of the circle. As a whole group, the students construct the circuit under the teacher's direction. It is important for the teacher to stress that no wires in the circuit should ever be allowed to touch. Students should also be told that the ends of a battery should never be wired together. It is suggested that the batteries be placed in the holder last. (If the students are not using the battery holder, the teacher should ensure that students do not allow the two wires attached to the battery to touch.) The teacher can refer to the ***Photographic Overview of Unit*** for instructions on how to complete an electrical circuit.

   The teacher asks students the following questions:
   - Why did you decide to connect those two parts?
   - Why do you think this circuit works/does not work?
   - What would happen if you didn't connect the wire to the light socket?
   - What happens when you only attach one wire to the battery?
   - What happens when metal pieces are not touching?

5. The teacher introduces and defines the term "circuit."

   - A circuit is the path that allows electricity to flow (the energy source [battery] connects to a wire, the wire connects to a light socket, the light socket connects to another wire, that wire connects back to the other side of the energy source).
   - The teacher explains that an electrical circuit must be a closed loop so an electrical current can pass. There cannot be any openings. All parts must be joined.
   - The teacher shows what happens when a circuit is not closed.

6. The teacher asks students the following question:
   - What do you think we would need if we want to turn the light on and off?

7. The teacher introduces and defines the term "switch".
   - A switch is an object that allows electricity to turn on and off within a circuit.

8. The teacher shows students a piece of wood, two push pins and a paper clip.

   The teacher asks students the following question:
   - How could we use these parts to create a switch?

9. The teacher places the wood, push pins and paper clip in the center of the circle. Under the direction of the teacher, various students add these new components to the circuit they just completed as a group.

10. The teacher should ask students the following questions:
    - Why do objects need switches?
    - Why is it important to turn lights on and off?

11. The teacher provides each student with the booklet, Electricity (***Providing Light for Your Plants 2***). The students read page one, discuss the information on the page and draw a picture. The teacher guides the students through each page in the same manner, allowing time for the students to cut out and staple the booklets.

The teacher asks students the following questions:

- Which natural resources are used to produce electricity?
- What are two sources of electricity?
- What objects use electricity to produce heat?
- What objects use electricity to produce sound?
- What objects use electricity to produce light?
- Why is electricity important to us?
- What would happen if we didn't have electricity?

12. Students explore new terms and concepts by reading selected books or listening to the teacher read.
13. Students explore new terms and concepts by viewing selected videos.
14. Students explore new terms and concepts by viewing selected Internet sites.

Explanation

1. Students explain verbally why they think the system works/does not work.
2. Students explain verbally how the switch was set up and why they think it works/does not work.
3. Students explain verbally why a switch will be important in their design.
4. Students verbally answer the following questions:
   - Do lights help plants to grow?
   - Why do you think an electrical circuit is needed in a lunar plant growth chamber?
   - What source of electricity do you think astronauts would be able to take to the moon easily?

Extension

1. Students sketch and label a diagram of an electrical circuit (***Worksheet 2 in the Engineering Portfolio and Journal***).
2. Students build an electrical circuit to light a bulb for use in a lunar plant chamber.

Evaluation

Rubrics guide and assess:

1. Student diagrams of an electrical circuit.
2. Student answers to questions about electricity. Assessment (***Providing Light for Your Plants 3***)
3. Students' electrical circuits.

Enrichment

1. Students can research electricity on the Internet.
2. Students can create a safety brochure about electricity.
3. Students could write a letter to an electrical company asking for information on electricity.

Lesson 3: Lesson Preparation

Teacher Planning

1. Make copies of the booklet, Electricity (***Providing Light for Your Plants 2***).
   Answer key for the booklet, Electricity
   1. Page 7 – flashlight, lamp, television, computer, etc.
   2. Page 8 – oven, dryer, blow dryer, curling iron, etc.
   3. Page 9 – television, radio, computer, telephone, video games, alarm clock, etc.
   4. Page 10 – the light will provide warmth to the seeds and light to the plants
   5. Page 12 – answers will vary

2. Make copies of Engineering Worksheet 2 (***Engineering Portfolio and Journal***).

3. Make copies of Assessment (***Providing Light for Your Plants 3***).
   Answer key for assessment piece
   1. Electricity
   2. Electrical outlet and batteries
   3. Batteries, light socket, lightblub, switch
   4. Please refer to definitions listed in lesson.
   5. No, electricity will not flow through this circuit. Electricity will not flow through the circuit because it is not a complete loop. The student should explain that the battery wire is not attached to the light socket.

4. Make sure you have all the tools/materials available.
5. Provide an area where all students can gather for the group discussion and assembly of the electrical circuit.
6. The battery holder has short wires that may be difficult to strip. The teacher may want to strip these wires before passing them out to students.

Tools/Materials/Equipment

- D-cell batteries (2)
- Battery holders
- Block of wood (2" x 2")
- Chart paper
- Electrical tape
- Flashlight
- Goggles
- Hammer
- Light bulbs
- Light sockets
- Paper
- Paper clips
- Pencils
- Screwdrivers
- Push pins
- Wire
- Wire strippers
- Copies of the booklet, Electricity (***Providing Light for Your Plants 2***).
- Copies of Engineering Worksheet 2 (***Engineering Portfolio and Journal***).
- Copies of the assessment piece (***Providing Light for Your Plants 3***).

Teacher Note: The teacher may choose to use other materials when creating an electrical circuit. A rubber band can be used to hold wires directly to the battery. A circuit can be created with just a light socket, lightblub, wire and a battery if the funds are not available to purchase all the materials above.

Teacher Note: Batteries must be matched to devices. A potential resource for teachers is the book, *Understanding Science Ideas – A Guide for Primary Teachers*. From that book (p. 69):

4.5V battery + 1.5V bulb = blown bulb
1.5V battery + 4.5V bulb = dim bulb
4.5V battery + 3V bulb = light shines normally

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Tool Safety Rules should be posted and reviewed:

1. Students should wear safety goggles at all times.
2. Students should carefully watch what they are doing when using tools.
3. Students should make sure vises, clamps and miter boxes are fastened securely.
4. Students should check to make sure all tools are safe and not use broken tools.

Electrical circuit safety:

1. Students should connect all wires before placing the batteries in place.
2. If students are using a battery holder, they should make sure that the wires do no touch each other when the batteries are in place.
3. If students are not using the battery holder, they should make sure the two wires that are connected to the battery do not touch.
4. Students should make sure that, when connecting wires together, electrical tape is wrapped around them to cover exposed wires.

Lesson 4: Watering Your Plants

Lesson Snapshot

Overview

Big Idea: Systems have parts that work together to accomplish a goal.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson requires that students sketch a diagram and build a watering system.

Lesson Duration: One hour.

Activity Highlights

Engagement: The teacher provides a cup of water to each student and asks questions. Students complete a worksheet.

Exploration: The teacher guides students through a booklet about water. Students read, discuss and illustrate. Students observe a plumbing system under a sink. The teacher provides materials for students to explore and create a watering system for the lunar plant growth chambers.

Explanation: Students verbally explain whether their systems work. The teacher asks students questions about watering systems and the importance of conserving water on the moon.

Extension: Students sketch and label a diagram of a watering system. Students build a watering system.

Evaluation: Rubrics guide and assess:

- Diagram of watering system.
- Student watering systems.

Lesson 4: Overview

Lesson Duration

- One hour.

Standards/Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the core concepts of technology. (ITEA/*STL* 2)
  - Systems have parts or components that work together to accomplish a goal. (ITEA/*STL* 2B)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
  - Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL 9B)*
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/*STL*-12)
  - Use hand tools correctly and safely and be able to name them correctly. (ITEA/*STL* 12 B)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure and make things. (AAAS 3A)
- Tools are used to help make things, and some things cannot be made at all without tools. Each kind of tool has a special purpose. (AAAS 8B)
- Most things are made of parts. (AAAS 11A)
- Something may not work if some of its parts are missing. (AAAS 11A)
- When parts are put together, they can do things that they couldn't do by themselves. (AAAS 11A)
- Make something out of paper, cardboard, wood, plastic, metal or existing objects that can actually be used to perform a task. (AAAS 12C)
- Use hammers, screwdrivers, clamps, rulers, scissors and hand lenses and operate ordinary audio equipment. (AAAS 12C)
- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Learning Objectives

Students will learn to:

- Identify and describe a system.
- Identify and describe parts that are needed to create a watering system.
- Express their ideas by sketching a diagram of a watering system.

Student Assessment Tools and/or Methods

1. Rubric for Diagram of Watering System

Category	Below Target – 0	At Target – 1	Above Target – 2
Diagram	Few pictures are accurately drawn, with few or no details.	Most pictures are accurately drawn, with some details.	All pictures are accurately drawn, with many details.
Sequence	Most parts are connected out of sequence.	Most parts are connected in the correct sequence.	All parts are connected in the correct sequence.
Labels	Few labels are correct, with few or no details.	Most labels are correct, with some details.	All labels are correct, with many details.
Neatness	Diagram is not neat. A small amount of text is neat. There are many visible stray marks and/or smears.	Diagram is neat. Most text is neat. There are few visible stray marks and/or smears.	Diagram is neat. All text is neat. There are no visible stray marks and/or smears.
Spelling	Many words are misspelled.	Most words are spelled correctly.	All words are spelled correctly.
Teacher Comment			

2. Rubric for Watering System

Category	Below Target – 0	At Target – 1	Above Target – 2
Parts	Some parts are missing. Parts are not securely attached.	Most parts are included. Most parts are attached securely.	All parts are included. Everything is securely fastened.
System	System doesn't work. Most parts are connected out of sequence and placed incorrectly.	System is working, but occasionally the water does not flow easily.	System is working properly.
Teacher Comment			

Resource Materials

Print Materials

1. Cooper, J. (1992). *Science secrets water*. Vero Beach, FL: Rourke Corp.
2. Hooper, M. (1998). *The drop in my drink*. New York: Viking.

3. Nelson, R. (2003). *Where is water?* Minneapolis, MN: Lerner.

Audiovisual Materials

1. Giakoumis, H. (Producer), & Jacobs, L. (Director). (1995). *The magic school bus at the waterworks* (Video). U.S.A.: Scholastic Productions.
2. Rodney-Pex, D. & Satage, R. (1993). *Murky water caper* (Video). America's Clean Water Foundation – 1-800-4-PLANET.

Internet Sites

1. *Local hazardous waste management program in king county*. (October 12, 2006). Retrieved April 14, 2007 from http://www.govlink.org/hazwaste/house/yard/watering.html
2. *Natural yard care: Practice smart watering for healthier plants*. Retrieved April 14, 2007 from http://www.govlink.org/hazwaste/house/yard/watering.html
3. Sample, S. (NASA Official). (October 10, 2006). *Droplet and the water cycle*. Retrieved April 14, 2007 from http://kids.earth.nasa.gov/droplet.html

Required Knowledge and Skills

1. Students should be able to identify how they get water in their homes/school.
2. Students should have an understanding that water is essential for all living things on Earth (plants, animals and humans).

Lesson 4: 5-E Lesson Plan

Engagement

1. The teacher gives each child a cup of water. The teacher asks the following questions.
    - What is in your cup?
    - Where did I get the water?
    - How did it get there?
    - Where does water come from each day?
    - What are some ways you use water?
    - Why is water important to us?
    - What other things need water to survive?

2. Students drink their water.
3. Students complete the worksheet, About Water (***Watering Your Plants 1***). The teacher allows students time to share their responses. The teacher may record responses on a chart

Exploration

1. The teacher provides each student with a copy of the booklet, Water (***Watering Your Plants 2***). The students read page 1, discuss the information on the page and draw a picture. The teacher guides the students through each page in the same manner, allowing time for the students to cut their pages out and staple the booklets.

   The teacher asks the following questions:
    - Where can we find water?
    - How do plants get water?
    - Where do people get water for indoor plants?

2. The teacher allows students to look at the plumbing system under a sink.
    - The teacher asks students to explain what they see.
    - The teacher discusses the term "system." (A system is something that has many parts or components that work together to accomplish a goal.)

   The teacher asks students the following question:
    - What parts make up this plumbing system?

3. The teacher gives each student a syringe, a piece of tubing 5 inches long, a plastic container and a small amount of water.

   The teacher asks the following questions:
    - What objects have I given to you?
    - Do any of these objects represent the plumbing system we saw?
    - What do you think we could create with all of these parts that would help plants to grow?

4. The teacher explains to the students that the plastic container will be the "pot" to hold the seeds that will be planted in their lunar plant growth chamber.

5. The teacher allows time for the students to create a watering system. The teacher can refer to the ***Photographic Overview of Unit*** for instructions on how to complete a watering system.

   The teacher walks around and asks the following questions:
   - Why do you think your watering system does/does not work?
   - Why did you decide to put your "pipe" there?
   - Is it better to have your "pipe" at the top, middle or bottom of your pot? Why?

6. Once the students have had enough time exploring and manipulating their objects, the teacher asks the following questions:
   - When your water comes out of your "pipe," what do you notice?
   - When people use a water hose, what allows the water to spray in various directions?
   - Why do you think it is important to have water spray in various directions?
   - What can you do to your "pipe" so that the water doesn't fall into one spot?

7. The teacher allows time for the students to work on their "pipe."
8. Students explore new terms and concepts by reading selected books and listening to the teacher read.
9. Students explore new terms and concepts by viewing selected videos.
10. Students explore new terms and concepts by viewing selected Internet sites.

Explanation

1. Students explain verbally why they think the system does/does not work.
2. Students explain verbally their answers to the following questions:
   - Why do you think a watering system is needed in your lunar plant growth chamber?
   - Why do you think astronauts would need to conserve water?

Extension

1. Students sketch and label a diagram of a watering system. (Worksheet 3 in the ***Engineering Portfolio and Journal***.)
2. Students build a watering system.

Evaluation

Rubrics guide and assess:

1. Student diagrams of a watering system.
2. Student watering systems.
3. Worksheet 3 in ***Engineering Portfolio and Journal***.

Enrichment

1. Students can write a poem about water.
2. Students can create a poster about water—where we get it; why water is important; ways to conserve it. The teacher allows students to share their knowledge with others.
3. Students can sketch and label Earth's water cycle. Information could be included about why this cycle could not happen on the moon.

Lesson 4: Lesson Preparation

Teacher Planning

1. Make copies of Engineering Worksheet 3 (***Engineering Portfolio and Journal***).
2. Make copies of the worksheet About Water (***Watering Your Plants 1***).
3. Make copies of the booklet, Water (***Watering Your Plants 2***).
4. Make sure all of the tools/materials are available.
5. Provide areas where students can build a watering system.

Tools/Materials/Equipment

- Tubing
- Syringes
- Hammer and nail
  (An alternative is any device that will pierce holes in the tubing so that water will spray out in various places.)
- Screws
- Paper
- Hole punch for paper or nail and hammer (An alternative is any device that will create a hole for the tubing to go through.)
- Cups
- Water
- Small plastic containers (Small plastic salad containers with hinge lids work well—cut off the top and use both the top and bottom; the containers for cereal that is sold in schools work well; and standard plant containers are another option.)
- Copies of the Engineering Worksheet 3 (***Engineering Portfolio and Journal***).
- Copies of About Water (***Watering Your Plants 1***).
- Copies of Water (***Watering Your Plants 2***).

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Tool Safety Rules should be posted and reviewed:

1. Students should wear safety goggles at all times
2. Students should carefully watch what they are doing when using tools.
3. Students should make sure vises, clamps and miter boxes are fastened securely.
4. Students should check to make sure all tools are safe and should not use broken tools.

Lesson 5: Designing the Lunar Plant Growth Chamber

Lesson Snapshot

Overview

Big Idea: Growing plants on the moon will require a chamber that offers an environment like Earth.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson requires that students create a design of a lunar plant growth chamber.

Lesson Duration: One hour.

Activity Highlights

Engagement: The teacher shows pictures of greenhouses and asks questions.

Exploration: The phrase "plant growth chamber" is discussed and defined. Students design a chamber using paper.

Explanation: Students share their models. Students verbally explain why an electrical system and watering system will be needed with the plant growth chambers. Students define the term "chamber"."

Extension: Students sketch and label a diagram of their lunar plant growth chambers.

Evaluation: A rubric guides the assessment of the diagram of a lunar plant growth chamber.

Lesson 5: Overview

Lesson Duration

- One hour.

Standards/Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the attributes of design. (ITEA/*STL* 8)
  - Everyone can design solutions to a problem. (ITEA/*STL* 8A)
  - Design is a creative process. (ITEA/*STL* 8B)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
  - The engineering design process includes identifying a problem, looking for ideas, developing solutions and sharing solutions with others. (ITEA/*STL* 9A)
  - Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL* 9B)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Geometry
  - Recognize, name, build, draw, compare and sort two- and three-dimensional shapes.
  - Describe attributes and parts of two- and three-dimensional shapes.

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students read a wide range of print and non-print texts to build an understanding of texts, of themselves and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.
- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Learning Objectives

Students will learn to:

- Sketch a diagram of their lunar plant growth chamber.
- Verbally explain their design to others.

Student Assessment Tools and/or Methods

1. Rubric for Diagram of Lunar Plant Growth Chamber

Category	Below Target – 0	At Target – 1	Above Target – 2
Diagram	Few pictures are accurately drawn, with few or no details.	Most pictures are accurately drawn, with some details.	All pictures are accurately drawn, with many details.
Labels	Few labels are correct, with few or no details.	Most labels are correct, with some details.	All labels are correct, with many details.
Neatness	Diagram is not neat. A small amount of text is neat. There are many visible stray marks and/or smears.	Diagram is neat. Most text is neat. There are few visible stray marks and/or smears.	Diagram is neat. All text is neat. There are no visible stray marks and/or smears.
Spelling	Many words are misspelled.	Most words are spelled correctly.	All words are spelled correctly.
Teacher Comment			

Resource Materials

Print Materials

1. Ring, S. (1999). *Design it! Build it!* New York: Newbridge Educational Publishing.

Required Knowledge and Skills

1. Students should have an understanding of an electrical circuit.
2. Students should have an understanding of a watering system.
3. Students should be familiar with the design process.

Lesson 5: 5-E Lesson Plan

Engagement

1. The teacher shows students a variety of greenhouses. The teacher asks the following questions:
    - What do you see in these pictures?
    - What are they called?
    - Why do people have them?
    - What materials were used to build them?
    - Why do you think they used glass/plastic for the sides?
    - How do they help people?
    - How would astronauts benefit from a greenhouse on the moon?

Exploration

1. The teacher asks the following questions:
    - Has anyone heard of the phrase, "plant growth chamber"?
    - What do you think it means?

    The teacher defines the phrase "plant growth chamber," as he/she feels appropriate for the students (a structure or room that will represent a little piece of Earth and will be placed on the moon to allow seeds/plants to grow so that astronauts will have food.).
2. The teacher asks the following question:
    - What shape do you think a plant growth chamber can be?

3. The teacher gives each student a sheet of paper and a couple pieces of tape, then asks the students to make a three-dimensional model of what they think a lunar plant growth chamber would look like.

    The teacher walks around asking the following questions as students are working:
    - What shape are you making?
    - Why do you feel that is the best shape?

4. The teacher asks the following questions:
    - If we were to put this structure up on the moon to grow plants for astronauts, what else should be in it?
    - Why should those items be in it?

Explanation

1. Students share their paper model and explain why they think this would be the best shape for the lunar plant growth chamber.
2. Students verbally explain why both a watering system and an electrical system are needed in their plant growth chamber.
3. Students verbally define the phrase "plant growth chamber."

Extension

1. Students sketch and label a diagram of their lunar plant growth chamber. The electrical system and watering system should be included in the diagram. See the ***Engineering Portfolio and Journal***, Worksheet 4.

Evaluation

Assessment rubric for the following is provided:
Students' sketches of their lunar plant growth chambers.

Enrichment

Students research the things that are grown in a greenhouse.

Lesson 5: Lesson Preparation

Teacher Planning

1. Prepare containers with all necessary materials so that they can be distributed to students.
2. Make copies of Engineering Worksheet 4 (***Engineering Portfolio and Journal***).

Tools/Materials/Equipment

- Paper
- Pencil
- Tape
- Scissors
- Rulers

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Lesson 6: Building a Lunar Plant Growth Chamber

Lesson Snapshot

Overview

Big Idea: Building a lunar plant growth chamber requires special tools and materials and human talent abilities.
Teacher's Note: Big ideas should be made explicit to students by writing them on the board and/or reading them aloud.

Purpose of Lesson: This lesson requires that students build a lunar plant growth chamber that incorporates all parts needed to sustain plants on the moon.

Lesson Duration: Five hours.

Activity Highlights

Engagement: Students write the steps to take during this engineering challenge. The teacher clears up any misconceptions after reading student responses.

Exploration: The size requirements of the lunar plant growth chambers are explained and demonstrated with strips of paper. The materials that students will be able to use to build their lunar plant growth chambers are shown. The materials store is introduced. Money is distributed. Students explore the tools. The teacher reviews tool names and proper use of each tool.

Explanation: Students verbally explain:

- The problem of this activity.
- The size requirements of the chamber.
- Safety rules they need to follow.
- The purpose of the store.
- What features will be included in their plant growth chambers.

Extension: Students build a lunar plant growth chamber.

Evaluation: Rubrics guide and assess:

- Student plant growth chambers

Lesson 6: Overview

Lesson Duration

- Five hours.

Standards/Benchmarks

Technology: Standards for Technological Literacy (*STL*) *(ITEA, 2000/2002)*

- Students will develop an understanding of the attributes of design. (ITEA/*STL* 8)
  - Everyone can design solutions to a problem. (ITEA/*STL* 8A)
  - Design is a creative process. (ITEA/*STL* 8B)
- Students will develop an understanding of engineering design. (ITEA/*STL* 9)
  - The engineering design process includes identifying a problem, looking for ideas, developing solutions and sharing solutions with others. (ITEA/*STL* 9A)
  - Expressing ideas to others verbally and through sketches and models is an important part of the design process. (ITEA/*STL* 9B)
- Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation and experimentation in problem solving. (ITEA/*STL* 10)
  - Asking questions and making observations helps a person to figure out how things work. (ITEA/*STL* 10A)
- Students will develop the abilities to apply the design process. (ITEA/*STL* 11)
  - Build or construct an object using the design process. (ITEA/*STL* 11B)
- Students will develop the abilities to use and maintain technological products and systems. (ITEA/*STL* 12)
  - Use hand tools correctly and safely and be able to name them correctly. (ITEA/*STL* 12B)

Science: Benchmarks for Science Literacy *(AAAS, 1993)*

- Tools are used to do things better or more easily and to do some things that could not otherwise be done at all. In technology, tools are used to observe, measure and make things. (AAAS 3A)
- Several steps are usually involved in making things. (AAAS 8B)
- Some kinds of materials are better than others for making any particular thing. Materials that are better in some ways (such as stronger or cheaper) may be worse in other ways (heavier or harder to cut). (AAAS 8B)
- Tools are used to help make things, and some things cannot be made at all without tools. Each kind of tool has a special purpose. (AAAS 8B)
- Most things are made of parts. (AAAS 11A)
- A model of something is different from the real thing but can be used to learn something about the real thing. (AAAS 11B)
- Use hammers, screwdrivers, clamps, rulers, scissors and hand lenses and operate ordinary audio equipment. (AAAS 12C)
- Make something out of paper, cardboard, wood, plastic, metal or existing objects that can actually be used to perform a task. (AAAS 12C)
- Measure the length in whole units of objects having straight edges. (AAAS 12C)
- Draw pictures that correctly portray at least some features of the thing being described. (AAAS 12D)

Mathematics: Principles and Standards for School Mathematics *(NCTM, 2000)*

- Geometry
  - Recognize the attributes of length, volume, weight, area and time.
- Measurement
  - Understand how to measure using nonstandard and standard units.
  - Select an appropriate unit and tool for the attribute being measured.
  - Use tools to measure.
- Number and Operations
  - Understand the effects of adding and subtracting whole numbers.
- Data Analysis and Probability
  - Represent data using concrete objects, pictures and graphs.

Teacher Note: While the national standards do not address money specifically, teachers may find state or local standards dealing with money are addressed in this lesson.

English Language Arts: Standards for the English Language Arts *(NCTE, 1996)*

- Students adjust their use of spoken, written and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- Students use spoken, written and visual language to accomplish their own purposes. (e.g., for learning, enjoyment, persuasion and the exchange of information).

Learning Objectives

Students will learn to:

- Understand the building process.
- Understand how to measure using standard units.
- Use an inch ruler.
- Use tools correctly and safely.
- Write about the building process.
- Explain and demonstrate the role of money in everyday life.

Student Assessment Tools and/or Methods

1. Rubric for Lunar Plant Growth Chamber

Category	Below Target – 0	At Target – 1	Above Target – 2
Parts	Some parts are missing. Parts are not securely attached.	Most parts are included. Most parts are attached securely.	All parts are included. Everything is securely fastened.
Electrical Circuit	Most parts are connected out of sequence and placed incorrectly in the growth chamber.	System is working, but occasionally the light goes out.	System is working properly.
Watering System	Most parts are connected out of sequence and placed incorrectly in the growth chamber.	System is working, but occasionally the water doesn't flow easily	System is working properly.
Neatness	Lots of glue is showing. Tape is not wound neatly and tightly.	Some glue is showing. Most tape is wound neatly and tightly.	No glue is showing. All tape is wound neatly and tightly.
Teacher Comment			

Resource Materials

Print Materials

1. Ring, S. (1999). *Design it! Build it!* New York: Newbridge Educational Publishing.

Audiovisual Materials

1. Ball, S. & Little, B. (Directors). (2001). *Hold onto your hard hats!, Bob the builder* (Video). Hit Entertainment.
2. Cockle, J. (Producer), & Burns A. & Walker, G. (Directors). (2005). *Build it and they will come, Bob the builder* (Video). Hit Entertainment.
3. Cockle, J. (Producer), & Burns A., Fogg, G. and Walker, G. (Directors). (2006). *When bob became a builder, Bob the builder* (Video). Hit Entertainment

Clip Art Obtained From:

- (1995-98). *Art explosion*. USA: Nova Development Corporation.
- (1993). *ClickArt*. Mountain View, CA: T/Maker Company.

Required Knowledge and Skills

1. Students should have an understanding of an electrical circuit (light).
2. Students should have an understanding of a watering system (moisture).
3. Students should understand the design-and-construction process.
4. Students should know how to measure using standard units of measurement.
5. Students should know how to use tools safely.

Lesson 6: 5-E Lesson Plan

Engagement

1. The teacher provides the Engineering Worksheet 1 (***Engineering Portfolio and Journal***) to the students. Students read what is on the page and write a response. The teacher clears up any misconceptions at this time

Exploration

1. The teacher writes the length and width size requirements on the board. (Length is 4–6 inches; width 4–6 inches. The teacher needs to make sure these sizes correlate with the plastic containers he/she is using as plant "pots.")
2. The teacher divides students into groups of two to four.
3. Students look at the size requirements on the boards. Students explain what they think the measurements mean.
4. The teacher provides each group with various sizes of the paper squares and rectangles (mentioned in the classroom preparation section).
5. Students put all the shapes that match the requirements in one pile and all the ones that don't into another pile.
6. As students place the shapes into the various piles, the teacher asks the following questions:
    - Why does that one go in that pile?
    - What is wrong with that shape?

7. The teacher hangs all the correct sizes of paper on the board.
8. The teacher asks the students the following questions:
    - Why did I only hang these shapes up on the board?
    - What is wrong with the shapes that were left on your desks?

    (The teacher may want to leave these shapes up so when students are building, they can compare their lunar plant growth chamber sizes to the sizes on the board.)

9. The teacher writes the height on the board (height is 5-11 inches).
10. The teacher gives each group a piece of paper and asks them to measure and cut a 5-inch strip and an 11-inch strip.

    The teacher asks the students the following questions as the students cut:
    - Which paper strip represents the shortest you can build your lunar plant growth chamber?
    - Which paper strip represents the highest you can build your lunar plant growth chamber?

    (The strips should be hung up around the room for students to use while they are building.)

11. The teacher draws student attention to all the pieces that fit the chamber requirements. The teacher places a plant "pot" on each width and length shape. (The chamber will only house the plant "pot" and the light. The students will need to build a separate compartment to hold the battery holder, wires and wooden block that holds the switch. The syringe and some of the tubing will hang out of the chamber.)

    The teacher asks the following questions:
    - What will your chamber hold in it?
    - Where will you put the parts for the electrical circuit?
    - What parts were used to create the electrical circuit?

12. The teacher hands each group these items:
    - Pieces of paper the following sizes
        - 3" x 5"
        - 3" x 6"
        - 4" x 5"
        - 4" x 6"
        - 5" x 5"
        - 5" x 6"
        - 6" x 6"
    - Block of wood 2 ½" x 4"
    - Battery holder.

    The teacher asks students the following questions:
    - Which pieces of paper hold the electrical circuit pieces best?
    - How did you arrange them?
    - Which size do you think is the best? Why?

    The teacher needs to explain that this compartment will need to be attached to the lunar plant growth chambers. It should either be attached to one of the sides or the back. It has to be as long as the chamber's length/width and cannot be longer/wider than 6 inches. The height has to be 2 inches. The size will vary from student design to student design. Some students may have a 5 inch by 6 inch compartment and others may have a 4 inch by 6 inch one. The teacher displays the sizes that the students feel are best and labels them.

13. The teacher hands out samples of the materials students will be able to use while building their chambers. The teacher asks students to discuss with each other what the materials are and how they could be used in their lunar plant growth chambers.

    The teacher walks around and asks the following questions:
    - Why do you feel that material would be good for that part?
    - How could the pieces be attached to each other?
    - How will you attach your watering system?
    - How will you attach your electrical system so the light will work?

14. The students look at the store and explain what they see.
15. The teacher asks the following questions:
    - What do you notice about the tubing sign?
    - If I wanted to purchase 5 inches of tubing, how much would I have to pay?

16. The students look at the Store Supplies Graph in their ***Engineering Portfolio and Journal***.
17. The teacher asks students to explain verbally what they will need to do with the graph.
18. Each student/team receives their bag of money.
19. The teacher asks the following question:
    - How much money do you think you have?

20. The teacher should allow time for students to calculate the amount in their bags.
21. The students are given an opportunity to explore the tools that are in the tool area. The teacher reviews the correct names of the tools, their purpose and how to use them safely.

Explanation

1. The students verbally explain what the problem is in this activity.
2. The students verbally explain what the shapes are on the board and their importance to this activity.
3. The students verbally explain the safety rules.
4. The students verbally explain what they need to do at the store.
5. The students verbally explain which systems they will need to place in their lunar plant growth chambers.
6. The students verbally explain the size requirements.

Extension

Students build a model of their lunar plant growth chamber using their unique designs.

Evaluation

Assessment rubrics for the following are provided:

1. Student lunar plant growth chambers.
2. Engineering Worksheet 5 (***Engineering Portfolio and Journal***).
3. Engineering Worksheet 6 (***Engineering Portfolio and Journal***).

Enrichment

1. Students can explain their lunar plant growth chamber to other students.
2. Students can write a letter to an astronaut about their lunar plant growth chamber.
3. Students may design an advertisement for the lunar plant growth chamber. The advertisement could be for television, radio, newspaper or magazine use.

Lesson 6: Lesson Preparation

Teacher Planning

1. Make copies of Engineering Worksheet 1 (***Engineering Portfolio and Journal***).

2. Make copies of the price list and graph (***Engineering Portfolio and Journal***).

3. Cut out various sized squares and rectangles out of paper in the following sizes measured in inches. On each shape write the words length and width. The size of the chambers will depend on the plant "pots" the instructor uses.
    - 2 x 3
    - 3 x 3
    - 4 x 4
    - 4 x 5
    - 4 x 6
    - 5 x 6
    - 5 x 5
    - 6 x 6
    - 7 x 7
    - 6 x 7
    - 5 x 7, etc.
4. Cut out pieces of paper the following sizes measured in inches. These are for the compartment that will hold the electrical circuit parts.
    - 3 x 5
    - 3 x 6
    - 4 x 5
    - 4 x 6
    - 5 x 5
    - 5 x 6
    - 6 x 6
5. Prepare trays with samples of the building materials for the chamber. Do not include the materials that will be used for the electrical circuit or the watering system.
6. Set up the classroom store. Make copies of the ***Money Sheets*** that have been provided. Each student/team should receive approximately $16.00. Plastic bags can be used to hold the money and plastic containers can be used to hold supplies. The materials signs should be copied, laminated and hung so they are visible to all students.
7. It is highly recommended that the teacher make copies of the front cover of the Lunar Plant Growth Chamber Journal (***Engineering Portfolio and Journal***) and several blank writing pages for each student. Students can document their creative work each day in their journals.
8. Make sure each student has his/her ***Engineering Portfolio and Journal***.
9. Make sure all tools are set out.
10. Make sure the size requirement sheet (***Engineering Portfolio and Journal***) is visible to all students. These requirements can be changed to fit the sizes of the "pots," or plastic trays.
11. Plug the glue guns in before the students begin to build.

Tools/Materials/Equipment

Tools

- Clamps
- Hammers
- Goggles
- Joiners
- Miter boxes
- Pencils
- Permanent black markers
- Rulers
- Saws
- Scissors
- Screwdrivers
- Student drill
- Wire strippers
- Yardstick

Materials for the Building Process

- D-cell batteries
- Battery holders
- Cardboard (Various Sizes)
- Coffee stirrers
- Construction paper (various sizes)
- Electrical tape
- Glue guns
- Glue sticks
- Lightbulbs
- Paper clips (small)
- Paper triangles
- Plastic (stiff)
- Plastic trays
- Popsicle sticks
- Sandpaper
- Screws
- Sockets
- Straws
- Styrofoam® (various sizes)
- Syringes (6cc or 10cc)
- Tape
- Push pins
- Tubing
- Electrical wire
- Wood (2-inch by 2-inch)
- Wood (2.5-inch x 4-inch)
- Wooden beams

Teacher Note: This is just a suggested list. Teachers should feel free to modify the list.

Teacher Note: The stiff plastic should be cut in rectangles and squares. Plastic salad containers or overhead sheets work well. For the plastic trays, any small containers will work (the containers from school cereal containers work well, and salad bars have small plastic containers). The 2-inch by 2-inch pieces of wood are for the light sockets. The 2.5-inch x 4-inch pieces of wood are used for the light switches.

Extra materials:

- Paper for the students to make 5-inch strips and 11-inch strips.
- Plastic bags for money—names should be written on each bag.
- Plastic containers to hold materials—pieces of masking tape can be placed on each container and names can be written.
- Paint for students to paint their chambers.

Classroom Safety and Conduct

Students are expected to follow normal classroom and school safety rules.

Tool Safety Rules should be posted and reviewed:

1. Students should wear safety goggles at all times
2. Students should carefully watch what they are doing when using tools.
3. Students should make sure vises, clamps and miter boxes are fastened securely.
4. Students should check to make sure all tools are safe and not use broken tools.

Electrical circuit safety:

1. Students should connect all wires before placing the batteries in place.
2. If students are using a battery holder, they should make sure the black and red wires do not touch each other when the batteries are in place. (A little smoke and smell will appear!)
3. If students are not using the battery holder, they should make sure the two wires that are connected to the battery do not touch.
4. Students should make sure that when connecting wires together, electrical tape is wrapped around them to cover exposed wires.

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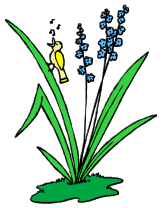
Appendices
Resource Documents

Natural Resources on Earth

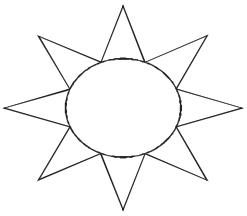
Name _____

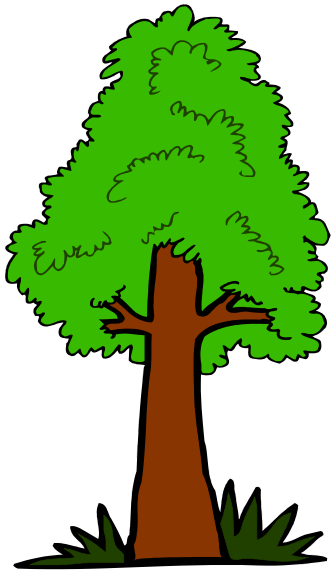


On the lines below, list your group's items.

Explain why each of these items is important to people.

Where can you find all of these items?





Natural Environment

Name _____

---

physical features

weather

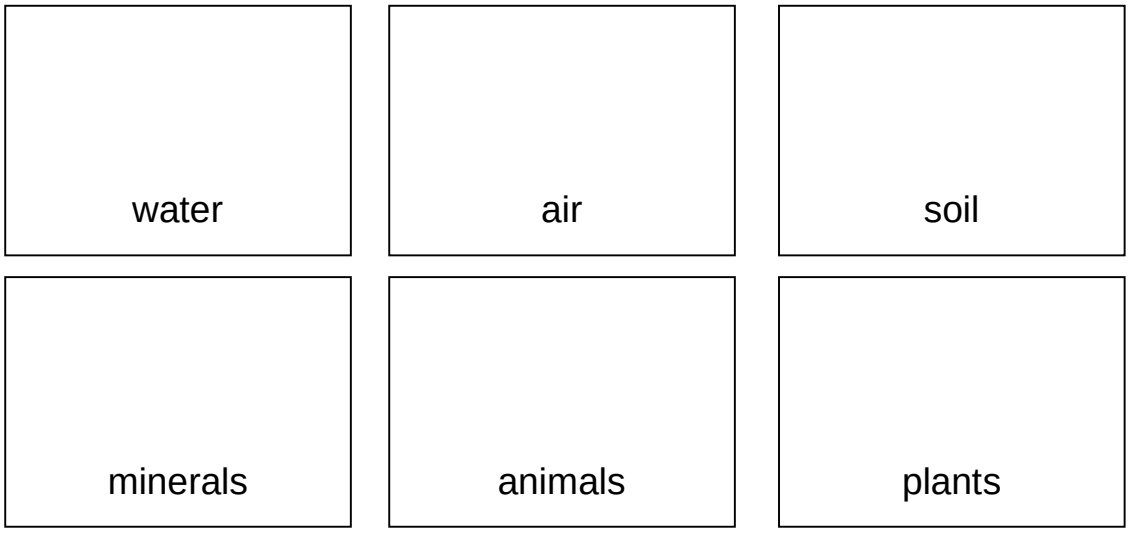
soil

vegetation (plants)

animals

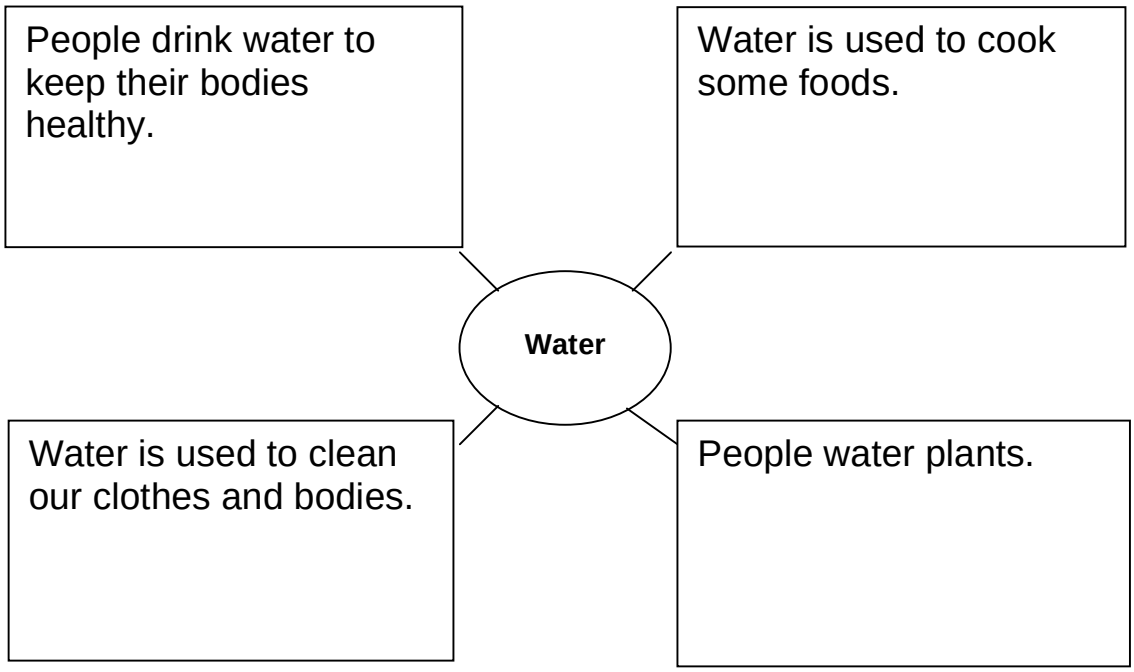
Our Earth is a special place. It has many **physical features,** such as mountains, beaches, plains, deserts, islands, peninsulas, oceans and rivers. The **weather** can vary each day and from place to place. There are different types of **soil** and **vegetation** (plants). Many **animals** roam around Earth. All of these things make up our natural environment.

Natural Resources

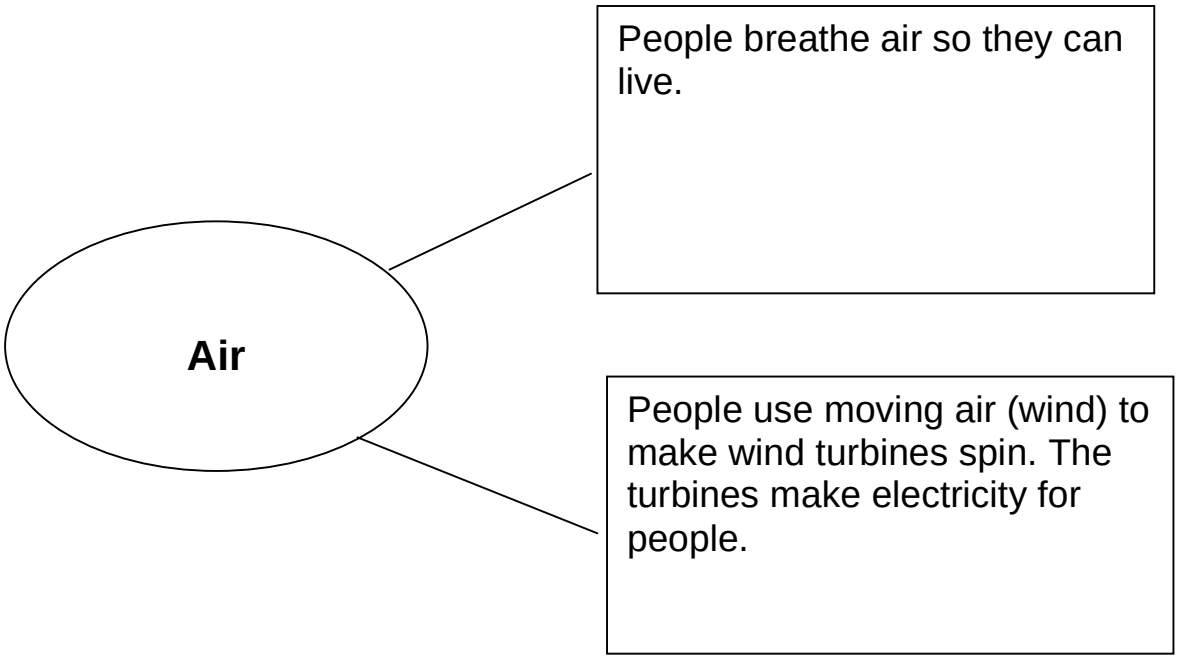


The natural environment provides many **natural resources** for people. Natural resources are always found in or on Earth. The basic natural resources are **water**, **air**, **soil**, **minerals**, **animals** and **plants**.

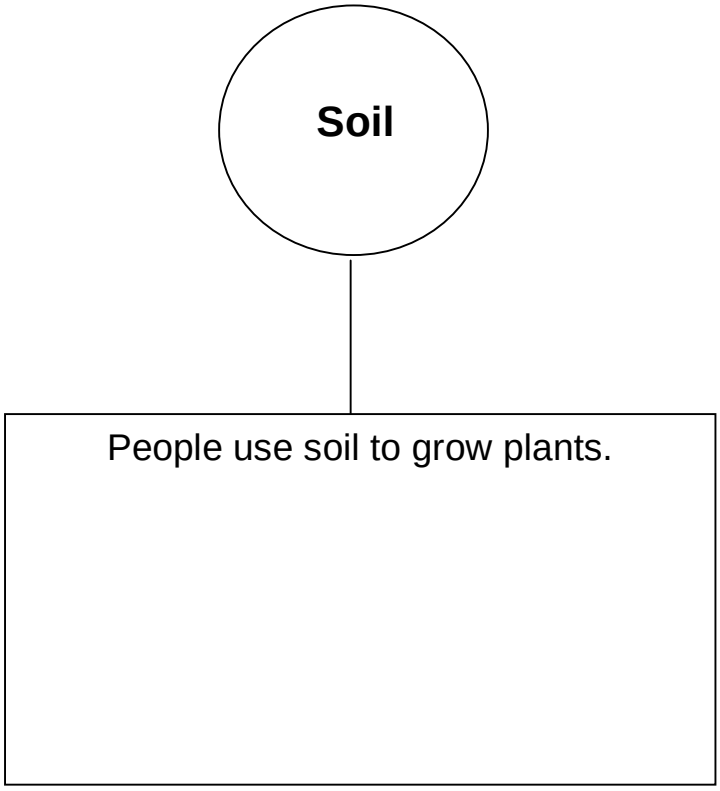
Which natural resources do you use?


People drink water to keep their bodies healthy.
Water is used to cook some foods.
Water
Water is used to clean our clothes and bodies.
People water plants.

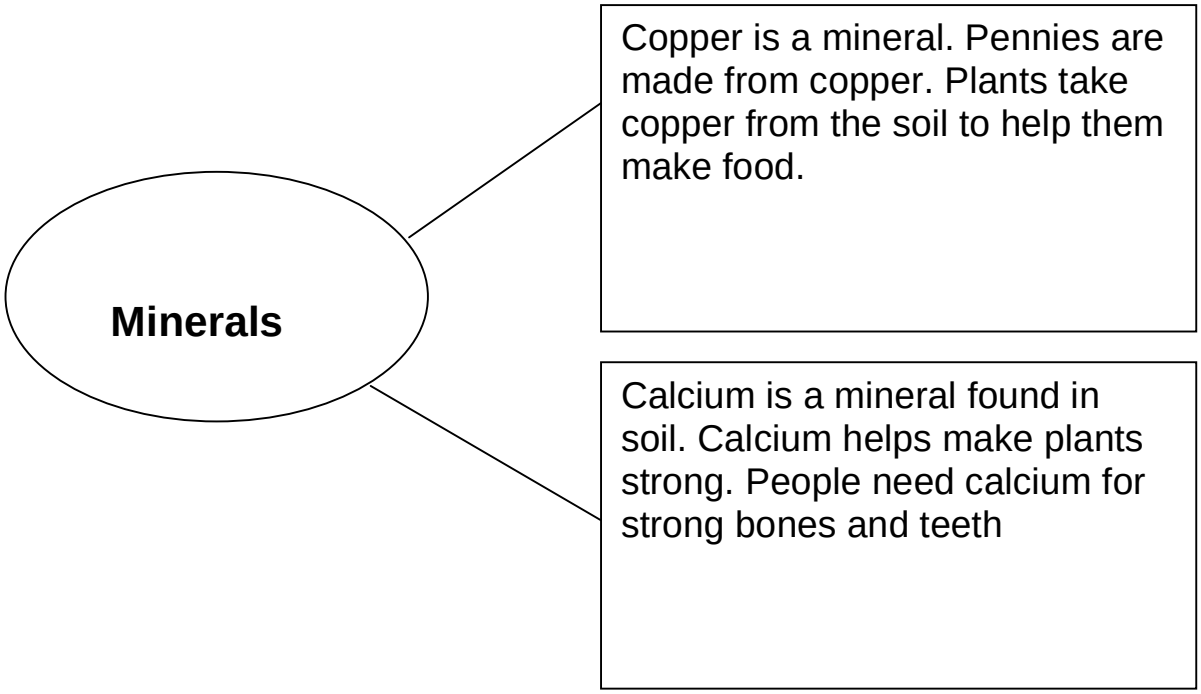
4


People breathe air so they can live.
Air
People use moving air (wind) to make wind turbines spin. The turbines make electricity for people.

5


Soil
People use soil to grow plants.

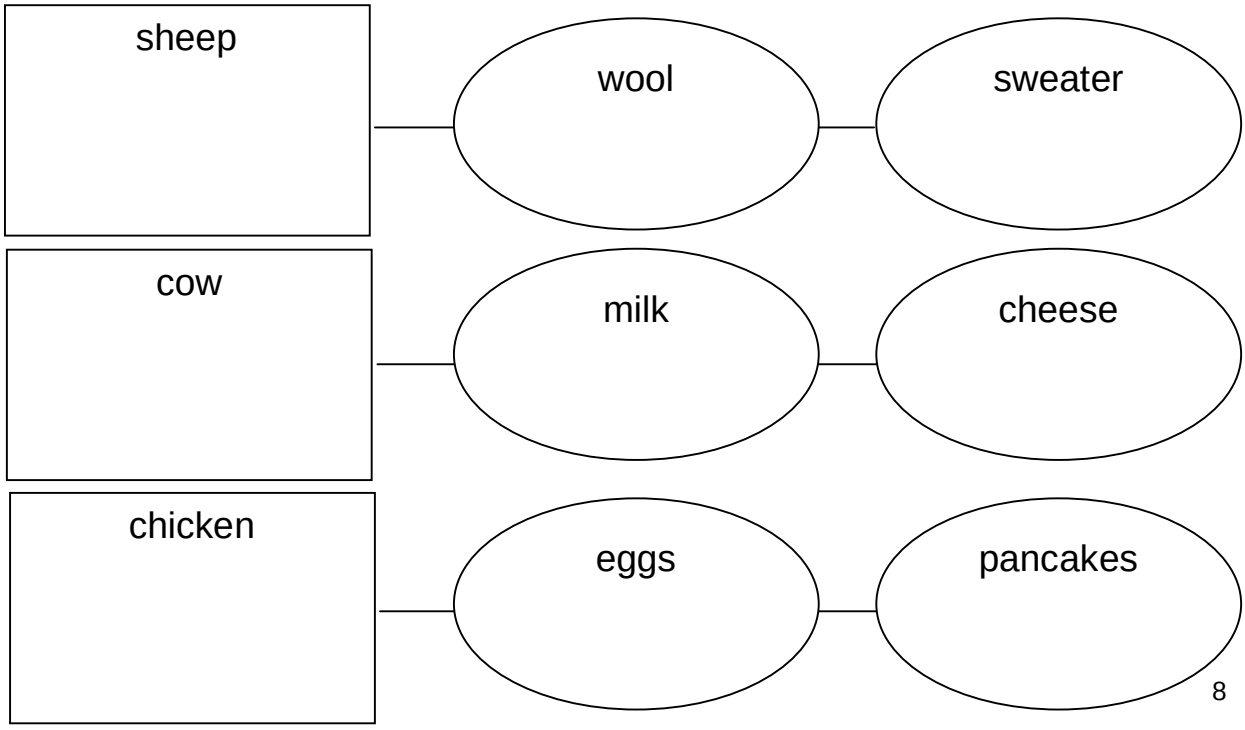
6


Minerals
Copper is a mineral. Pennies are made from copper. Plants take copper from the soil to help them make food.
Calcium is a mineral found in soil. Calcium helps make plants strong. People need calcium for strong bones and teeth

7

Animals

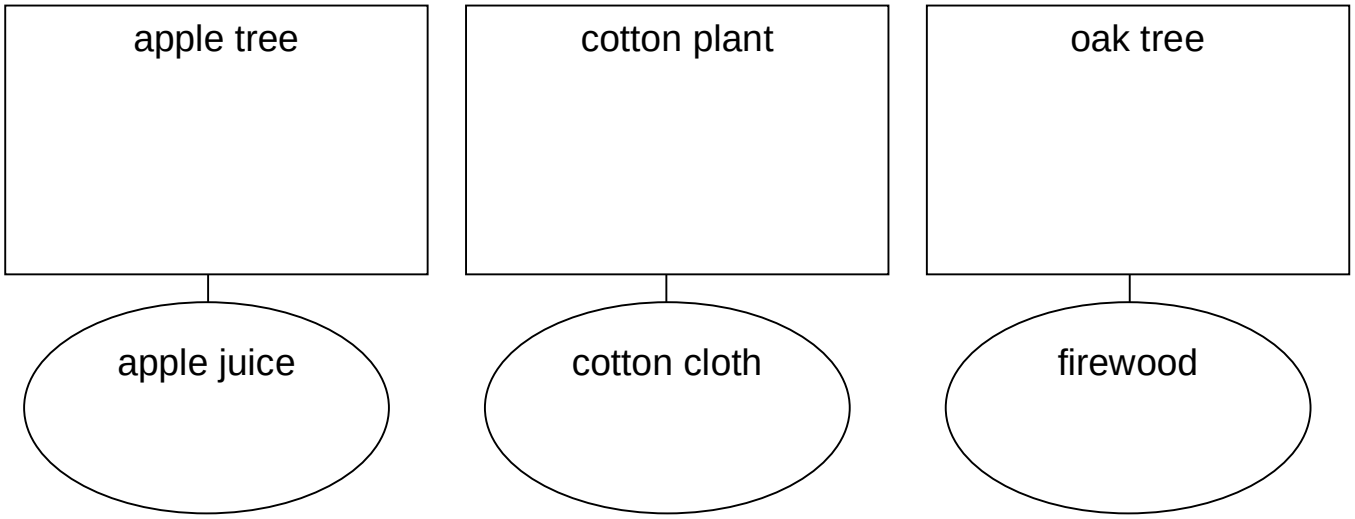
People use animals for food and clothing.



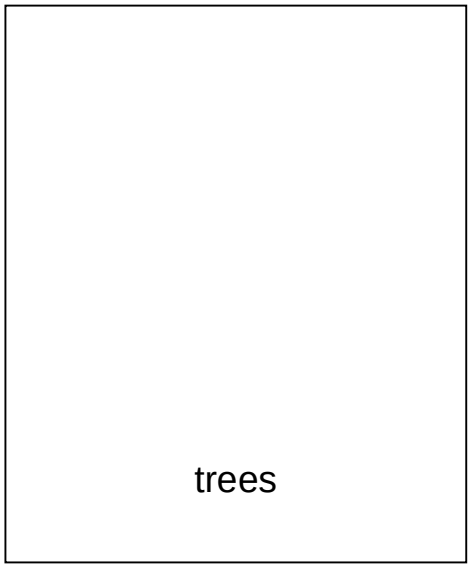
8

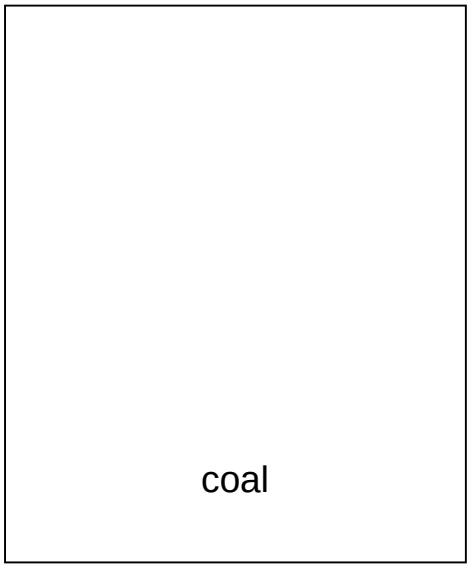
Plants

Many plants are used to produce food, clothing or fuel.

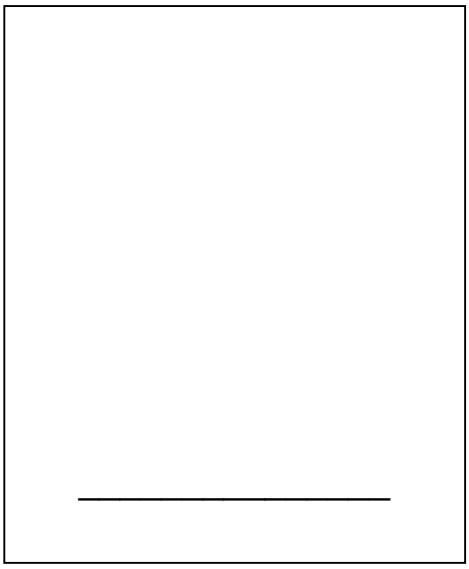


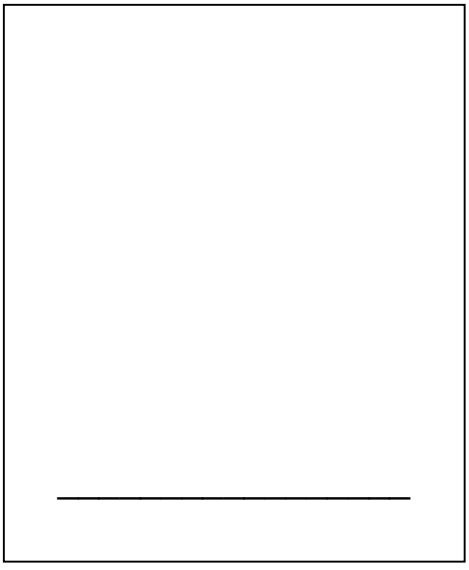
9



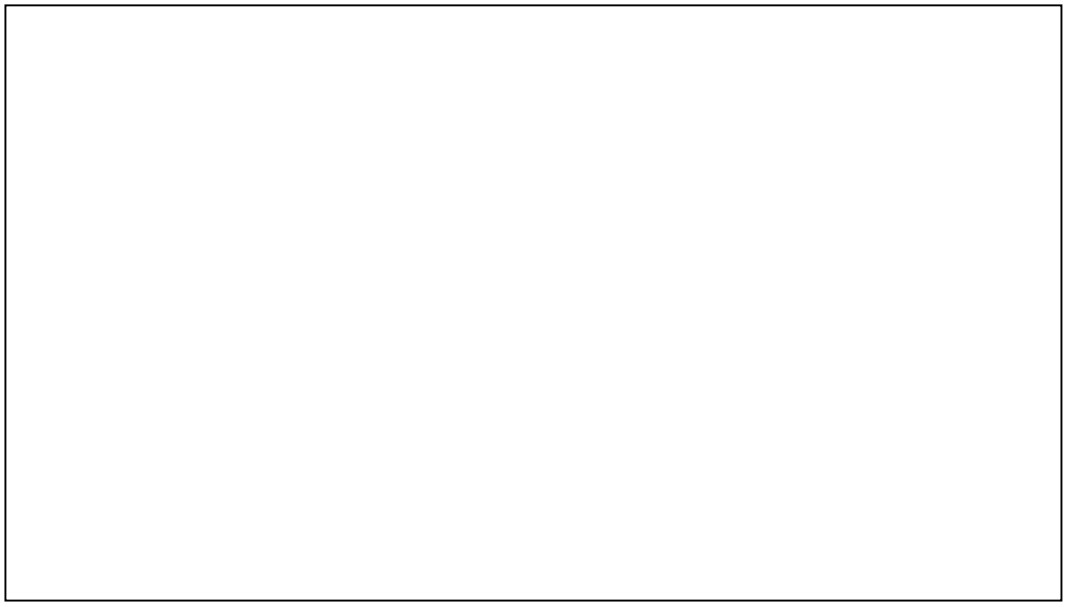


Some of our natural resources are limited. People need to use them wisely so the resources will be around for many years.





Draw and label two natural resources you use every day.



What natural resources can be found on the moon? Draw and label.

Do you think any of the natural resources would help plants to grow on the moon? Explain your answer.

Would any of the moon's natural resources be able to be used by astronauts to build a lunar growth chamber? Explain your answer.

Seeds on Our Earth

Name _____

Seeds are important to us because they give us different kinds of food.

1.

Many types of seeds are sent to factories to be made into food. Wheat seeds are ground to make flour. When you eat a peanut butter sandwich, you are eating crushed and ground peanut seeds.

2.

Some seeds are used in soups or desserts. The vegetable soup you eat may contain peas and corn. These are both kinds of seeds. Think about the cookies you eat with nuts in them. You are eating seeds!

3.

Have you ever eaten sunflower seeds, pumpkin seeds or popcorn? These are types of seeds that we enjoy.

4.

Apples, oranges, grapes, green beans, peaches, plums and pears all contain seeds.

5.

Seeds are unique because inside each seed is a tiny plant just waiting to grow. Each seed also has food inside to feed the tiny plant.

6.

Seeds need water, warmth and air to grow. Seeds do not need soil for food because seeds have food inside them. The sun warms the soil which helps seeds stay warm.

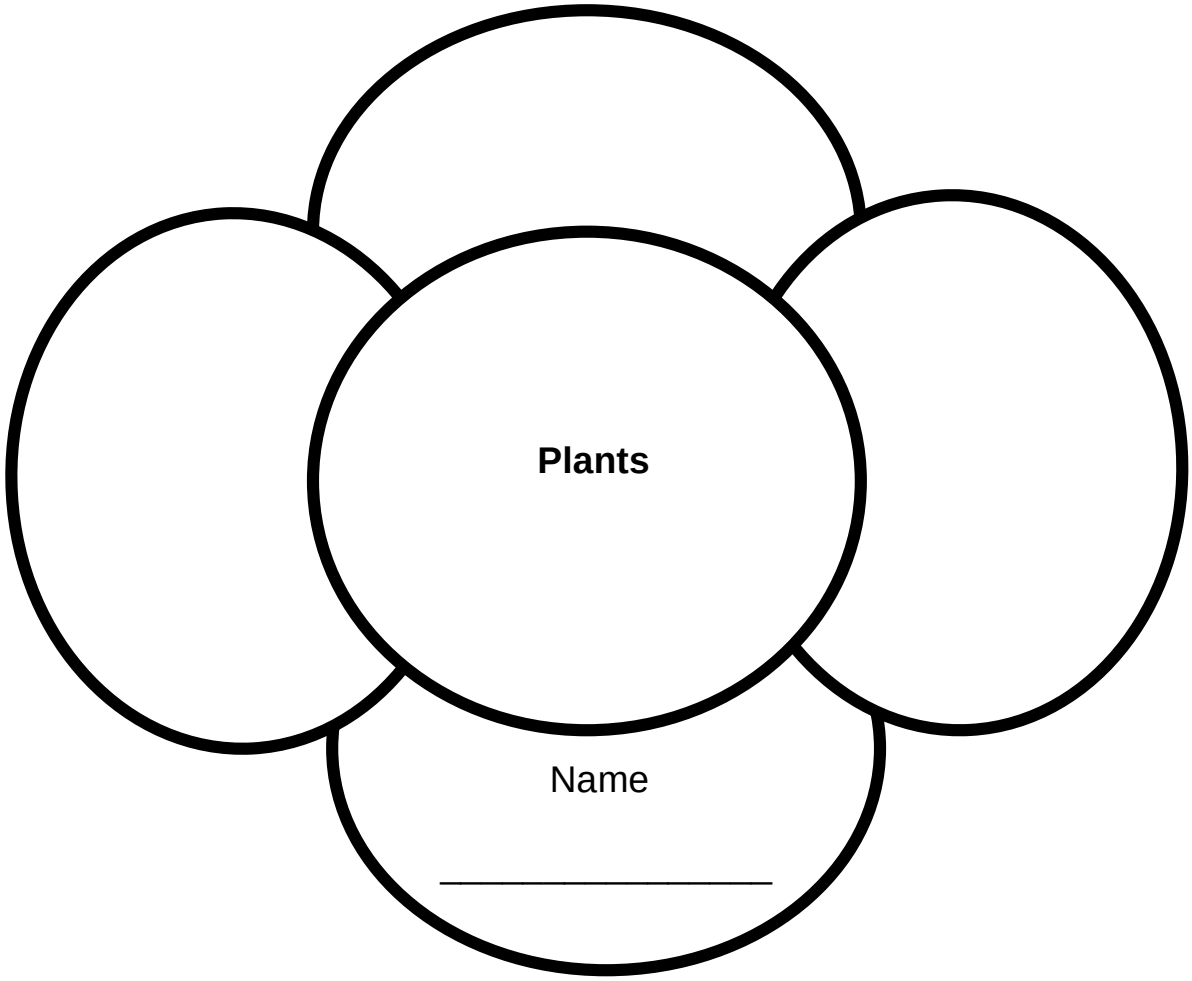
7.

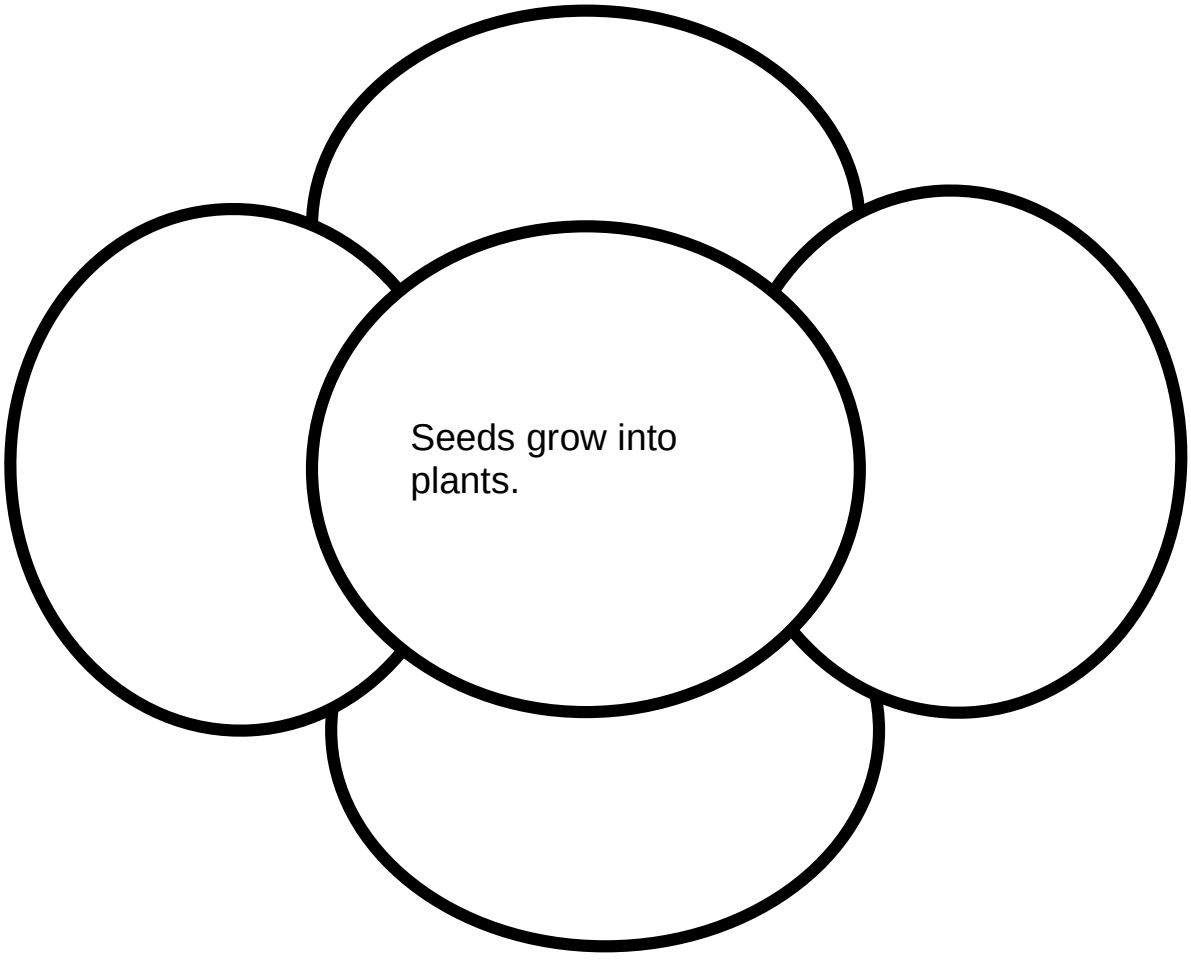
Seeds are an important part of our Earth. They give us foods to eat and new plants.

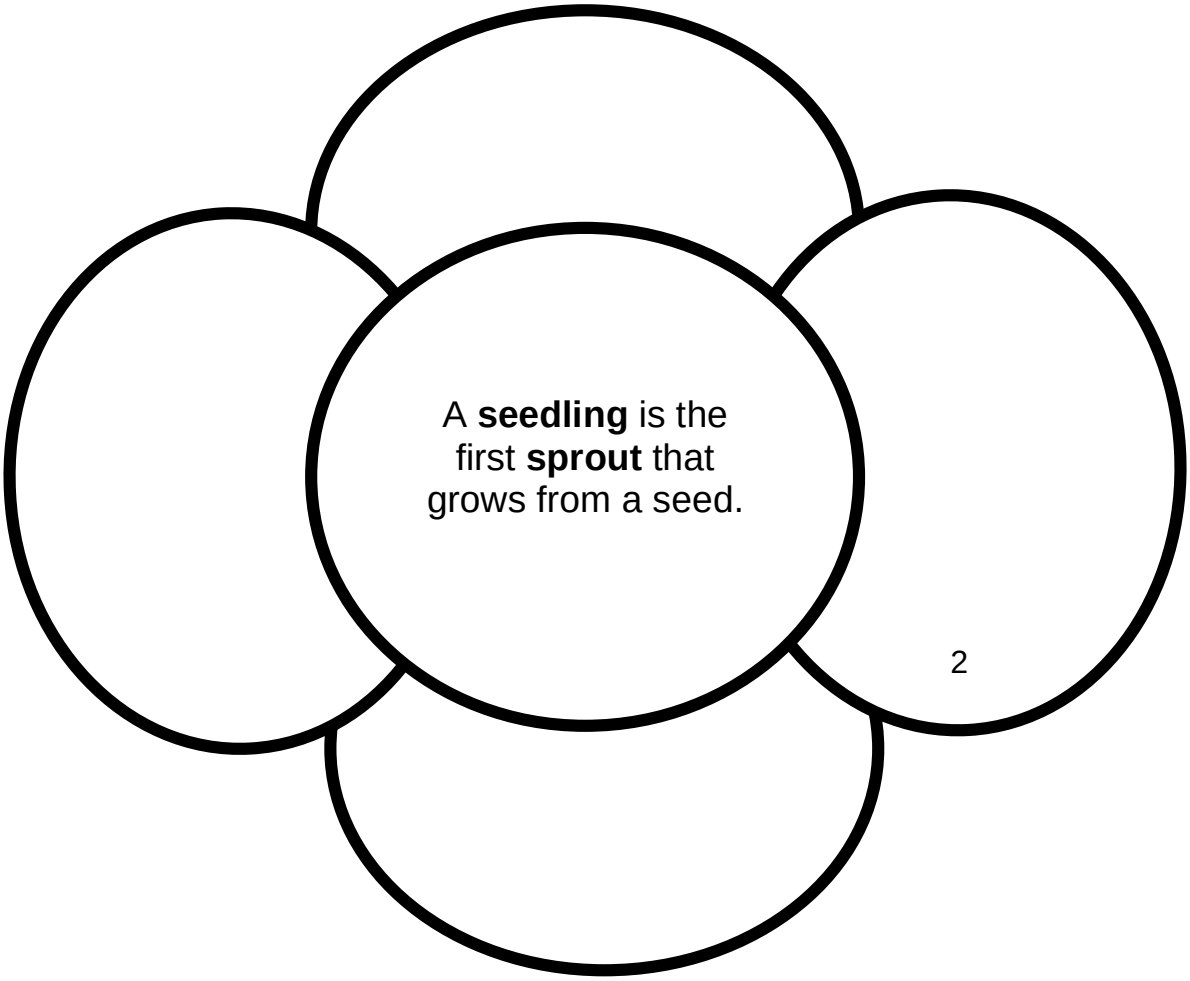
8.

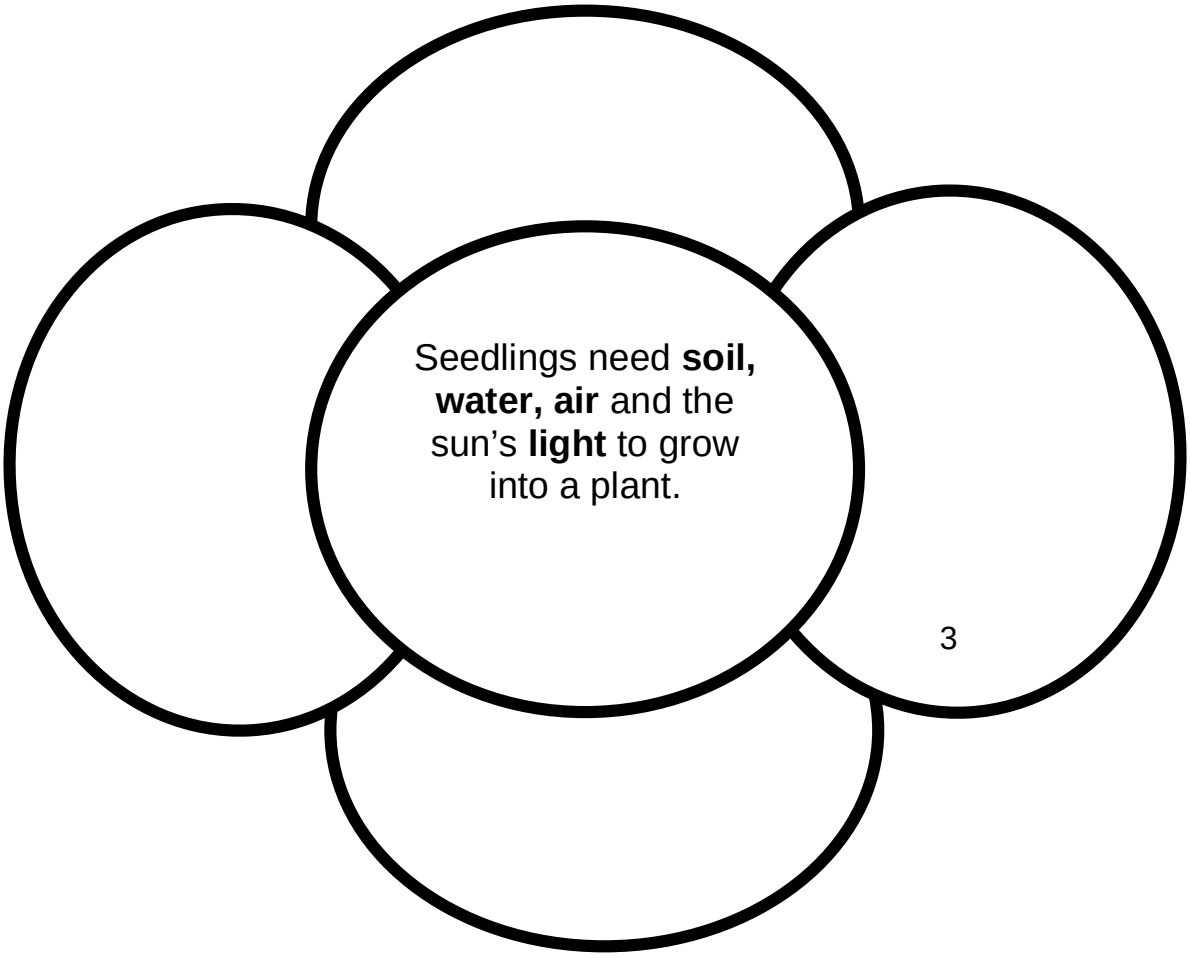
Draw and label at least four seeds you have seen.

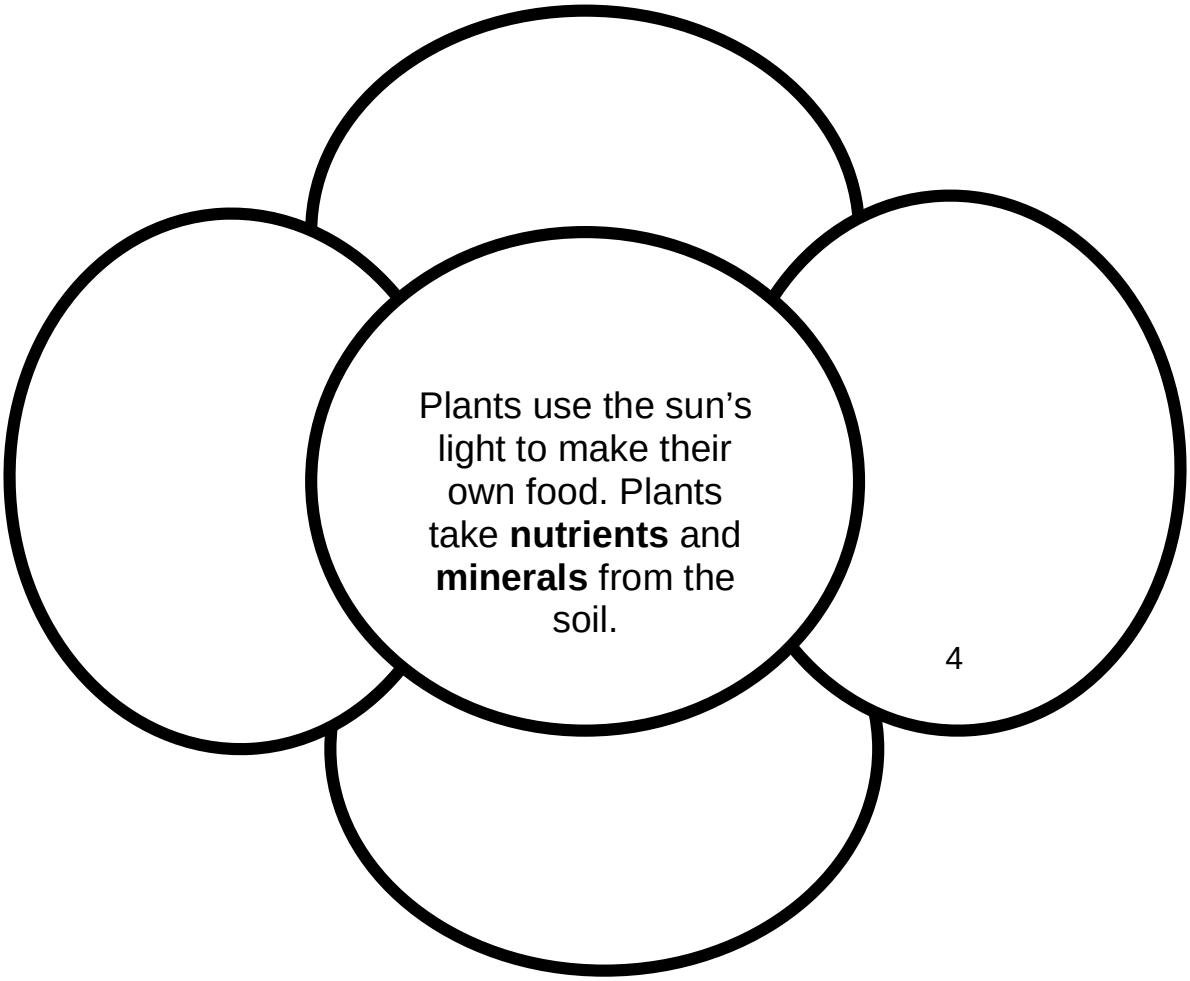
9.

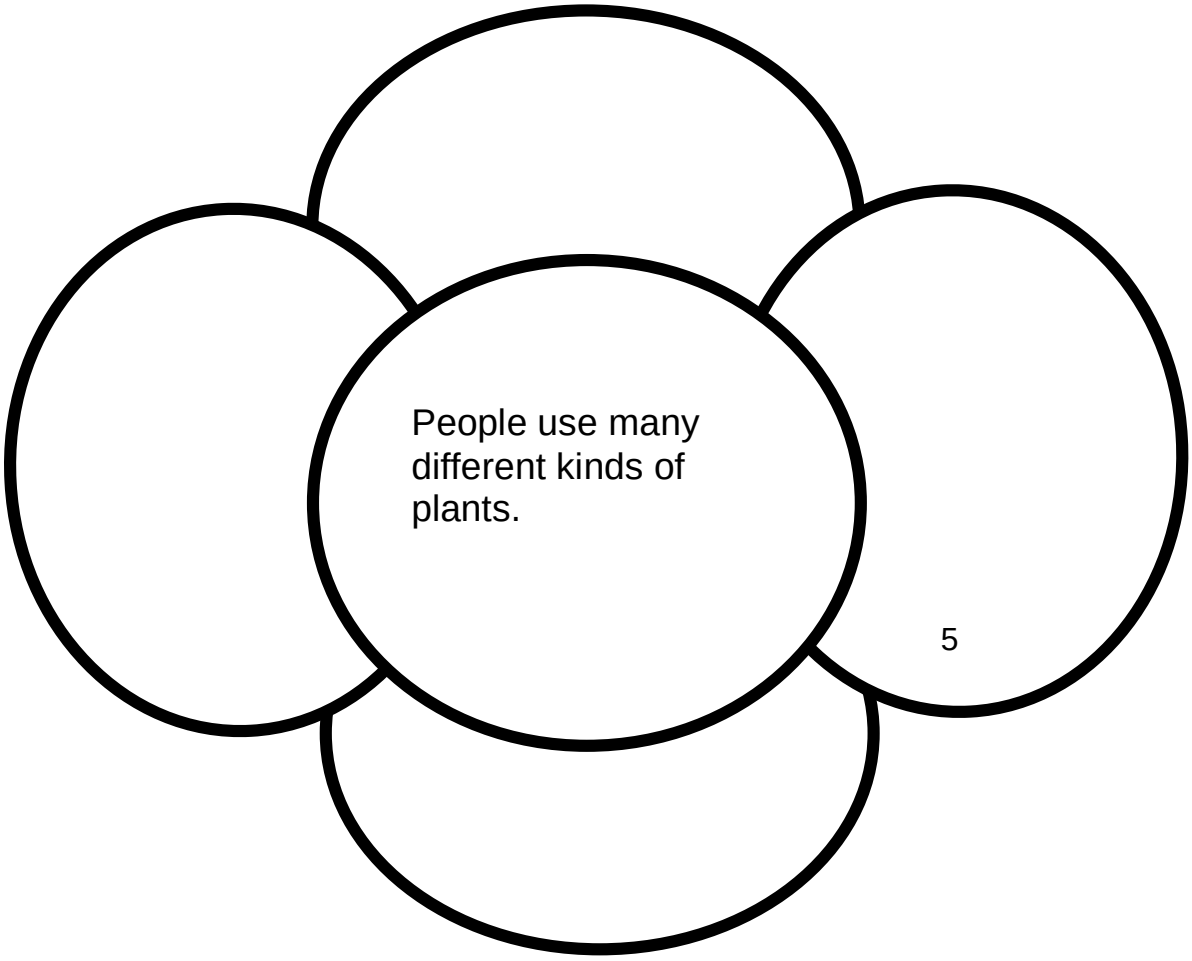

Plants
Name
_____

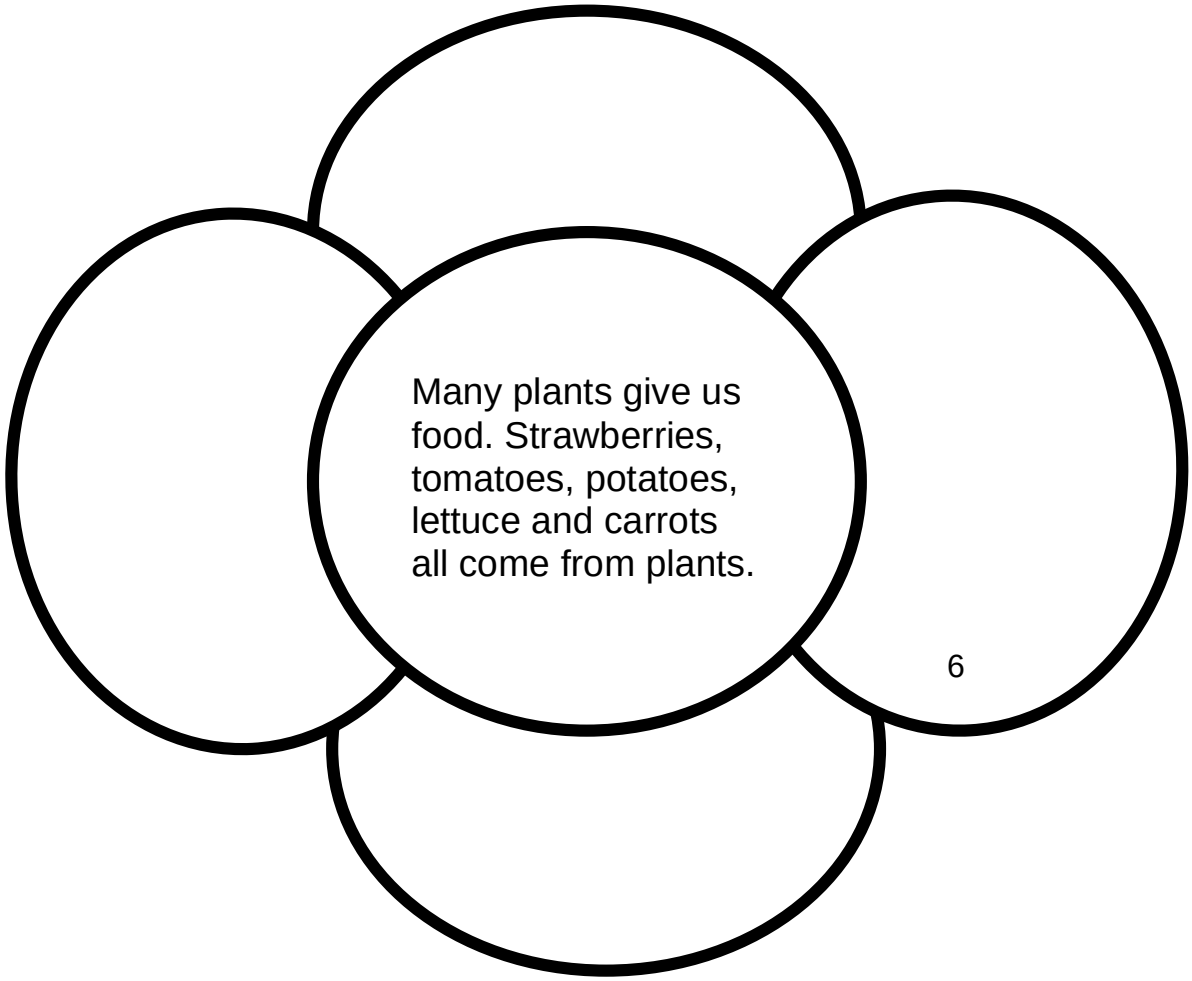

Seeds grow into plants.

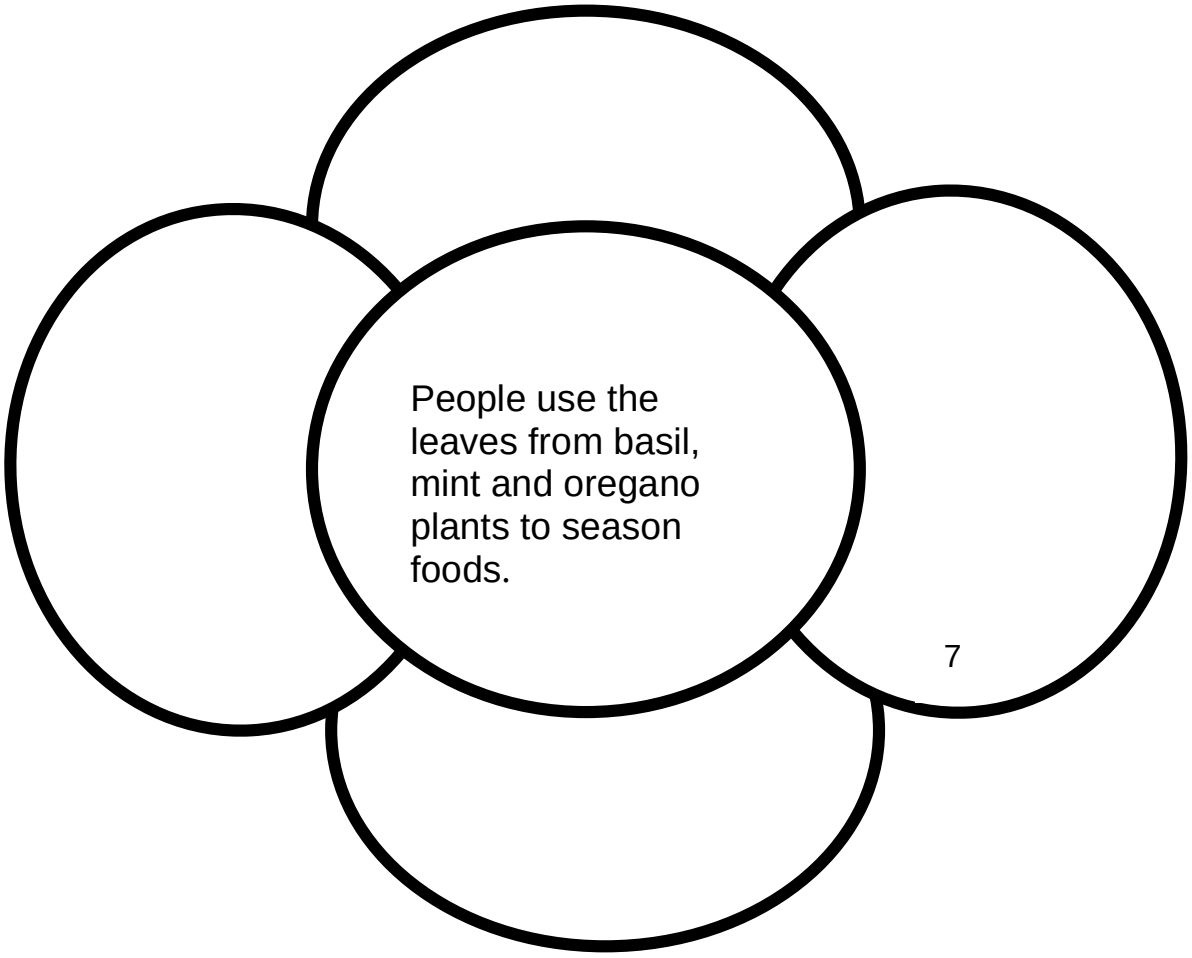

A **seedling** is the first **sprout** that grows from a seed.
2

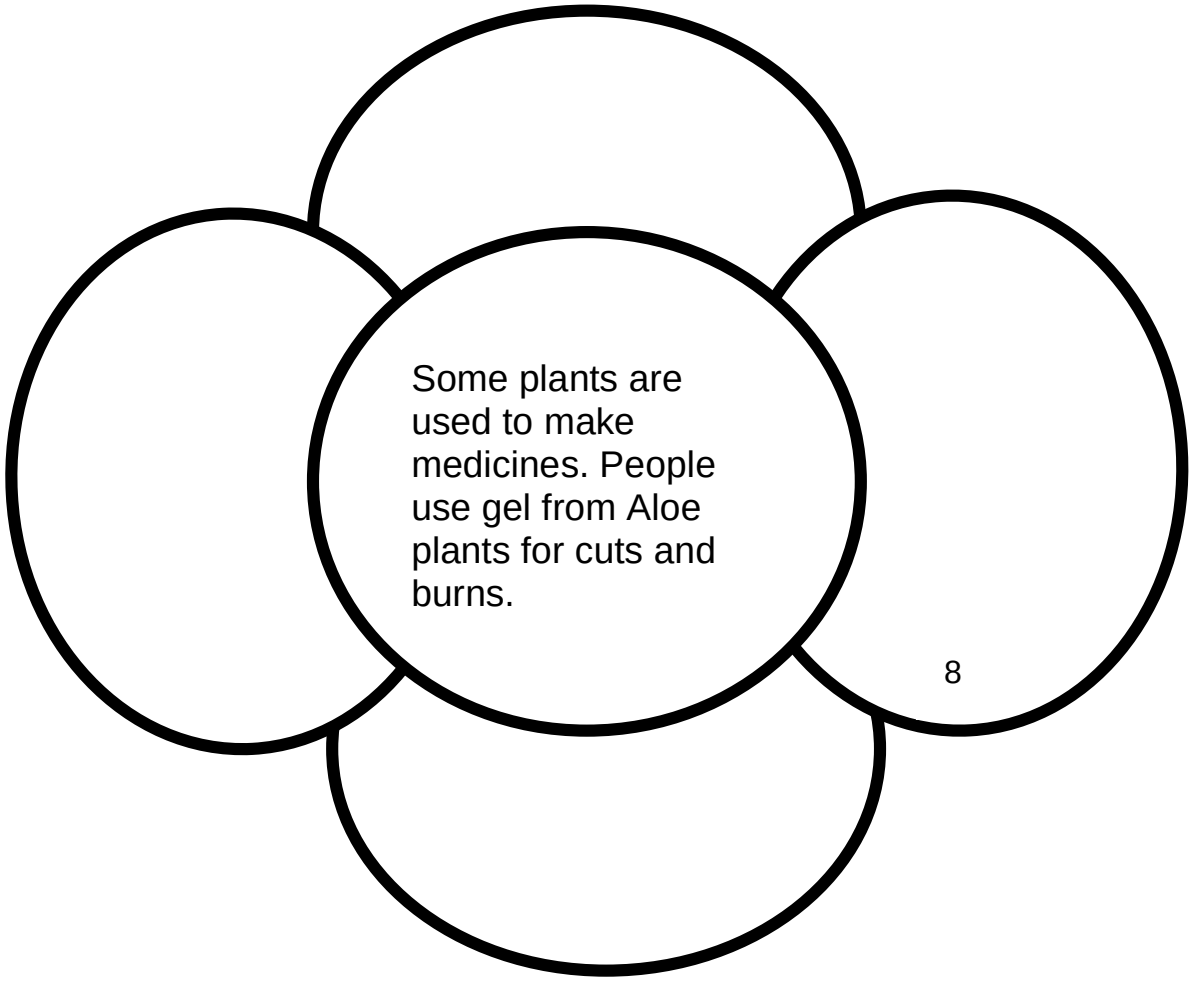

Seedlings need **soil, water, air** and the sun's **light** to grow into a plant.
3

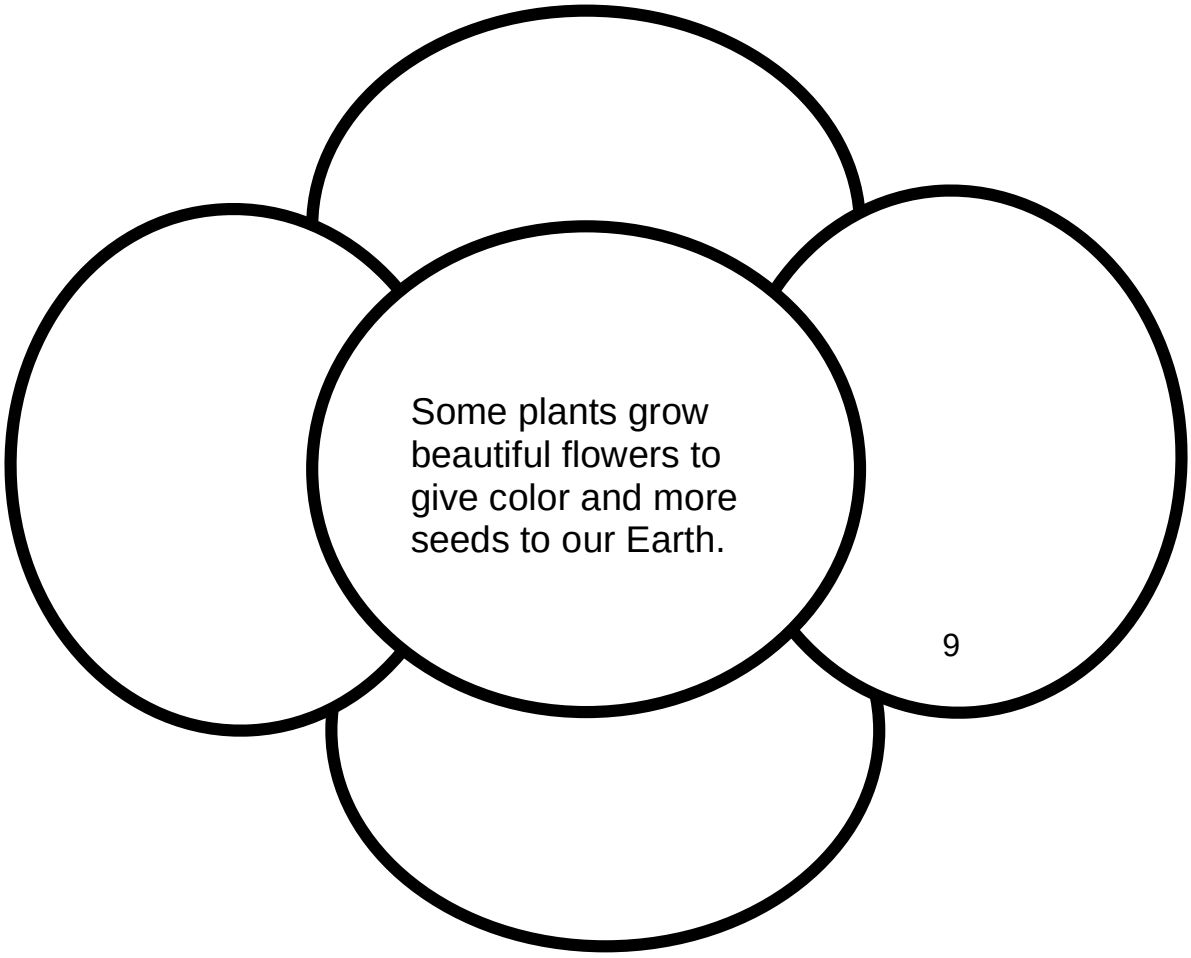

Plants use the sun's light to make their own food. Plants take **nutrients** and **minerals** from the soil.
4

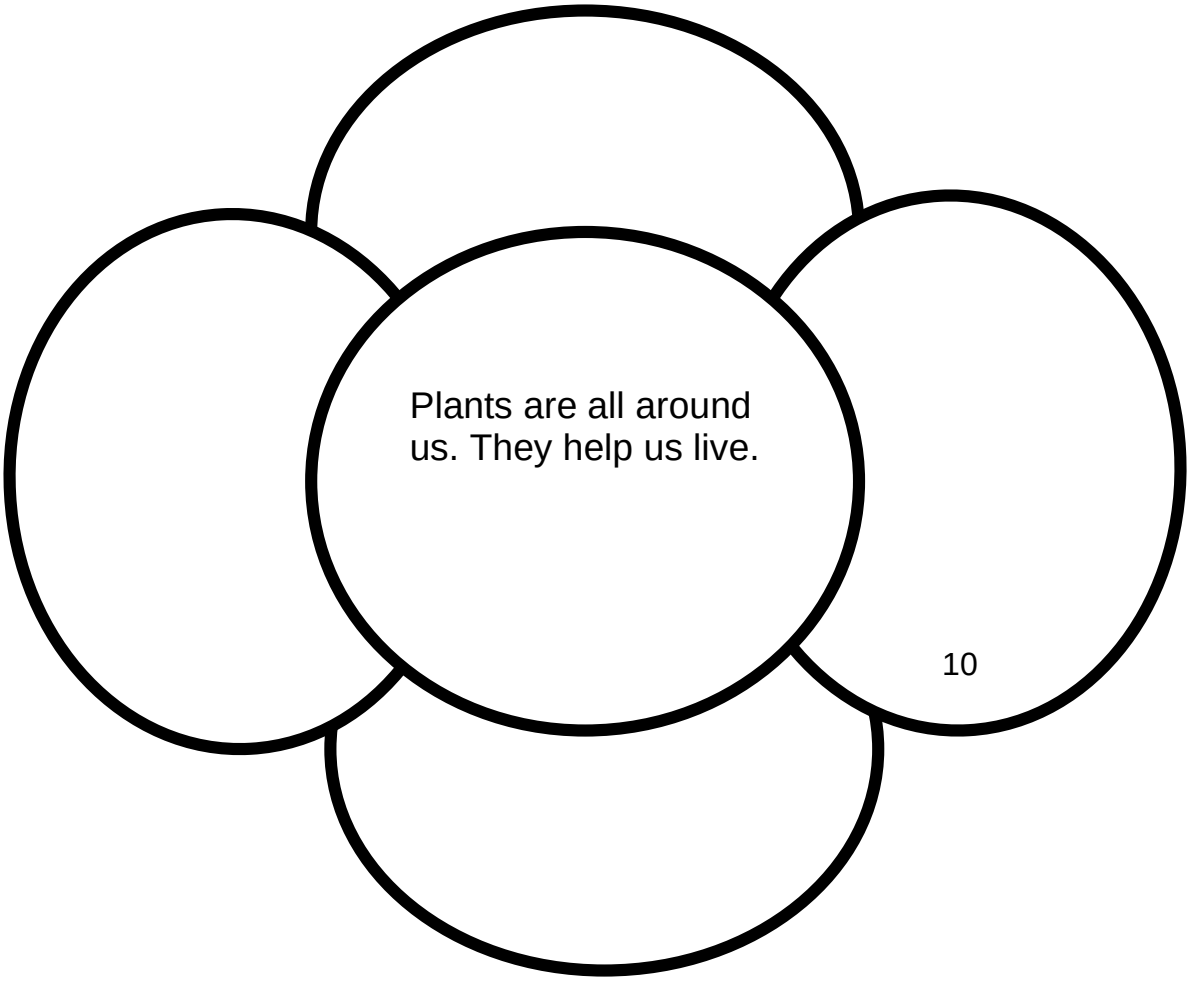

People use many different kinds of plants.
5

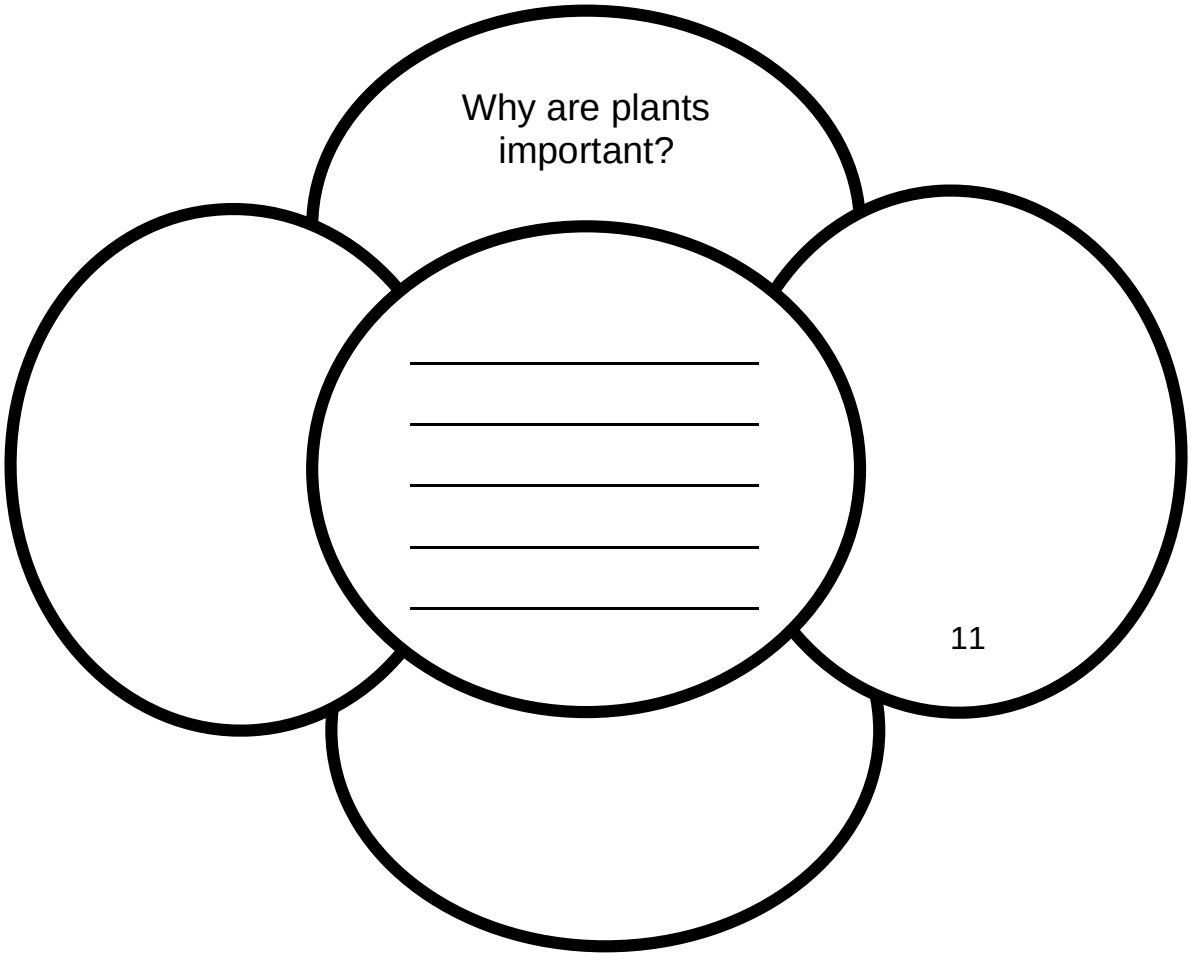

Many plants give us food. Strawberries, tomatoes, potatoes, lettuce and carrots all come from plants.
6


People use the leaves from basil, mint and oregano plants to season foods.
7


Some plants are used to make medicines. People use gel from Aloe plants for cuts and burns.
8


Some plants grow beautiful flowers to give color and more seeds to our Earth.
9


Plants are all around us. They help us live.
10


Why are plants important?
11

Food From Plants

Name _____

Draw and label four foods that come from plants.

Which is your favorite food? Explain why this is your favorite food.

Seeds and Plants on Earth

Name _____

1. What is needed for these seeds to germinate on Earth? Illustrate and label.

2. What is needed for this plant to grow on Earth? Illustrate and label.

3. List the items from above that are Earth's natural resources.

_____

_____

Name _____

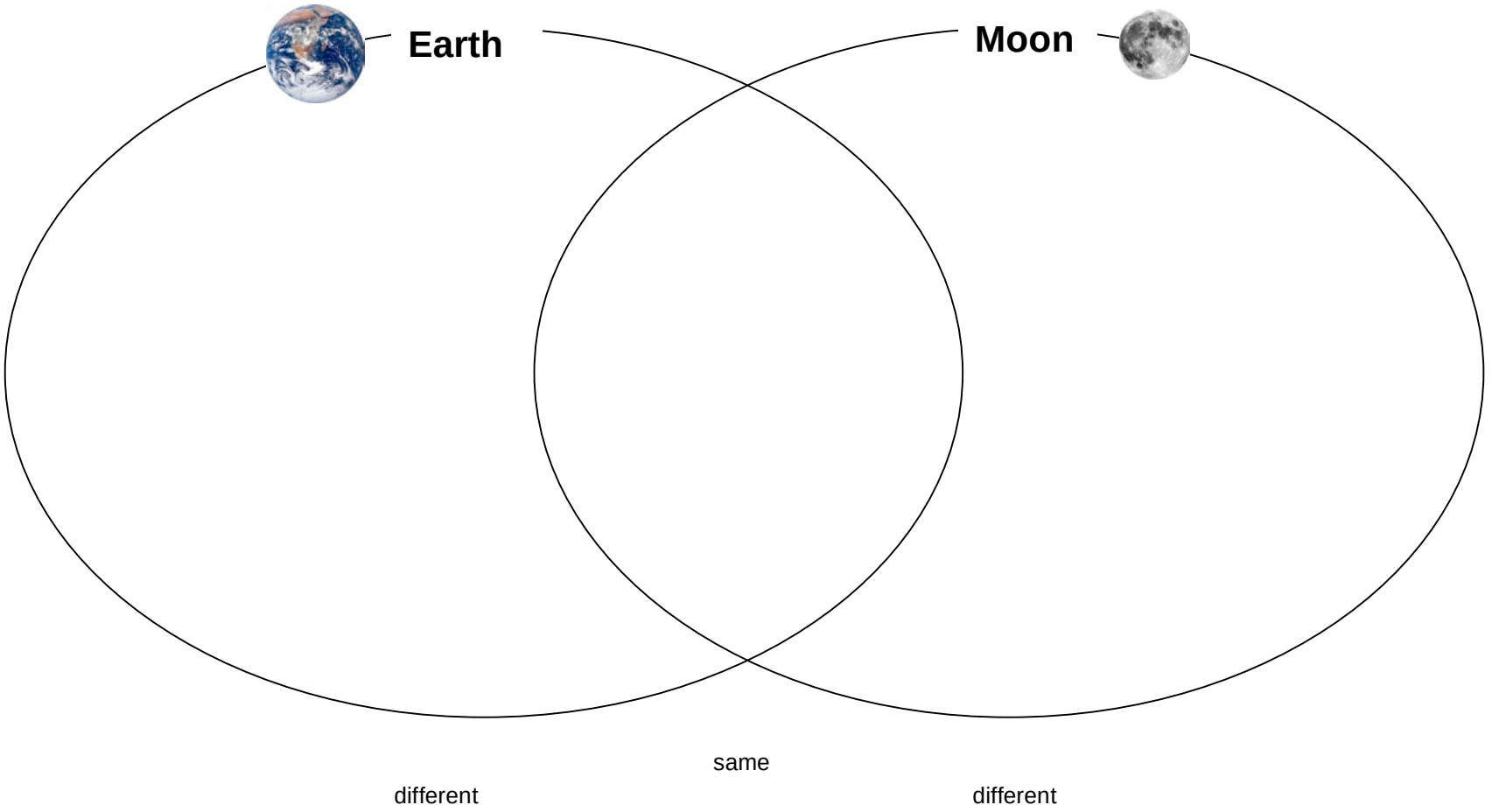
KWL

Moon

Know	Want to Know	Learned
Write at least two things you know about the moon.	Write at least two things you want to know about the moon.	Write at least two things you learned about the moon.

Name _____

Let's compare and contrast the Earth and the moon. List words to describe each one in the correct spaces.



Seeds on the Moon

Name _____

If we planted some seeds on the moon do you think they would grow? Use information from what we have read to explain your answer.

Plant Growth Chamber Engineer

Name _____

What would you put in a lunar plant growth chamber if you were an engineer designing and building one? Explain your answer.

Our Moon

Name _____

Let's blast off and learn about the moon!

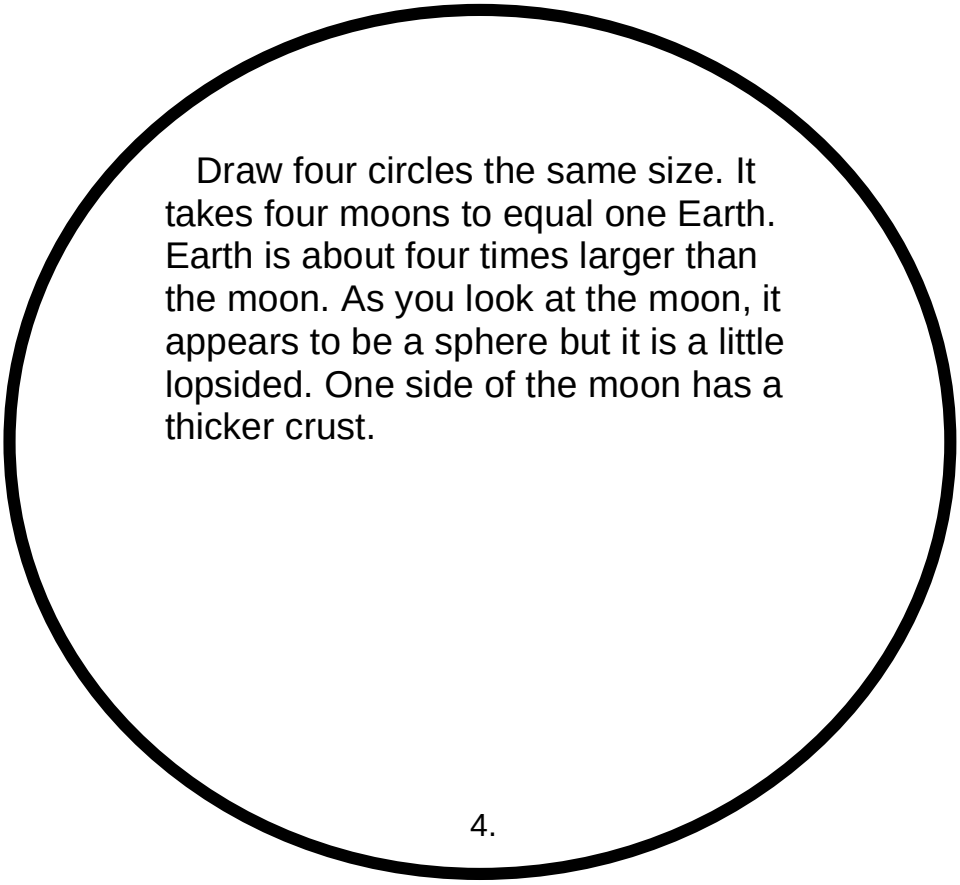
1.

The moon is about 240,000 miles, or about 382,400 kilometers from Earth. It would take two to four days to travel there on a spacecraft.

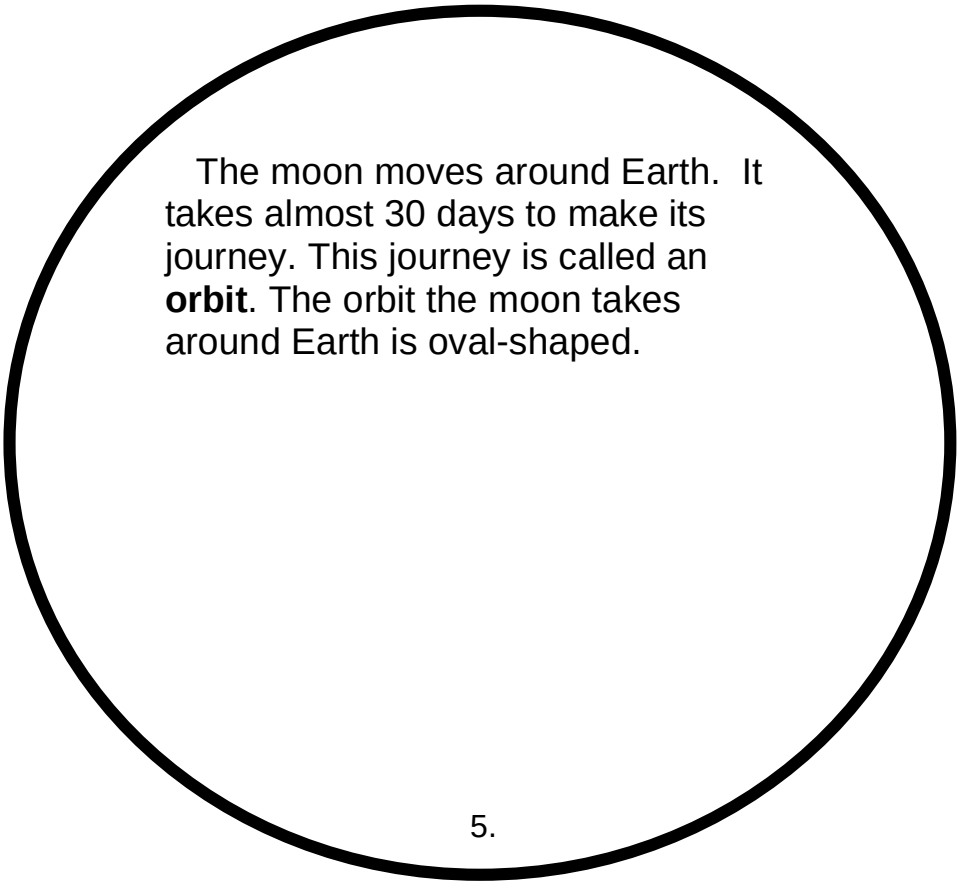
2.

Scientists believe the moon is about 4.6 billion years old.

3.


Draw four circles the same size. It takes four moons to equal one Earth. Earth is about four times larger than the moon. As you look at the moon, it appears to be a sphere but it is a little lopsided. One side of the moon has a thicker crust.

4.


The moon moves around Earth. It takes almost 30 days to make its journey. This journey is called an **orbit**. The orbit the moon takes around Earth is oval-shaped.

5.

As we look at the moon each evening, it appears to change shape. The different shapes you see are called the “**phases** of the moon.”

6.

You can see the moon because of the sun. The light you see on the moon at night is really the reflection of the sun.

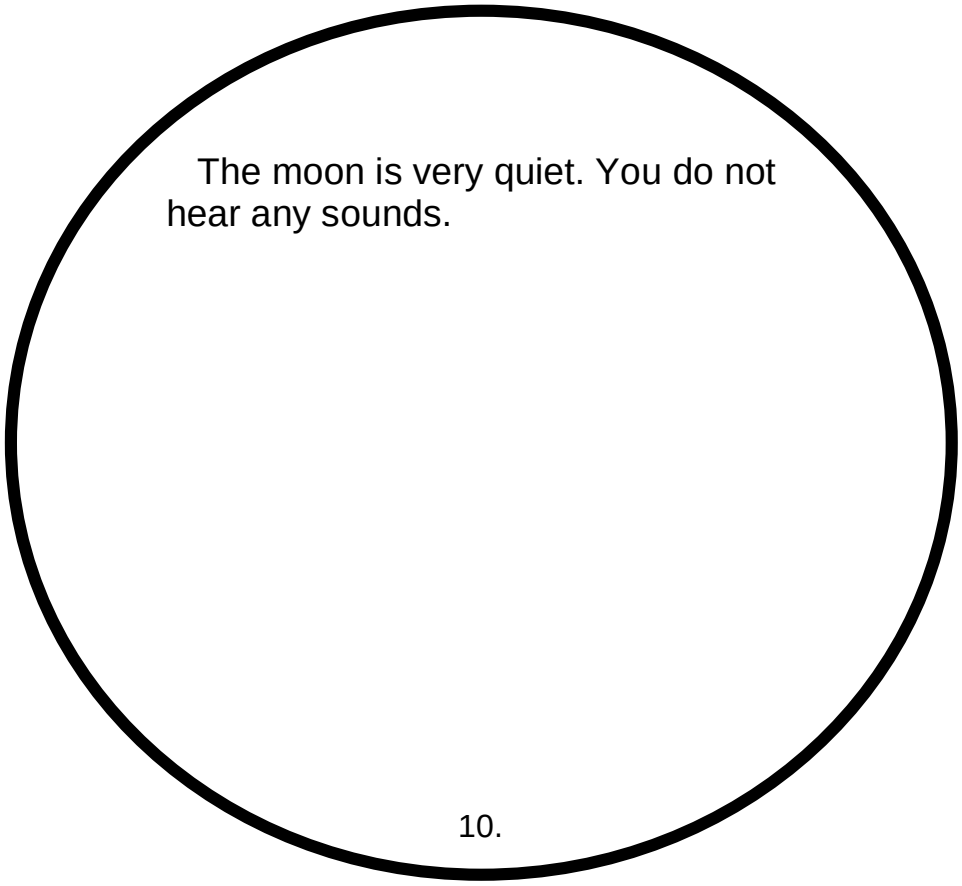
7.

When you step on the moon, the surface is like a powder. In some places it is 12 inches, or 30 centimeters, deep. The moon's surface has a lot of rocks. The powder and the rocks are the moon's natural resources.

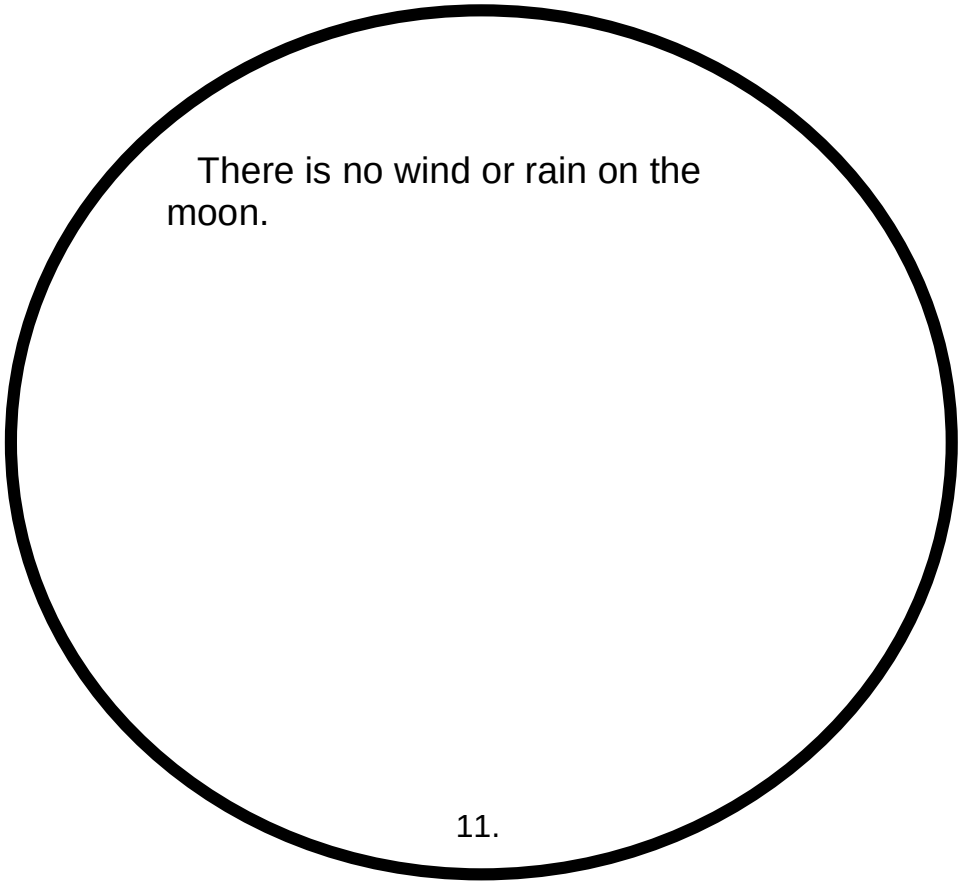
8.

Look around. You see lots of different landforms: mountains, valleys, wide flat plains and hills. There are many deep holes, which are called **craters**. Rocks and stones fly through space. Sometimes, they hit the moon and make craters.

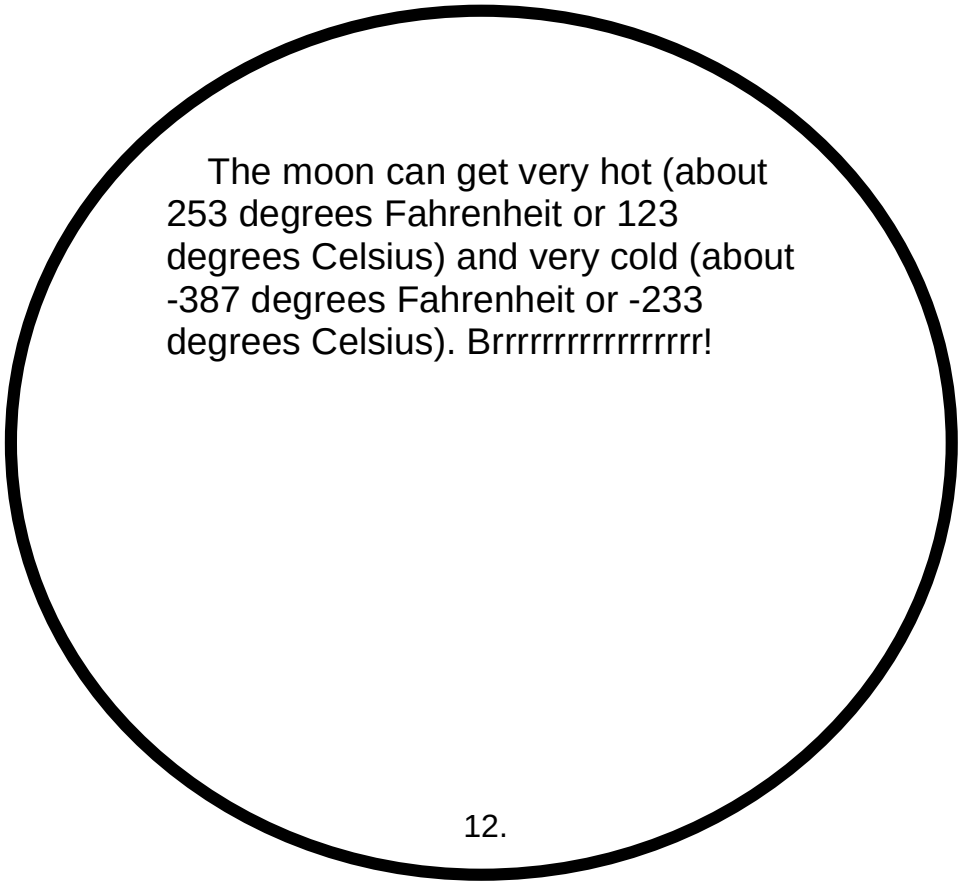
9.


The moon is very quiet. You do not hear any sounds.

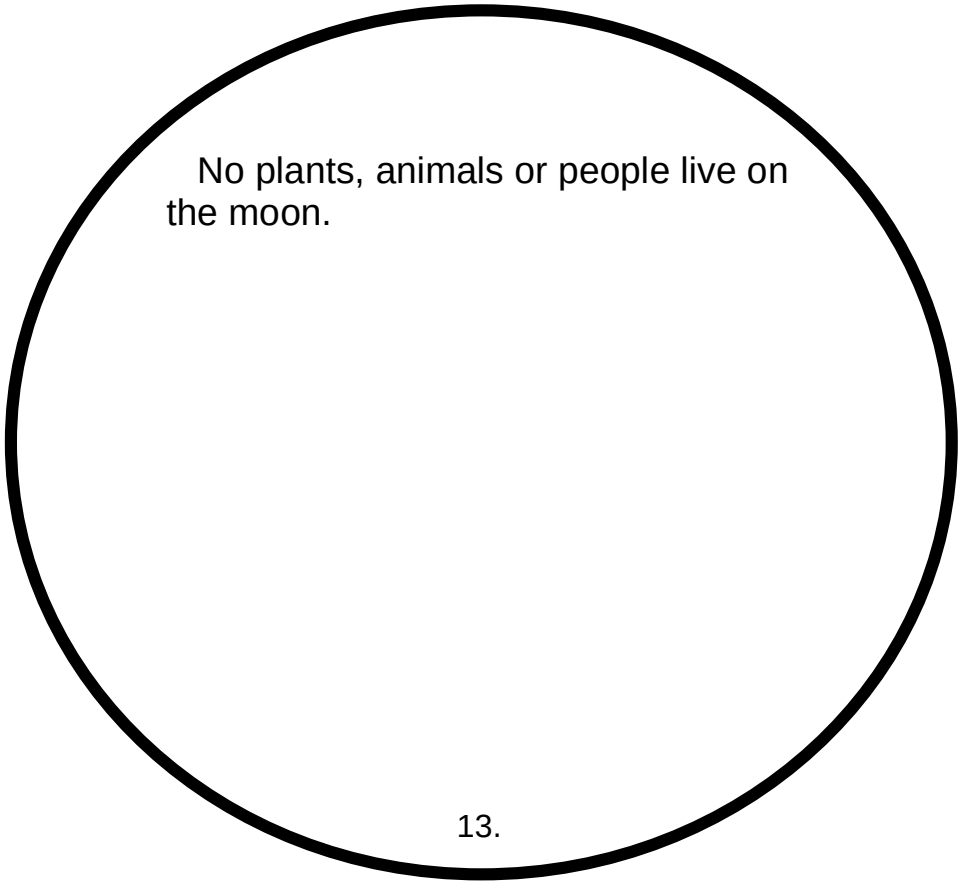
10.


There is no wind or rain on the moon.

11.


The moon can get very hot (about 253 degrees Fahrenheit or 123 degrees Celsius) and very cold (about -387 degrees Fahrenheit or -233 degrees Celsius). Brrrrrrrrrrrrrrrr!

12.


No plants, animals or people live on the moon.

13.

The moon has gravity, but not as much as Earth. If you weigh 60 pounds on Earth, you would only weigh 10 pounds on the moon. Watch out, your steps will be like leaps!

14.

Maybe one day you will take a “leap” on the moon!

15.

Would you like to be an astronaut one day and travel to the moon? Why or why not?

16.

If people were to live on the moon, what would they need to survive?

17.

Parts of an Electrical Circuit

Name _____

Illustrate and label each object your teacher shows you. Write a sentence explaining what you think each one does.

1.

2.

3.

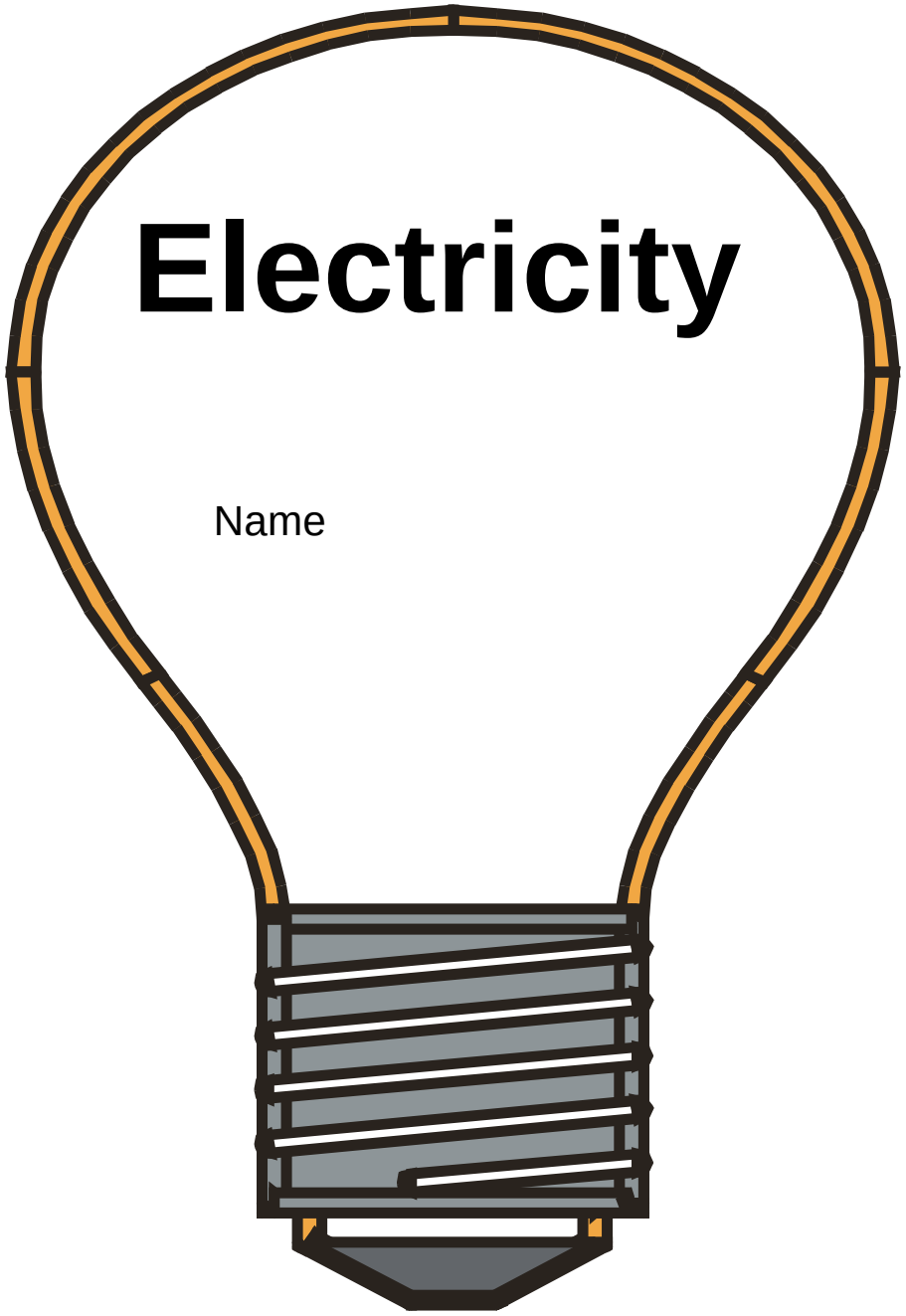
4.

5.

6.

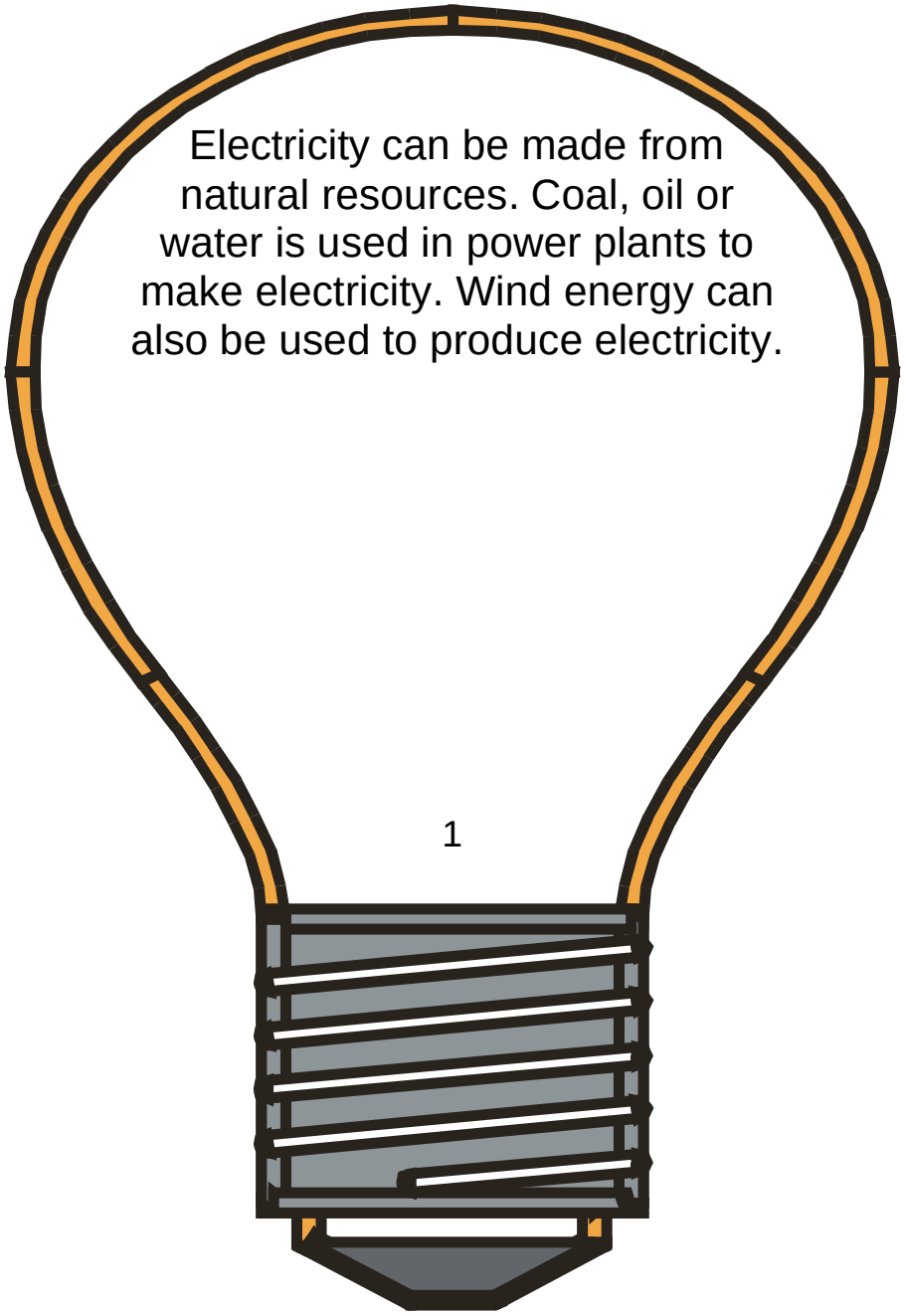
Electricity

Name



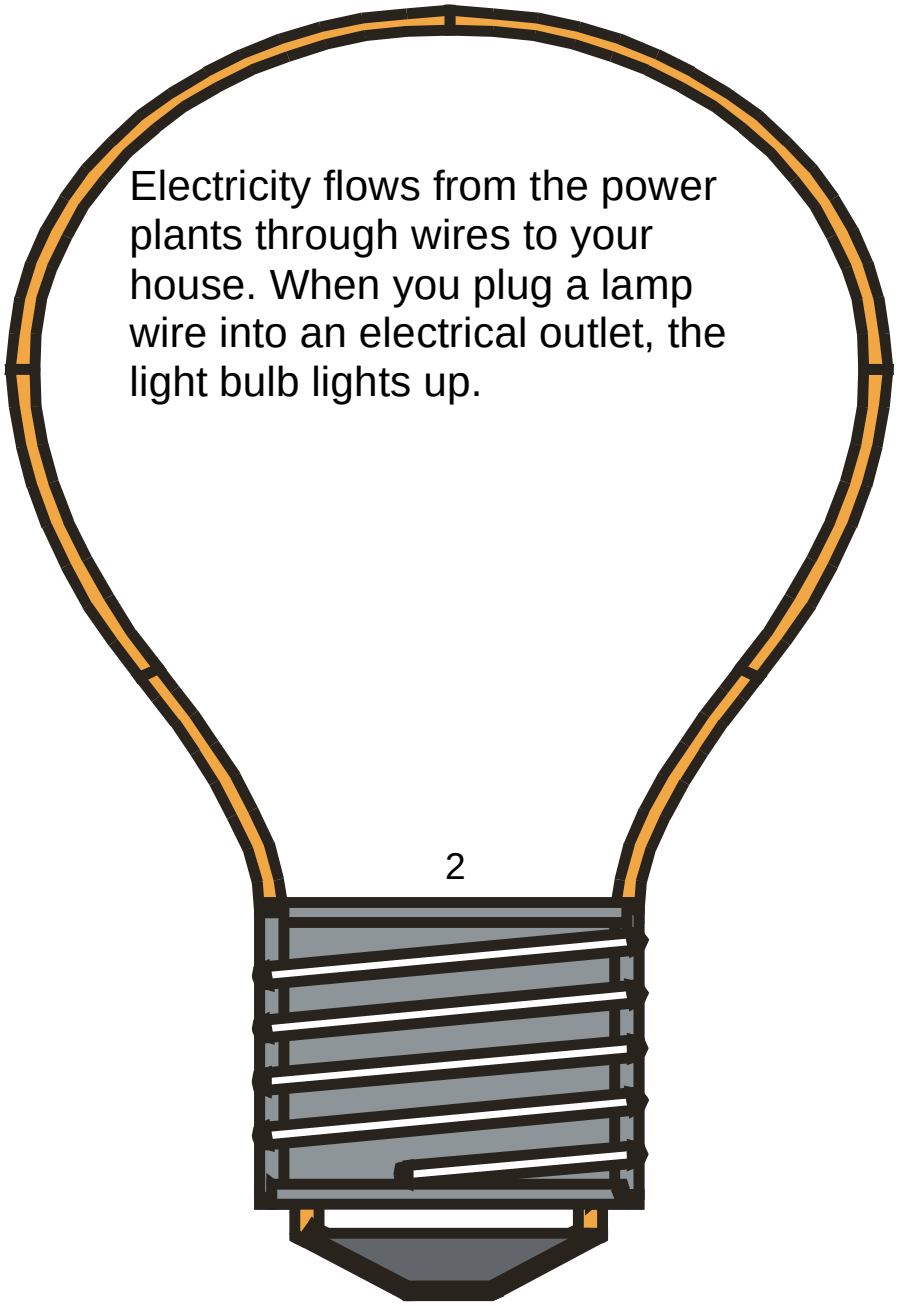
Electricity can be made from natural resources. Coal, oil or water is used in power plants to make electricity. Wind energy can also be used to produce electricity.

1



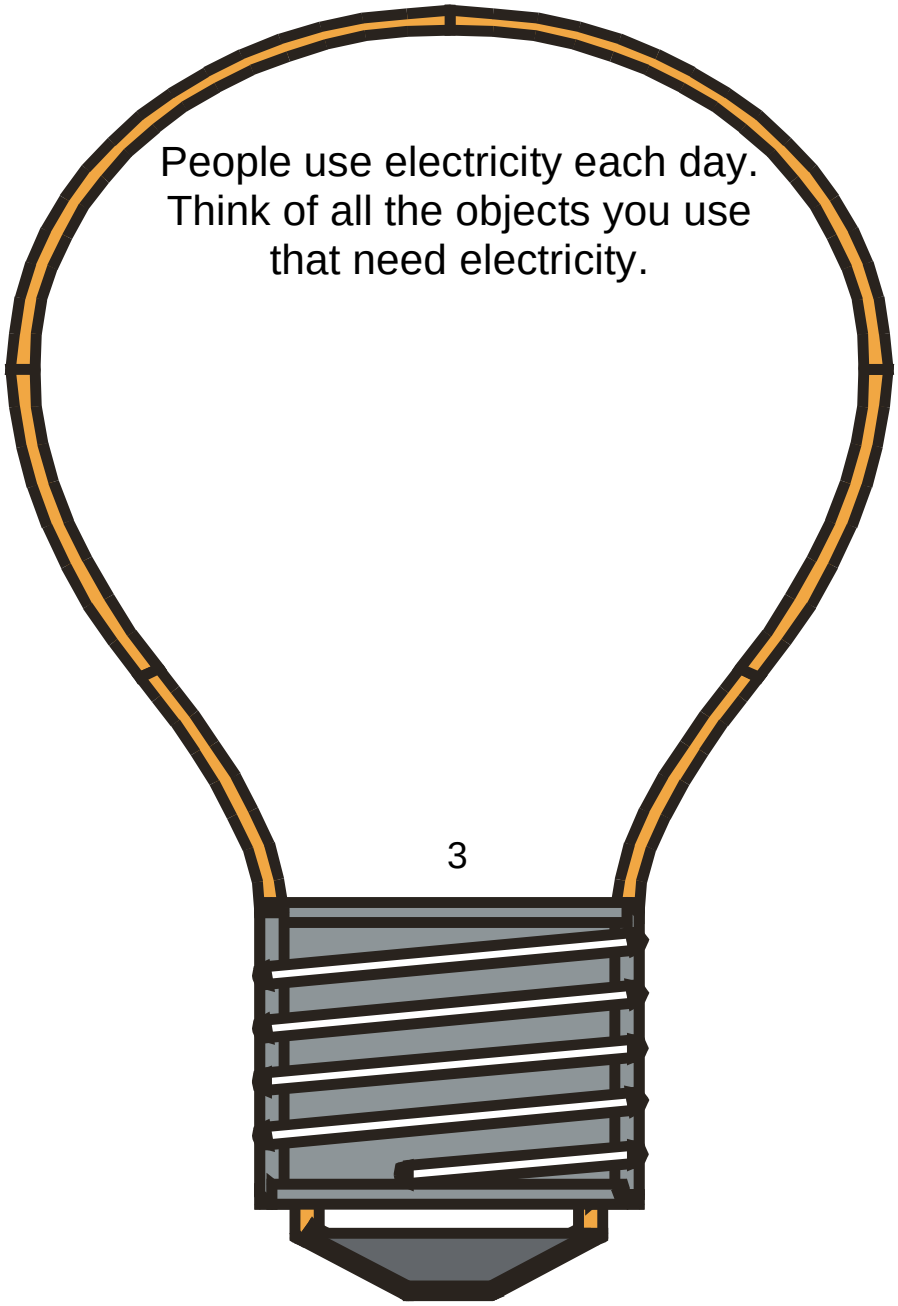
Electricity flows from the power plants through wires to your house. When you plug a lamp wire into an electrical outlet, the light bulb lights up.

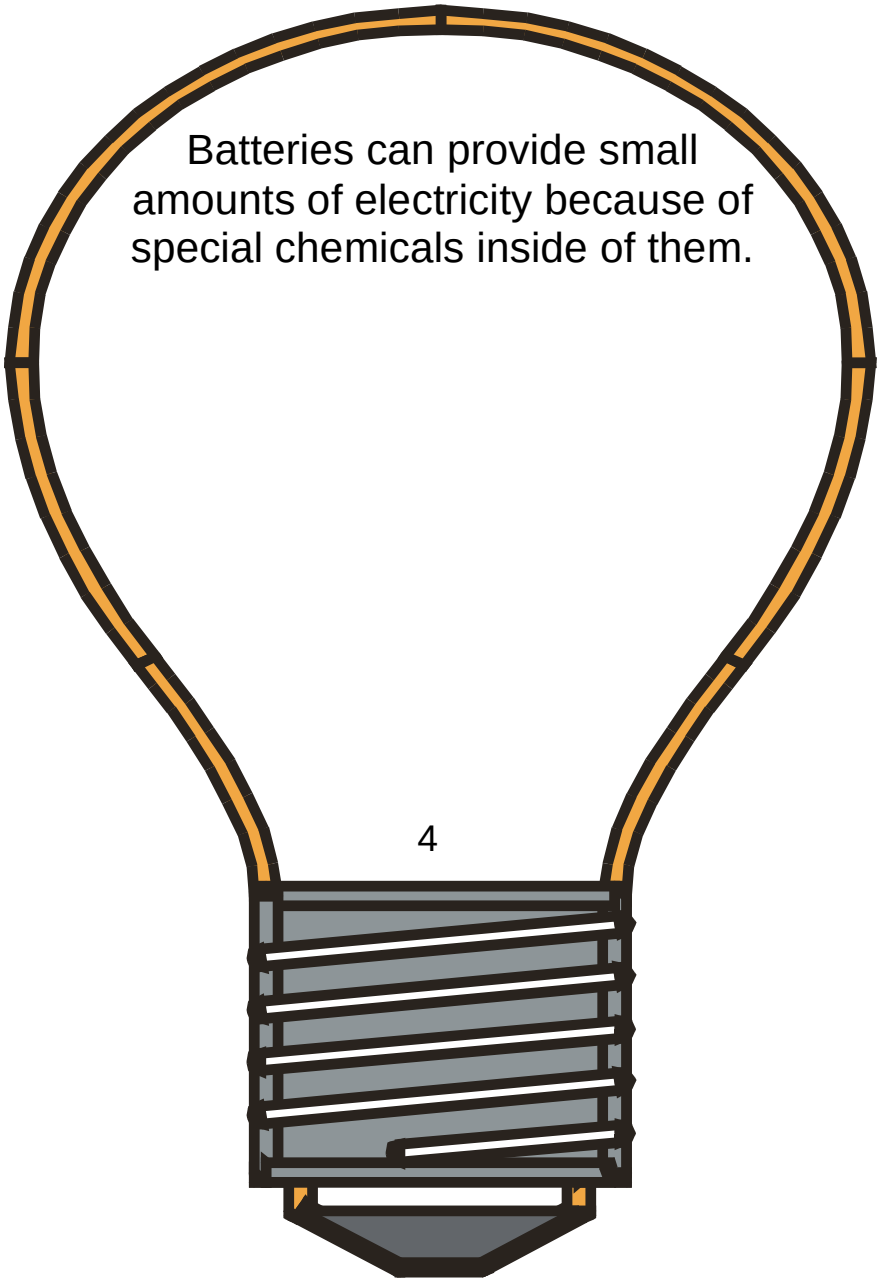
2

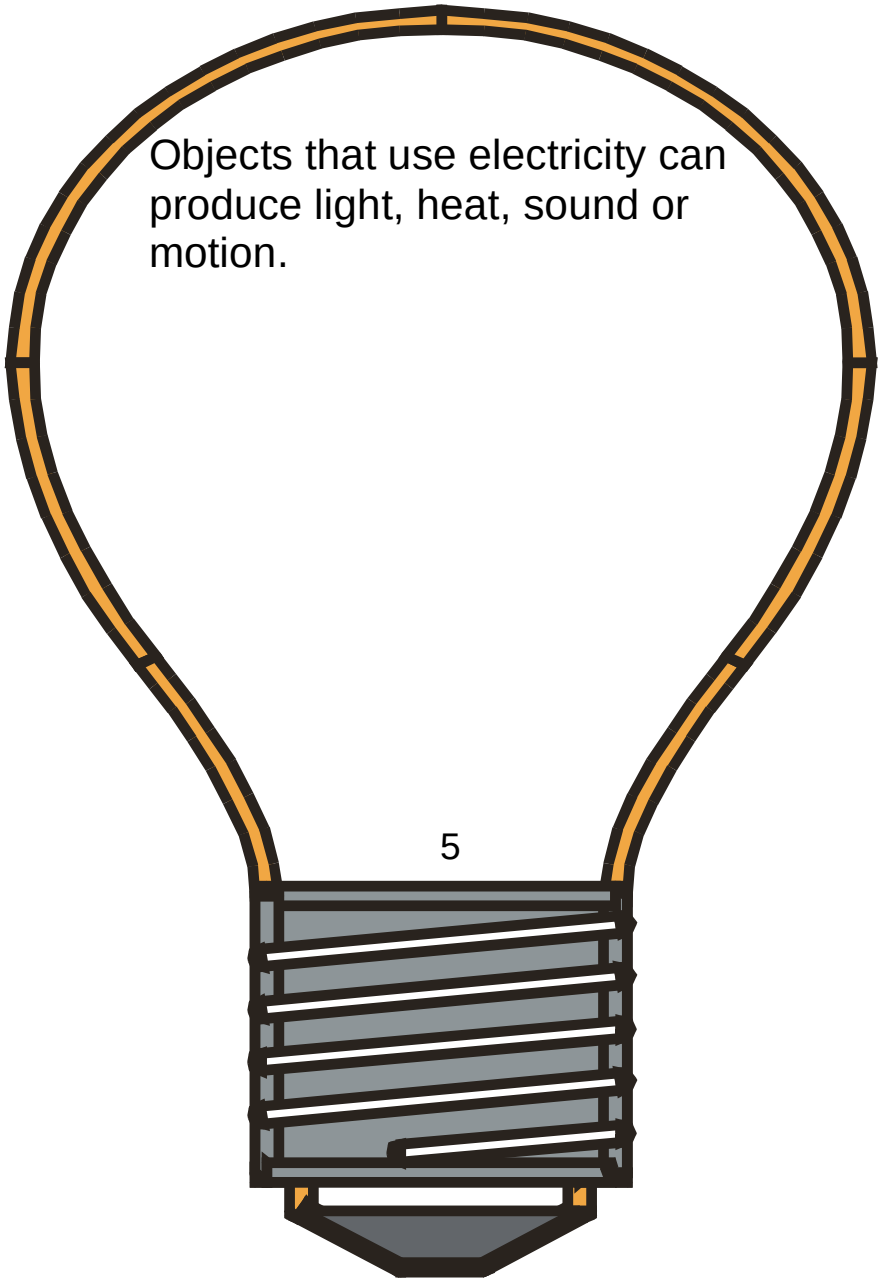


People use electricity each day. Think of all the objects you use that need electricity.

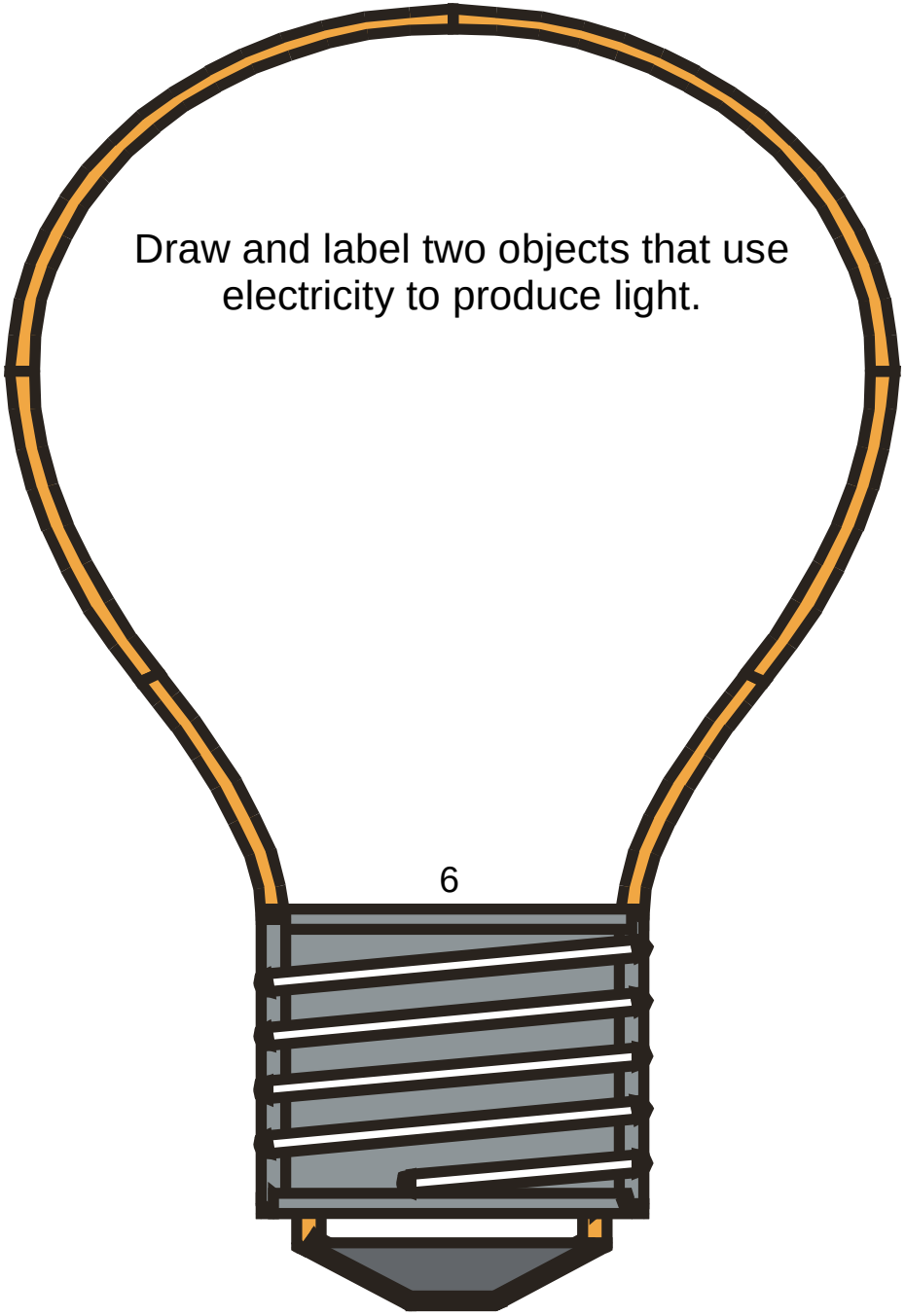
3




Batteries can provide small amounts of electricity because of special chemicals inside of them.
4

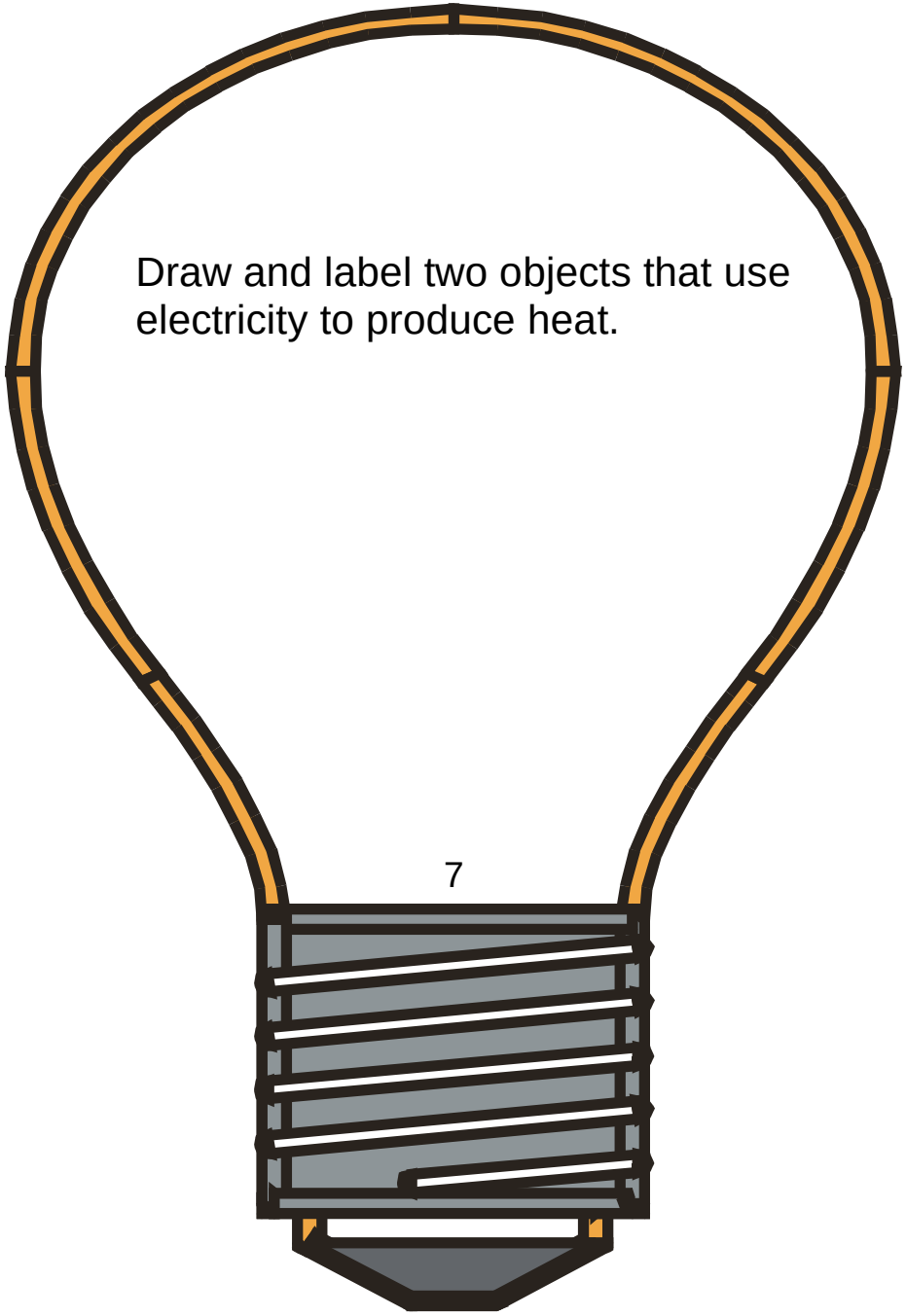

Objects that use electricity can produce light, heat, sound or motion.
5

Draw and label two objects that use electricity to produce light.

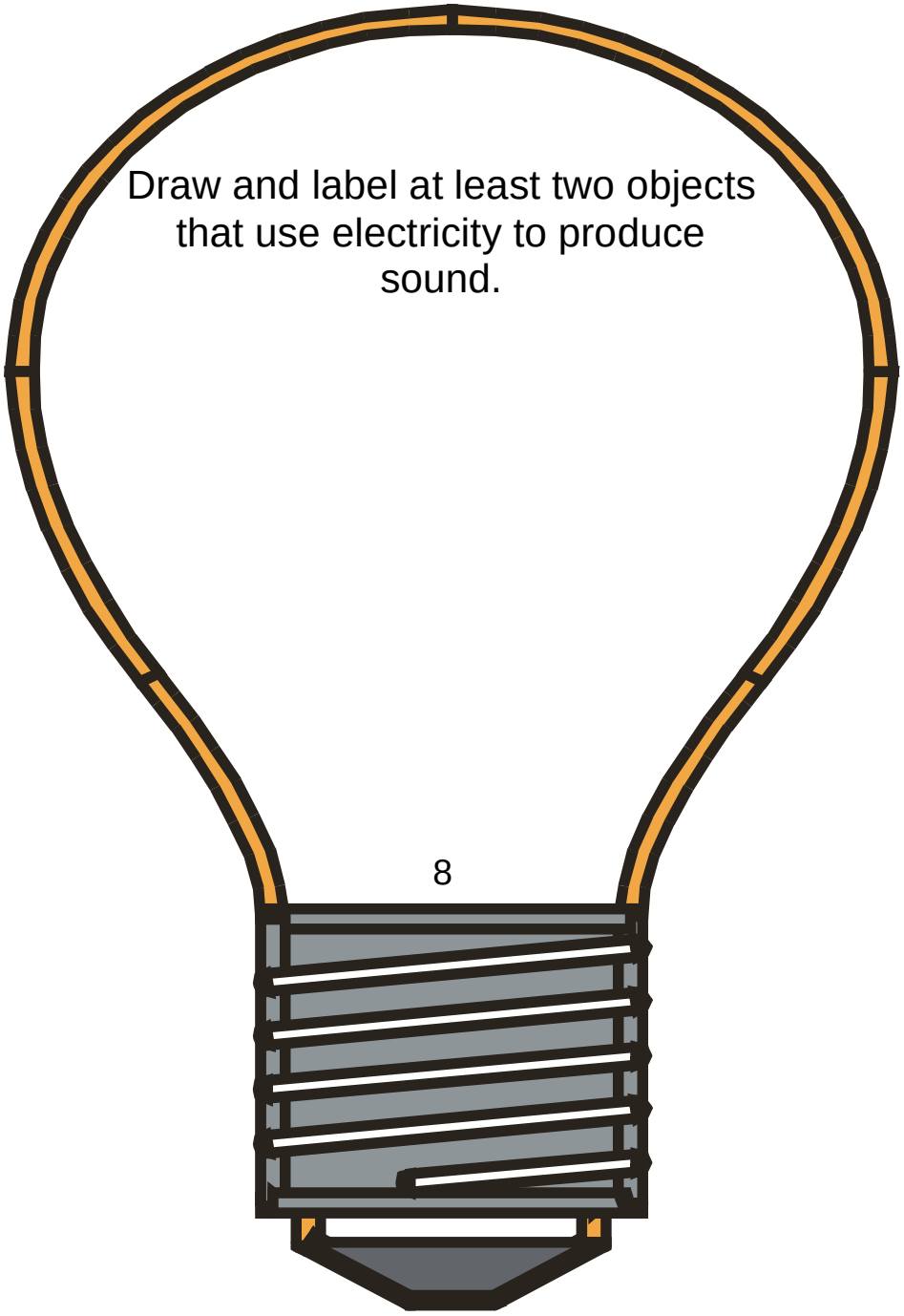


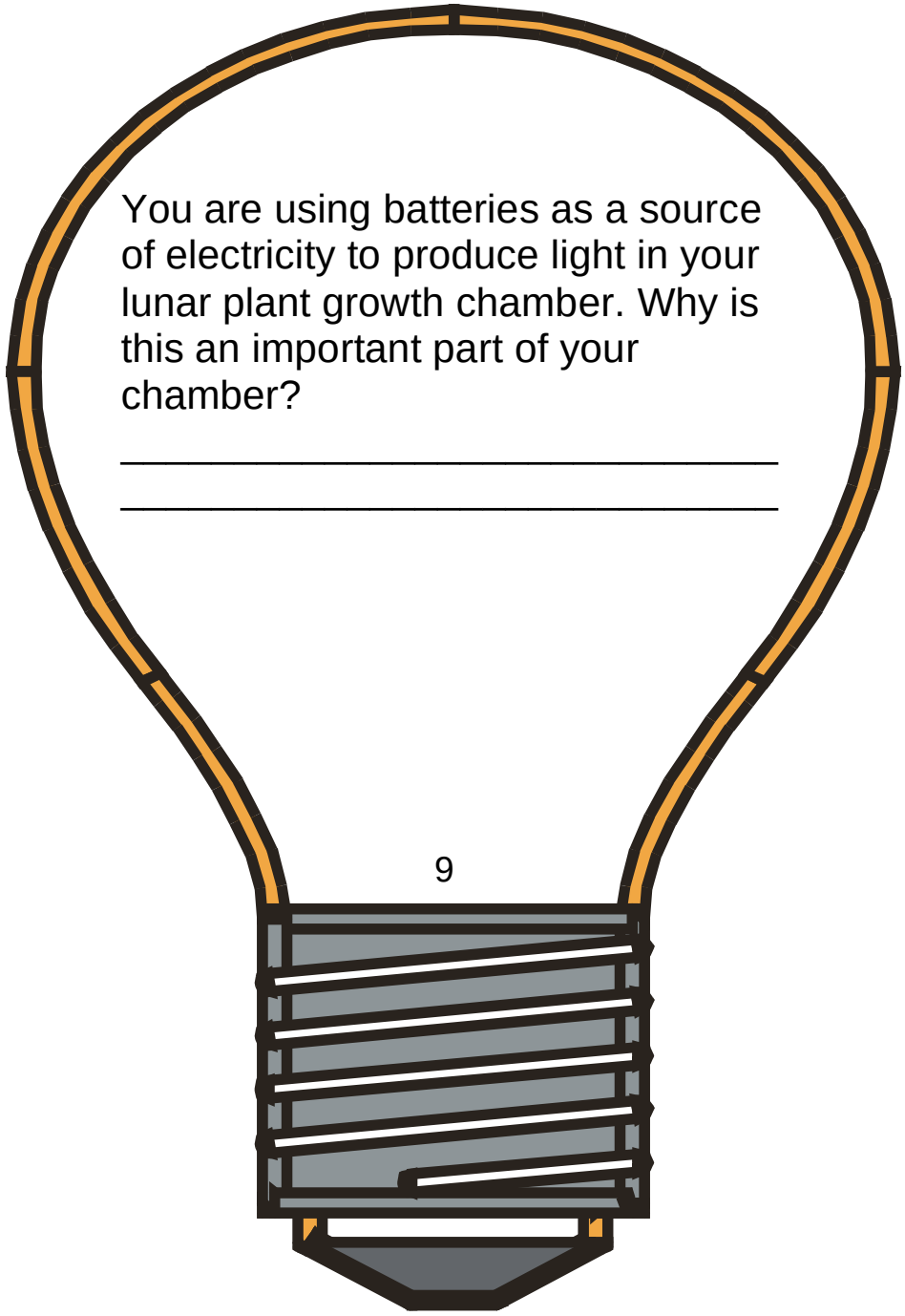
6

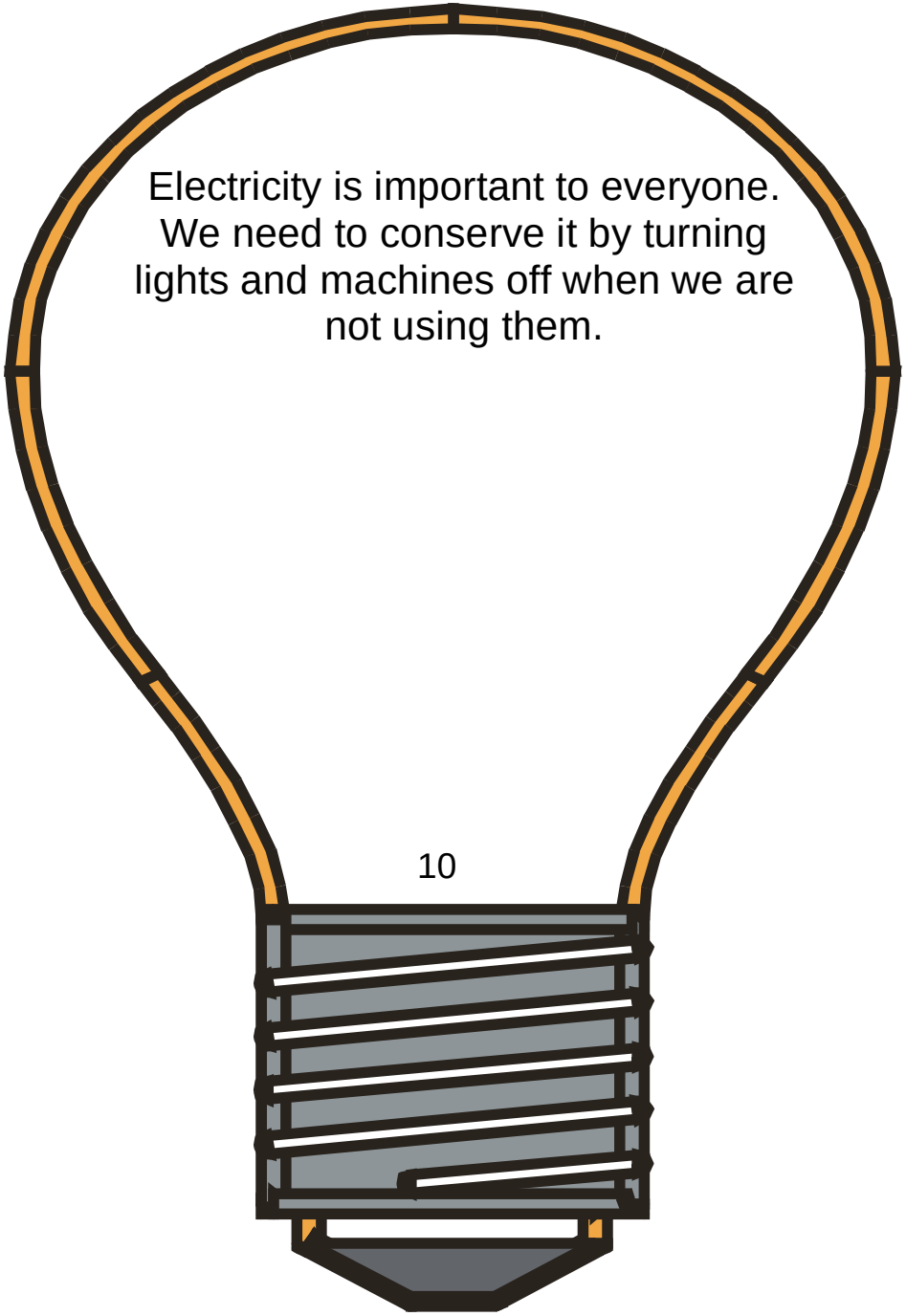
Draw and label two objects that use electricity to produce heat.



7

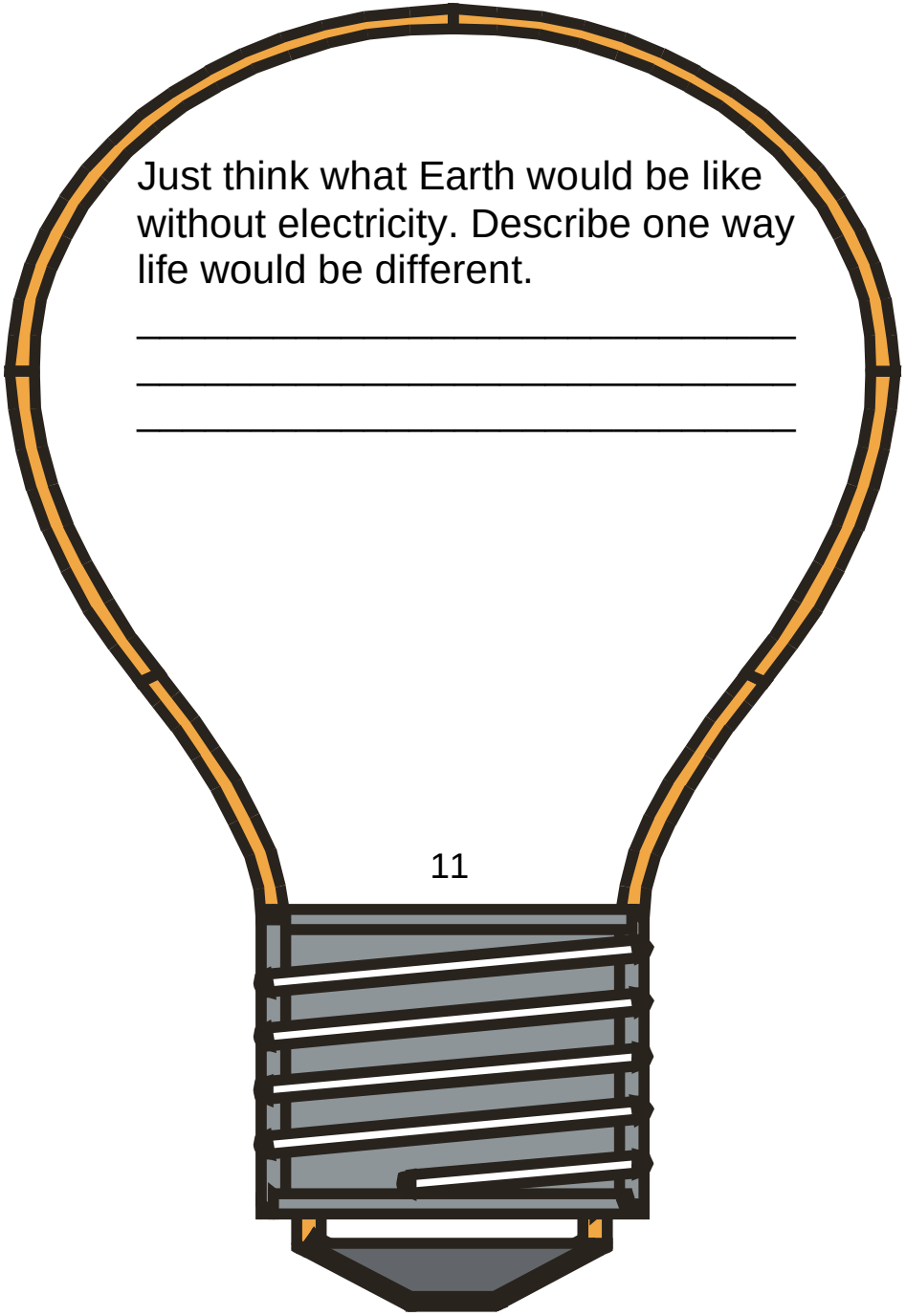

Draw and label at least two objects that use electricity to produce sound.
8


You are using batteries as a source of electricity to produce light in your lunar plant growth chamber. Why is this an important part of your chamber?
_____
_____
9



Electricity is important to everyone. We need to conserve it by turning lights and machines off when we are not using them.

10



Just think what Earth would be like without electricity. Describe one way life would be different.

_____

_____

_____

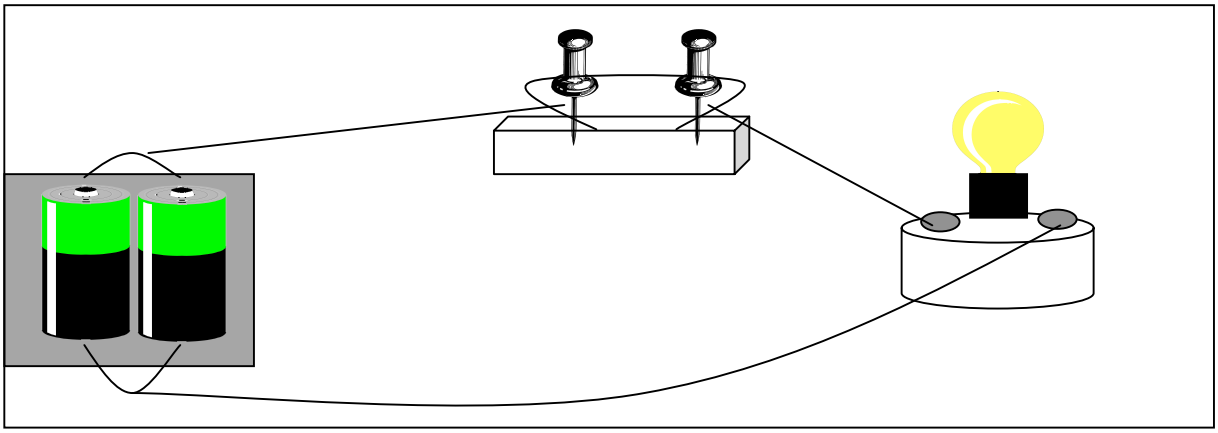
11

Name _____

1. What type of energy did you learn about?

2. What are two sources of electricity?

3. Look at the illustration of the electrical circuit below.
   - Label the following parts: batteries, light bulb, light socket, wires and switch.



4. Write a definition for each part of the circuit.
   - battery
   - light socket
   - light bulb
   - switch
   - wire

5. Will electricity flow through this circuit so that the light can turn on and off? Explain your answer.

About Water

Name _____

Where do you get water from each day?

List three ways you use water.

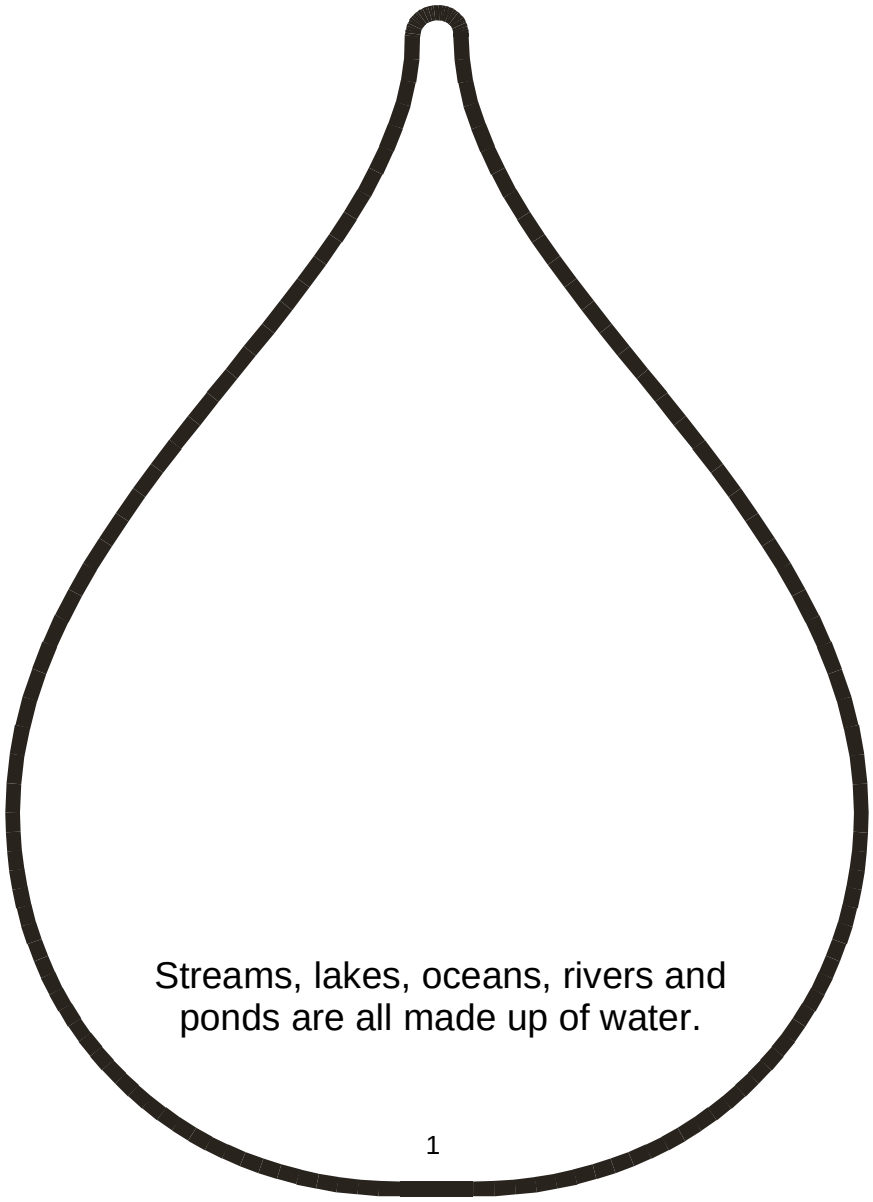
Why is water important to us?

Why is water important to plants?

Illustrate one way you use water.

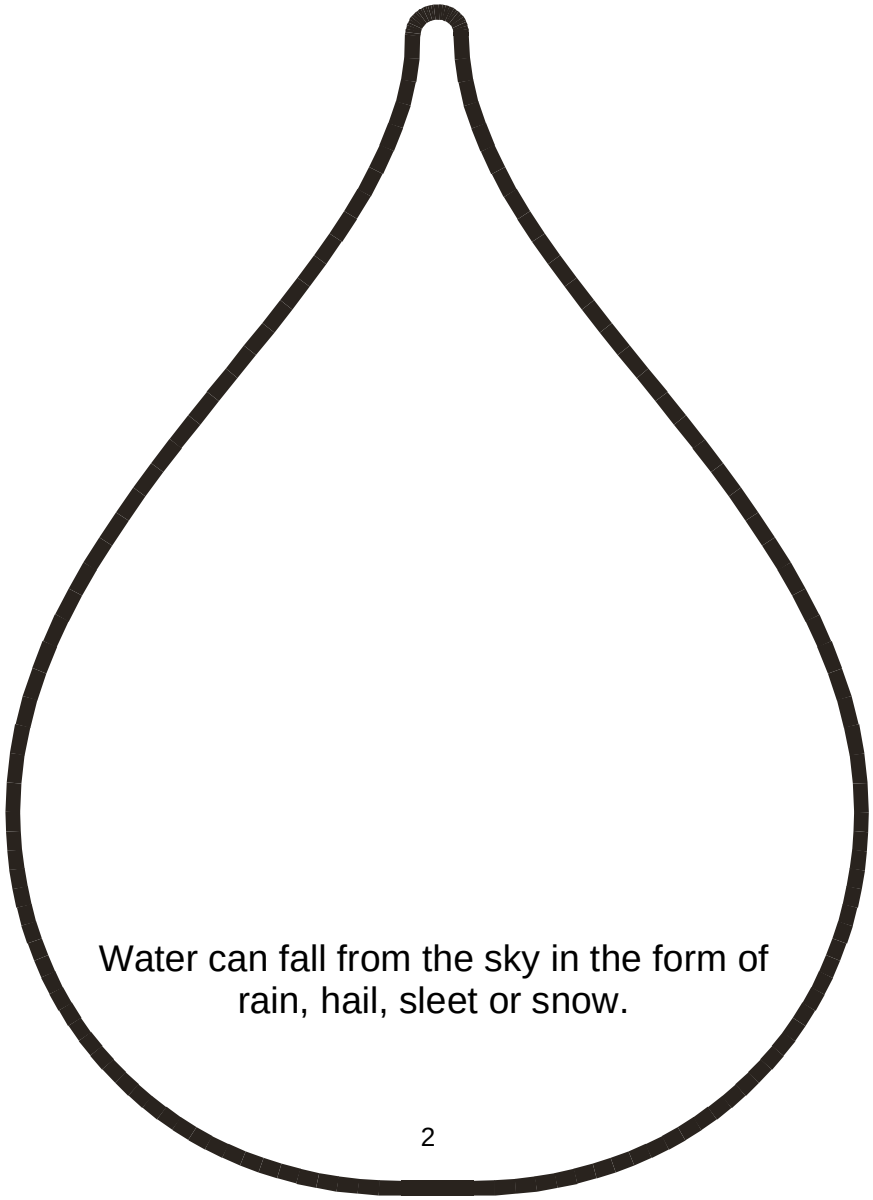
Water

Name _____



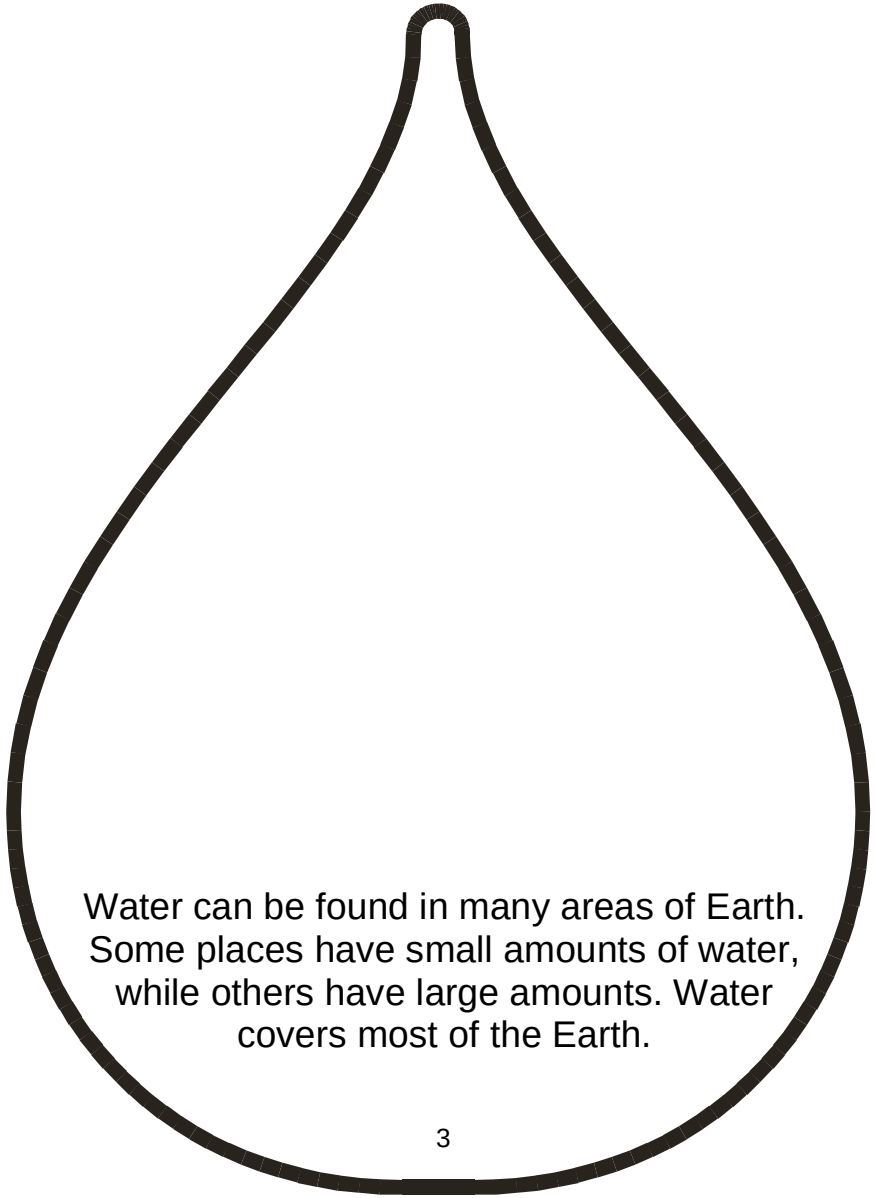
Streams, lakes, oceans, rivers and ponds are all made up of water.

1



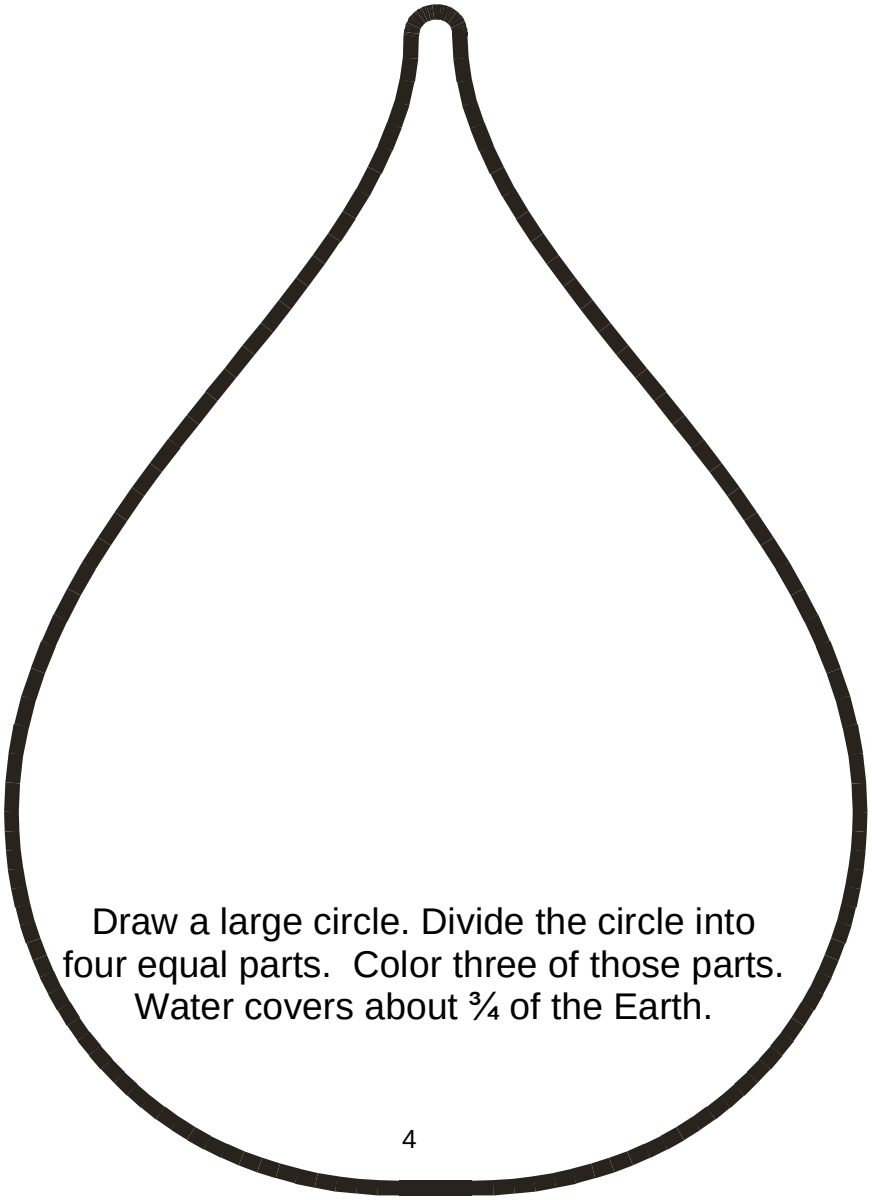
Water can fall from the sky in the form of rain, hail, sleet or snow.

2



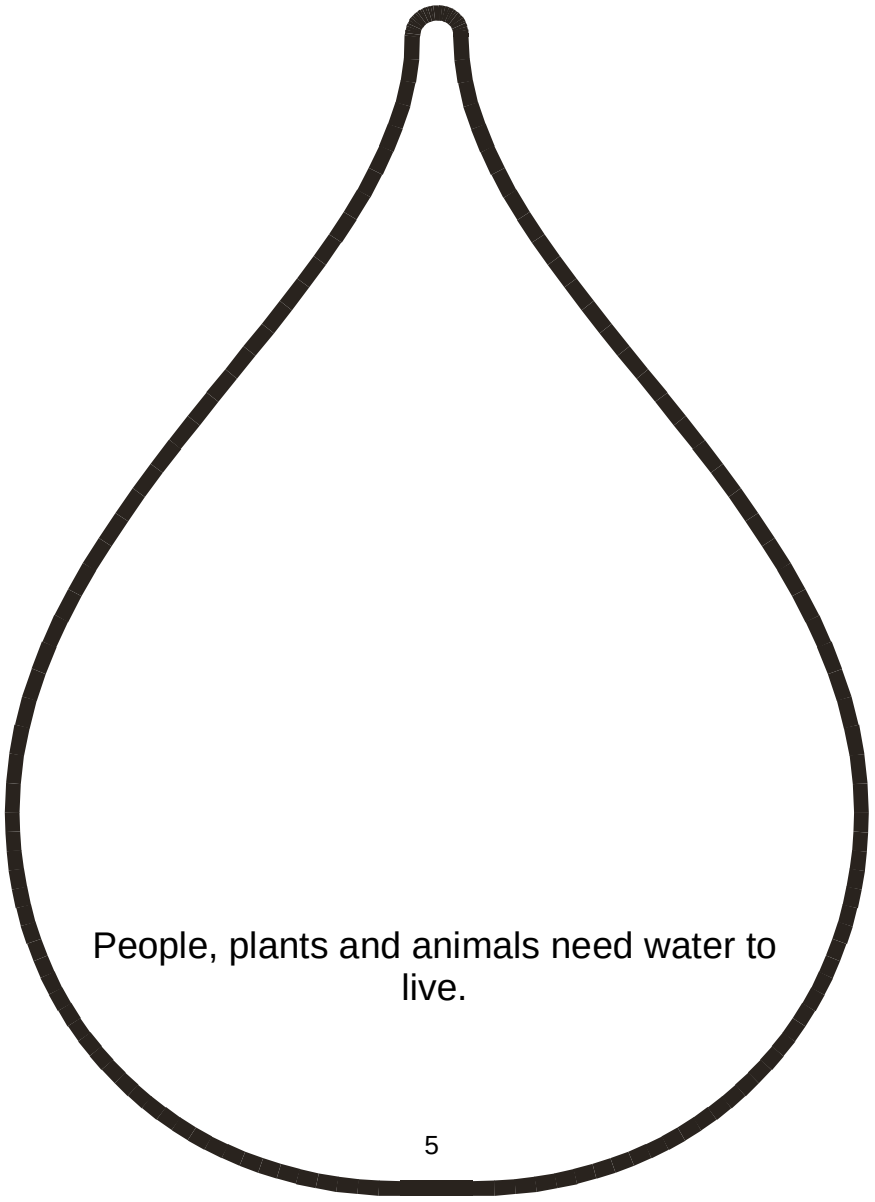
Water can be found in many areas of Earth. Some places have small amounts of water, while others have large amounts. Water covers most of the Earth.

3



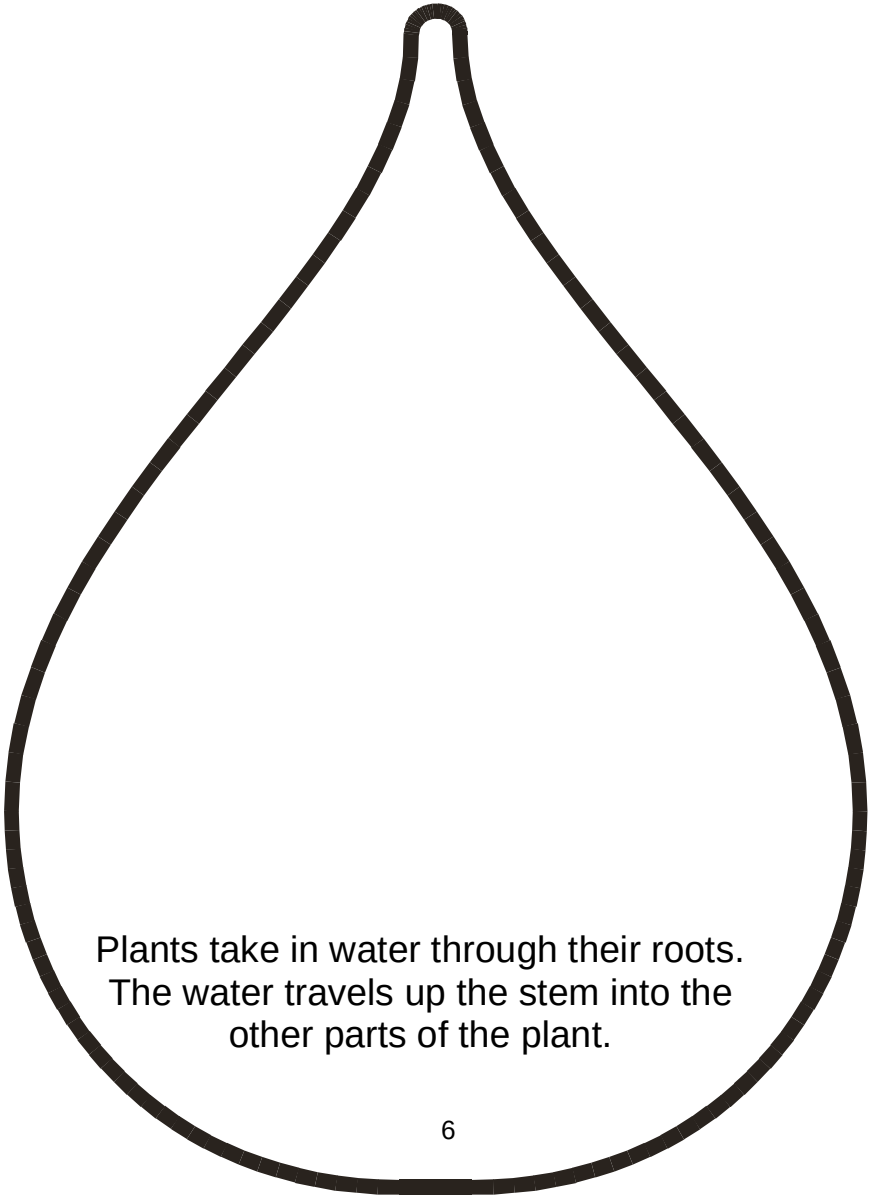
Draw a large circle. Divide the circle into four equal parts. Color three of those parts. Water covers about ¾ of the Earth.

4



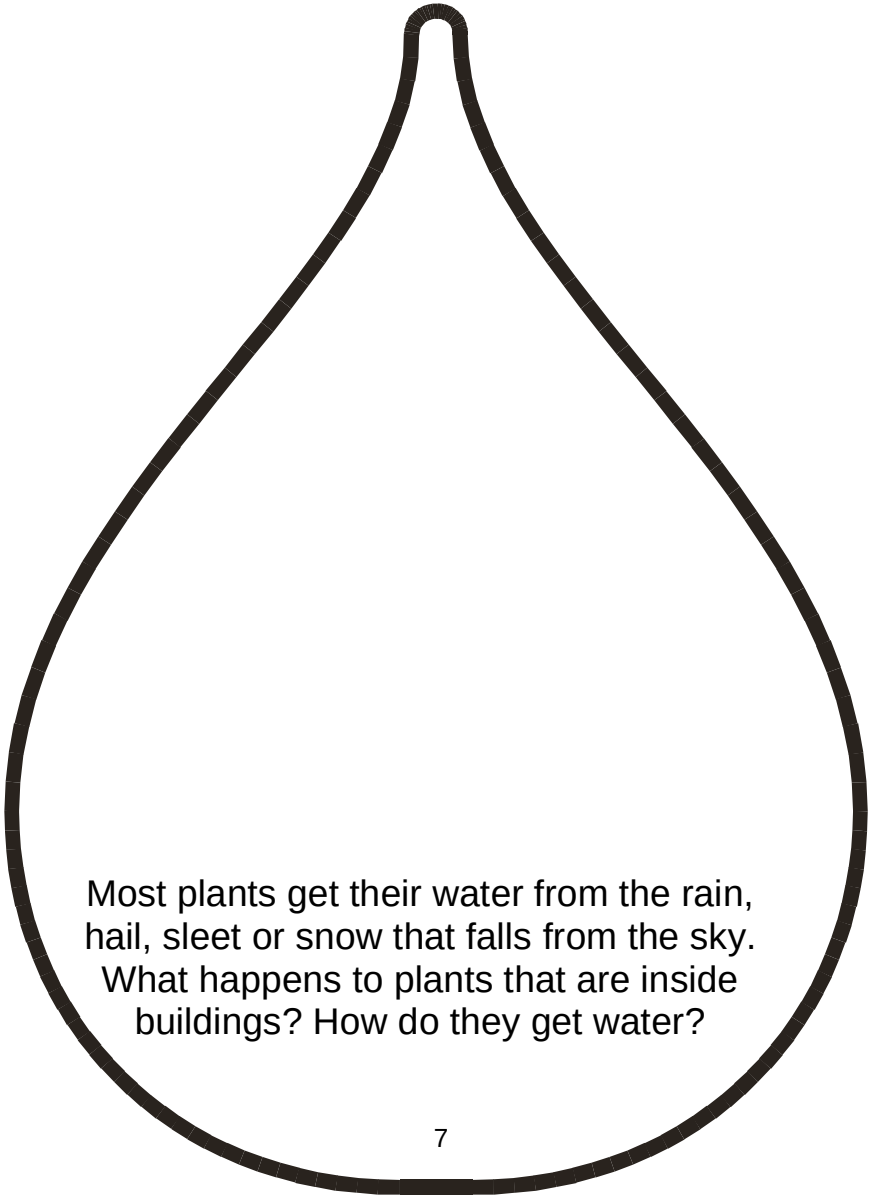
People, plants and animals need water to live.

5



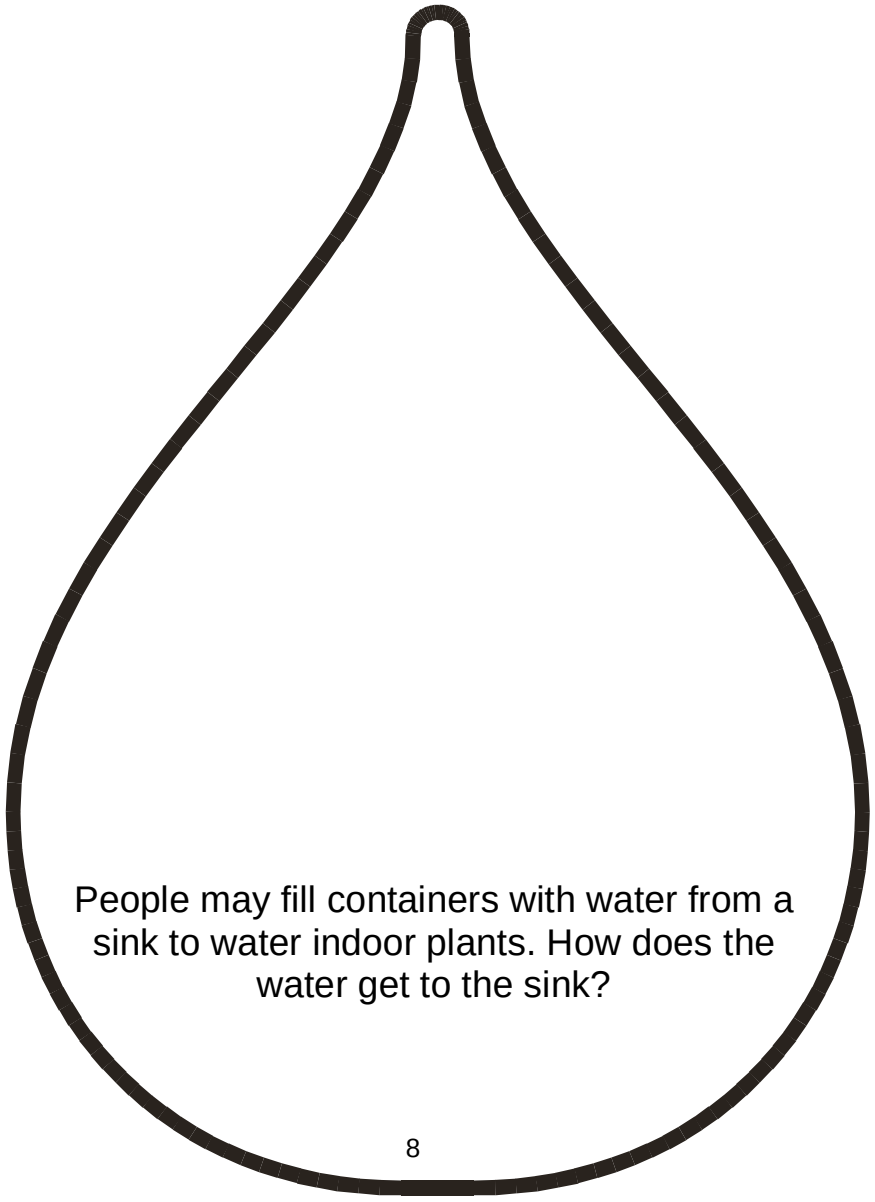
Plants take in water through their roots. The water travels up the stem into the other parts of the plant.

6



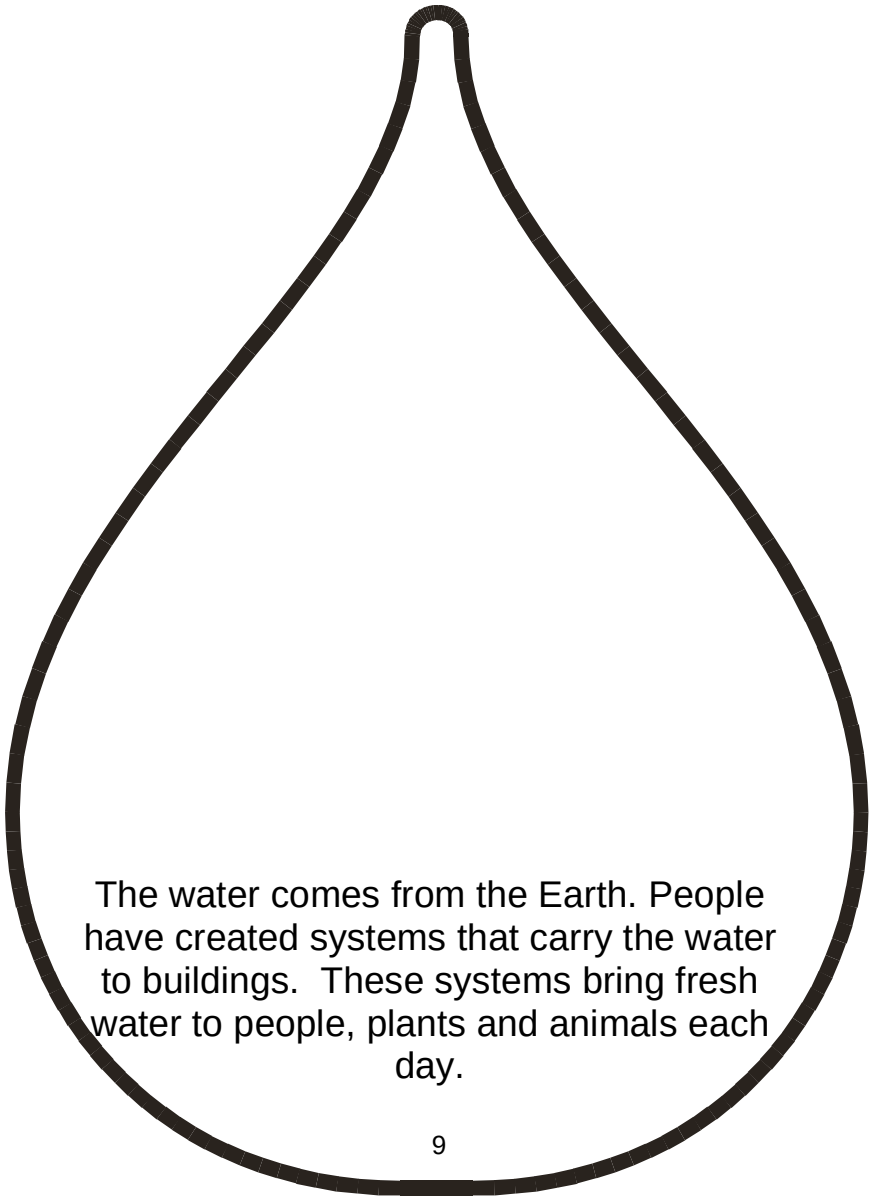
Most plants get their water from the rain, hail, sleet or snow that falls from the sky. What happens to plants that are inside buildings? How do they get water?

7



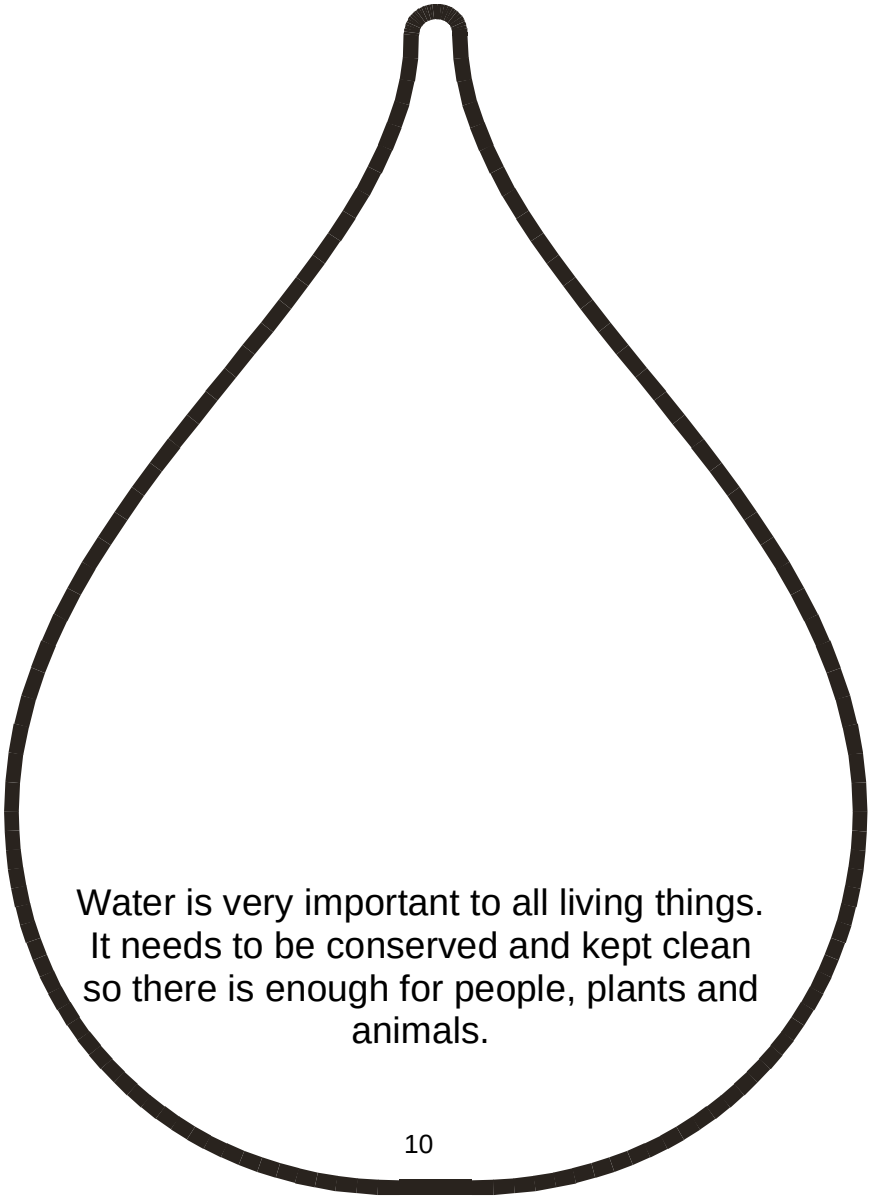
People may fill containers with water from a sink to water indoor plants. How does the water get to the sink?

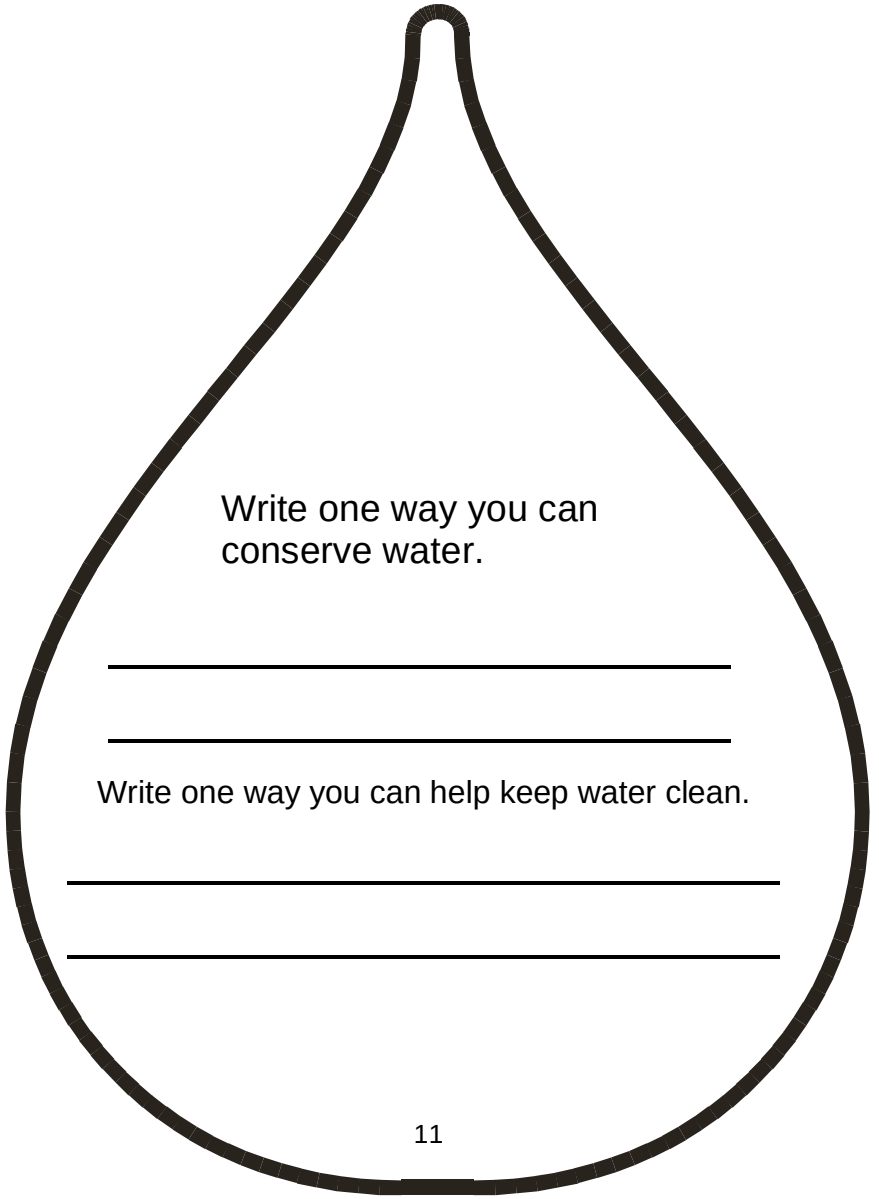
8



The water comes from the Earth. People have created systems that carry the water to buildings. These systems bring fresh water to people, plants and animals each day.

9


Water is very important to all living things. It needs to be conserved and kept clean so there is enough for people, plants and animals.
10


Write one way you can conserve water.
Write one way you can help keep water clean.
11

Engineering Portfolio

Lunar Plant Growth Chamber

Name _____

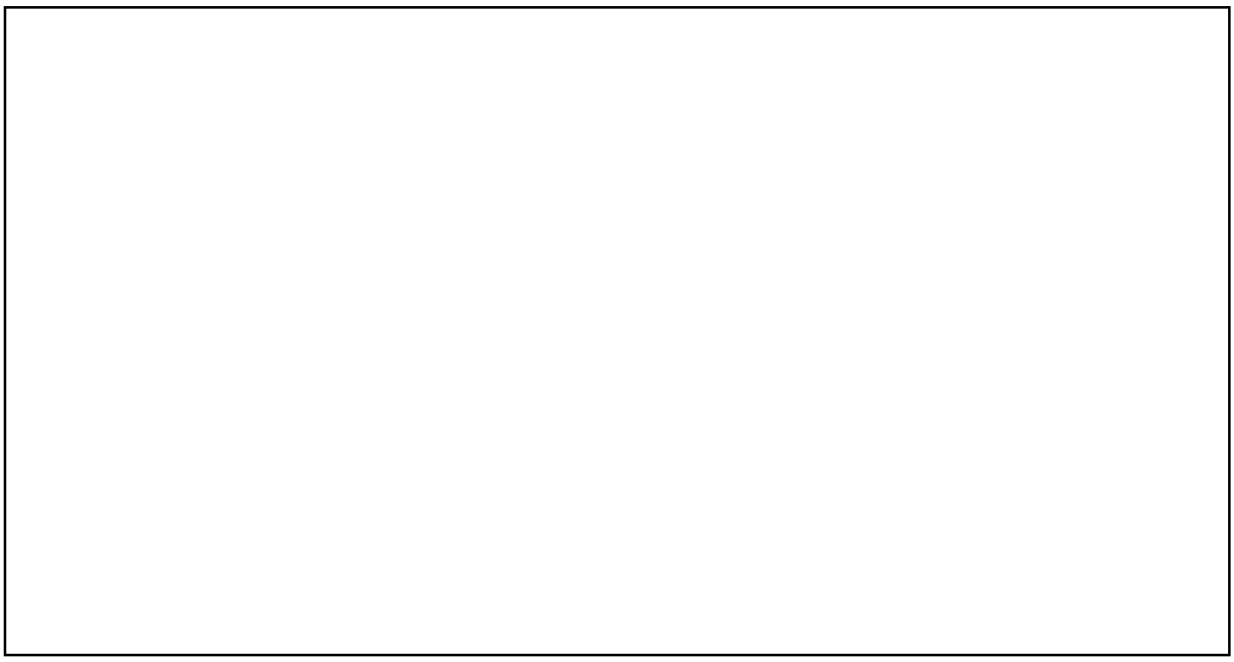
Engineering Worksheet 1

State the Problem:
What do you need to do?

Draw a picture of yourself.

Engineering Worksheet 2

Draw an electrical circuit. Label each part.

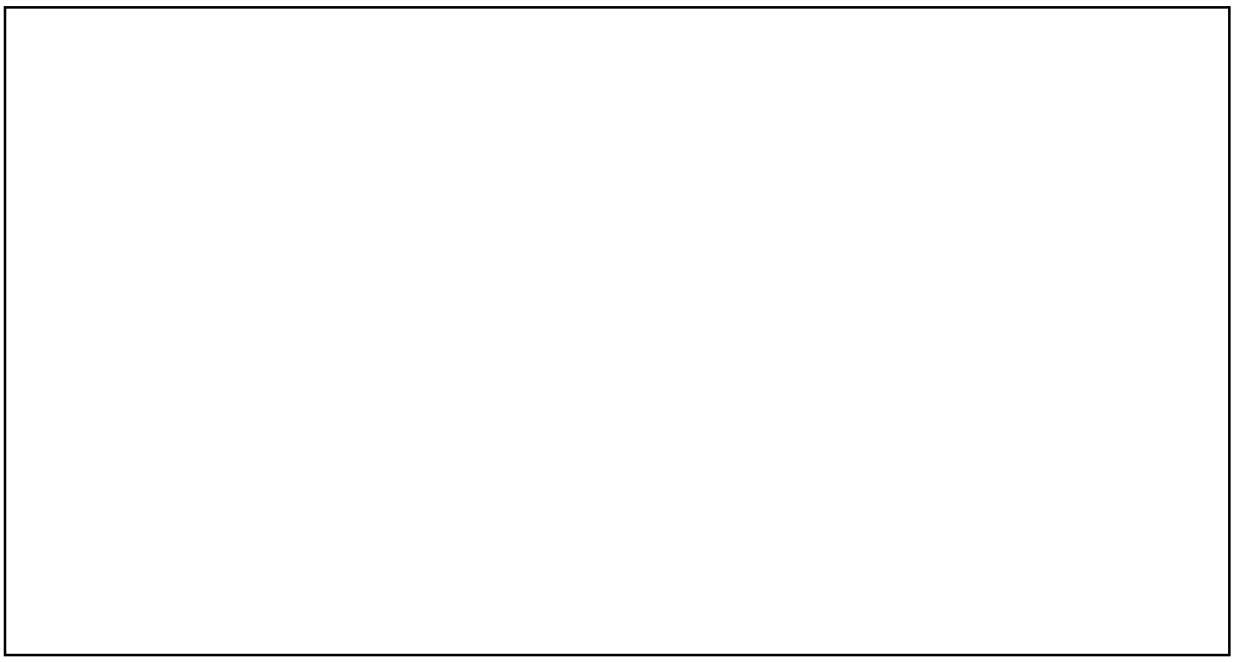


Explain the steps you will follow to make sure your electrical circuit works.

Engineering Worksheet 2 (continued)

Engineering Worksheet 3

Draw your watering system. Label each part.



Explain the steps you will follow to make sure your watering system works.

Engineering Worksheet 3 (continued)

Engineering Worksheet 4

Draw your lunar plant growth chamber model.
Did you include:

- the chamber
- the electrical circuit
- the watering system

Label each part.

Engineering Worksheet 5

Draw your lunar plant growth chamber model.
Label each part.

Explain the steps you took to build your lunar plant growth chamber.

Engineering Worksheet 5 (continued)

Engineering Worksheet 5 (continued)

Engineering Worksheet 6

Evaluate your lunar plant growth chamber.

What is the size of your lunar plant growth chamber?

Length: _____

Width: _____

Height: _____

Does your lunar plant growth chamber meet the size requirements? Explain your answer.

_____

_____

_____

_____

_____

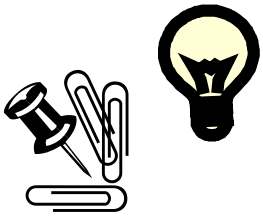
_____

Engineering Worksheet 6 (continued)

Does your electrical circuit work? How do you know?

Does your watering system work? How do you know?

Price List for Materials



Item	Price
battery	85¢
battery holder	63¢
cardboard	4¢
coffee stirrer	3¢
construction paper	8¢
electrical tape	6¢
glue stick	28¢
light bulb	96¢
paper clip	10¢
paper triangles	1¢
plastic	32¢
plastic tray	45¢
popsicle stick	11¢
push pin	12¢
sandpaper	1¢
screw	7¢
socket	76¢
straw	5¢
Styrofoam®	62¢
syringe	14¢
tape	2¢
tubing	6¢ an inch
wire	2¢ an inch
wood	15¢
wooden beams	4¢ an inch

Store Supplies

Graph each item you purchase from the store.

Items in the Store

battery																
battery holder																
cardboard																
coffee stirrer																
construction paper																
electrical tape																
glue stick																
light bulb																
paper clip																
paper triangles																
plastic																
plastic tray																
popsicle stick																
push pin																
sandpaper																
screw																
socket																
straw																
Styrofoam®																
syringe																
tape																
tubing																
wire																
wood																
wooden beams																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Number of Items Bought

Lunar Plant Growth Chamber Requirements

Length – The chamber must be between 4 inches and 6 inches long.

Width – The chamber must be between 4 inches and 6 inches wide.

Height – The chamber must be between 5 inches and 11 inches high.

You must include:

- an electrical circuit
- a watering system
- a chamber
- a compartment to hold your electrical circuit

Lunar Plant Growth Chamber Journal

Name _____

Date _____

Battery
85¢

Battery Holder
63¢

Cardboard
4¢

Coffee Stirrer
3¢

Construction Paper
8¢

Electrical Tape
6¢

Glue Stick
28¢

Light Bulb
96¢

Paper Clip
10¢

Paper Triangles
1¢

Plastic
32¢

Plastic Tray
45¢

Popsicle Stick
11¢

Push Pin
12¢

Sandpaper
1¢

Screw
7¢

Socket
76¢

Straw
5¢

Styrofoam
62¢

Syringe
14¢

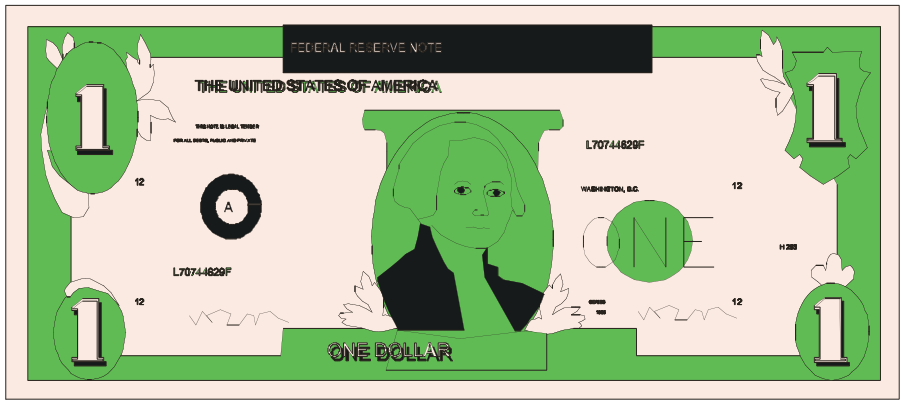
Tape
2¢

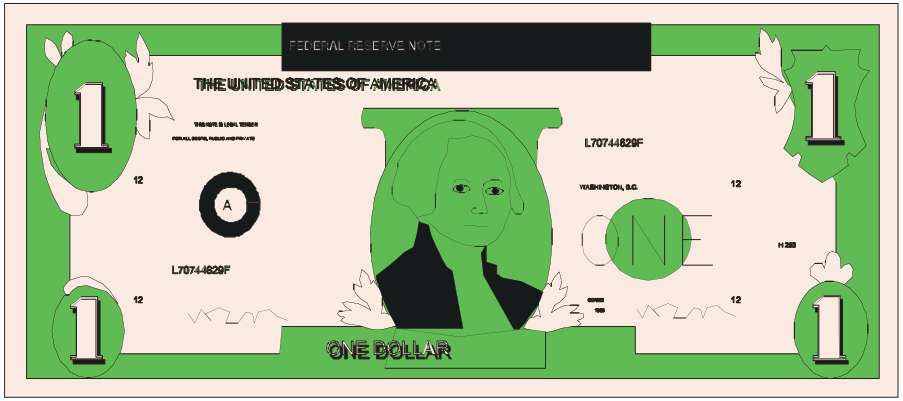
Tubing
6¢ an inch

Wire
2¢ an inch

Wood
15¢

Wooden Beam
4¢ an inch


FEDERAL RESERVE NOTE
THE UNITED STATES OF AMERICA
L70744629F
ONE DOLLAR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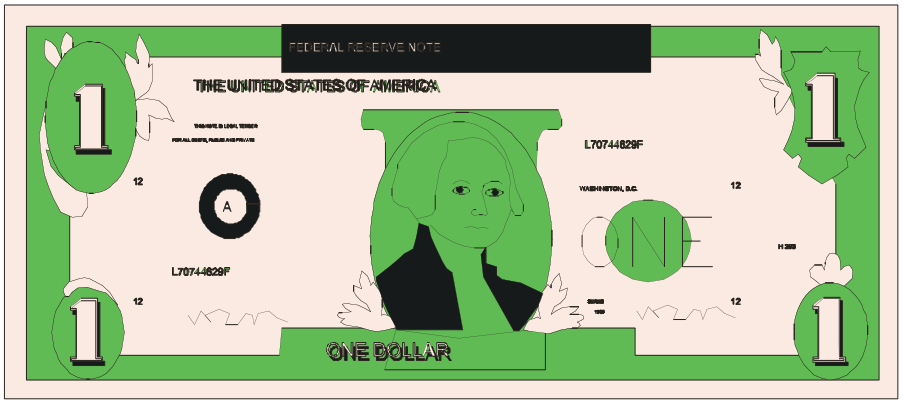
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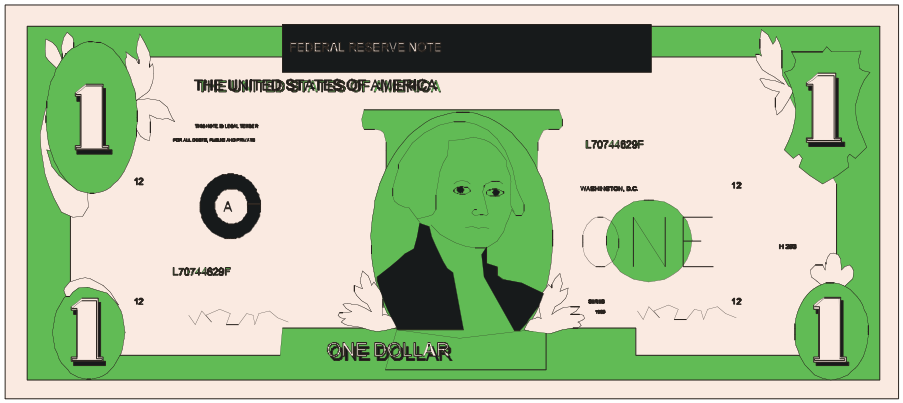
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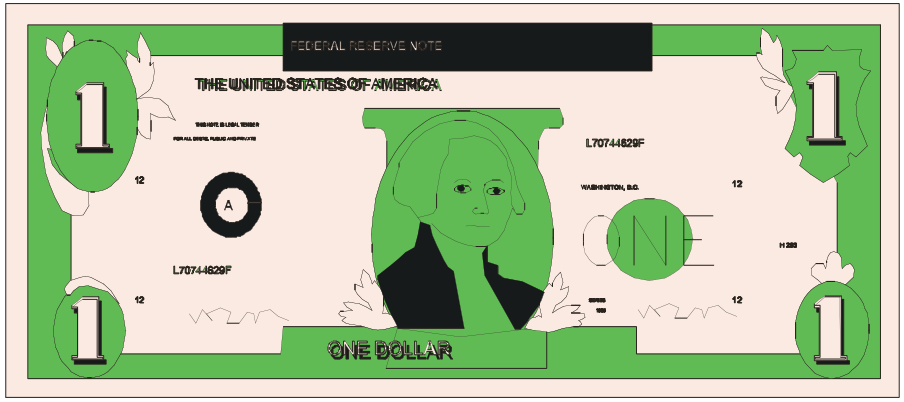
FEDERAL RESERVE NOTE
THE UNITED STATES OF AMERICA
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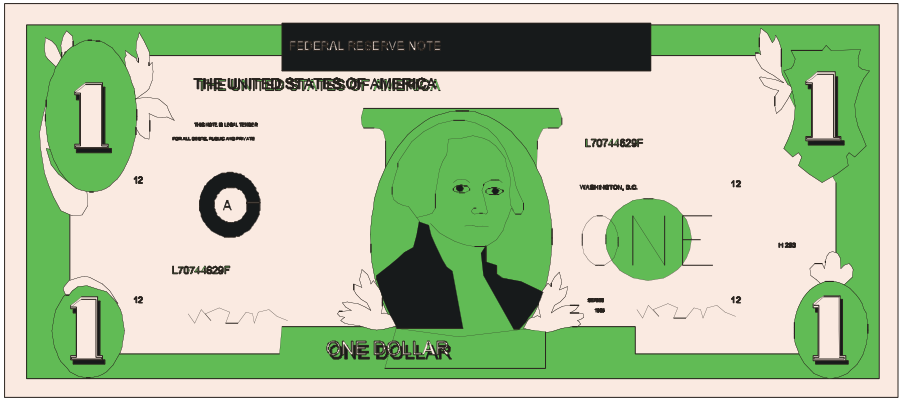
FEDERAL RESERVE NOTE
THE UNITED STATES OF AMERICA
L70744629F
ONE DOLLAR

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IN GOD WE TRUST
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Moon Munchies
A Standards-Based Elementary School Unit

Photographic Overview of Unit

Note: The teacher should discuss the safety rules with the students. Students should wear goggles when using tools.

Girl

Getting Started

If there are a variety of plastic trays ("pots"), the teacher may want students to decide which one they will use first, as the size of the "pots" may determine the size of student lunar growth chambers. The teacher may suggest that students measure their "pots" before beginning to build. This may all revolve around a question/answer session. (Questions such as: What must go inside your chamber? How will you determine how wide and long you will make your chamber? What can you do to make sure your "pot" will fit inside your chamber? Which material do you think you should purchase first? Why?) For the building process, students may choose to work on the chambers first and then the watering systems or vice versa. The electrical systems and their containers should be the final pieces that students construct. They will need to determine the length of the wires and the placement of the lights once the chambers have been constructed. The pictures below are intended to assist the teacher, but they are not meant to suggest a particular way that items should be built. (For example, some students may choose to measure and cut their tubing first and then poke a hole in their container.) When building the watering systems, chambers and electrical systems, students should be allowed to explore the materials and put materials together as they see fit.

Watering System

Students need to determine the best placement for their tubing. They need to remember that the water needs to soak into the soil so that all the seeds/plants can be watered. Once students have determined the placement of the tubing, a hole should be made in each "pot" using a pair of scissors, hole puncher or hammer and nail.

Boy

Boy

Students need to measure and cut a piece of tubing. They need to determine the length.

Boy

Boy

Using hammers, students need to hammer screws and/or nails in their tubing so they pierce holes through it. (The screws and nails need to be large enough to make the holes an appropriate size.) The teacher should make sure students have a piece of wood under their tubing so holes are not made in tables or the floor. They may also use scissors to cut holes in various places in their tubing. (Alternate the sides of the tubing.) This procedure will hopefully allow the water to disperse in their "pots" in various spots. When they test their tubing, they should have a "sprinkling" effect.

Boy

Boy

Students should have the opportunity to test their watering systems before everything is securely fastened. Larger holes and/or more holes may need to be added if systems are not working properly. The teacher may want to keep small paper cups by the sink so students can pour water into their syringes easily.

The pieces of tubing should reach into the center of the "pots." They should be glued securely. The teacher should make sure the holes the students make are filled in with glue to prevent dirt and water from leaking out and creating a mess.

Boy

Boy

The syringes should be securely glued to the pieces of tubing once the chambers are made and the students feel their watering systems are working properly. Some of the tubing and syringes will be on the outside of the chambers.

Electrical System

The teacher needs to remember that while students are creating their electrical circuit, there is not one correct way. It does need to be a complete loop, but students can connect parts differently. Some students will attach a longer wire to one of the battery holder wires, while some will connect that same battery wire directly to a push pin. The layout below is not in any particular order. Some students will purchase their wire first and then strip it. Others may purchase their light sockets and wood first and mark and drill the holes. Students should be permitted to create their circuits in their own way.

Boy

Girl

Students should measure and cut two pieces of wire. The length of the pieces should be determined by the placement of their lights in their lunar growth chambers and the placement of their battery holders and switches.

Students need to use wire strippers to strip the ends of their wires before attaching them to the various parts.

Boy

If students attach two wires together, they need to remember to wrap electrical tape around them carefully. They should not see bare wires.

Girl

Students will need to place their sockets on a 2" x 2" piece of wood and use a pencil to mark where they need to drill holes for the screws. (Make sure the drill bit is smaller than the diameter of the screw.)

Girls

Students can use a student drill to make holes in their wood pieces. (This will make it easier for the students when attaching their sockets to the wood pieces.)

Boy

Using a screwdriver, students need to attach their sockets to pieces of wood.

Students should loosen the screws that were on the sockets when they were purchased. Wires will need to be wrapped around the screws. Then the screws will need to be screwed back into the socket so the wires are securely tightened.

Boy

Boy

Two push pins should be hammered into the pieces of wood that are 2 ½“ x 4”. The students need to determine the distance using their paper clip.

Boy

Wires need to be wrapped around each push pin. It may be a battery wire or a wire that has been attached to the socket.

Hands

Paper clips should be configured so that one end is wrapped around a push pin while the other end is straightened to create the switch.

The battery holder wires need to be attached. Students need to determine what each wire will be attached to; another wire, a push pin or the socket.

Boy

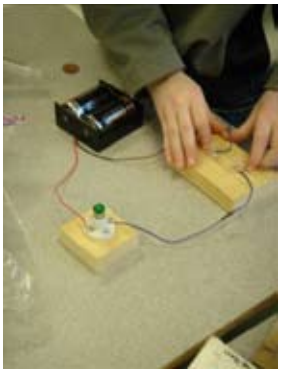
The batteries should be the last thing that the students place in their electrical circuit. They need to make sure the two battery wires do not touch each other. There will be smoke, and the batteries will get hot!

Hands

Once students have completed their circuits they need to make sure they work! Please remember that students will make their circuit loops differently. There are many ways to make the electrical circuit so that the lights turn on.

Girl and Boy

Students



Hands

Lunar Growth Chamber

While students are building their lunar growth chambers they need to be reminded of the size requirements. The length can be 4" to 6", the width 4" to 6" and the height 5" to 11". Students should be expected to keep their rulers on their desks at all times. The instructor may want to periodically check students' measurements. Students will design and build their chambers in a variety of ways. It is highly recommended that each student/group be expected to have a top that opens up or lifts up. It is very difficult to place the soil inside, plant the seeds and check the soil without a top that opens.

Some students may use wooden beams to construct a frame that will hold other materials to create the sides, tops or bottoms.

Girl

Girl

Girl

These beams should be measured and then sawed.

Girls

Boy

Saw

A miter box should be clamped to a table in order for students to saw their wood pieces. Clamps should be used to hold the wooden pieces in place.

Beams

Girl

Jointers can be used to hold the wooden beams in place while students use "regular" white glue to glue triangles in the corners. The triangles should be added to the fronts and backs of the frames.

Boy

Styrofoam may be used as the sides, top or bottom of the lunar growth chambers.

Boy

Cardboard can be glued to create the sides of the lunar growth chambers.

Some chambers may have a handle to lift the top.

Student

Student

Some students may cut windows so that they can see what is happening inside their chambers.

Students need to decide where they will place their lights in their chambers. The piece of wood which holds the light should be glued inside the chambers.
Some students may glue them to the tops of the chambers, while others may glue them to the sides. Students should decide that place will provide the best warmth and light for their seeds/plants.

Girl

Compartment for the Electrical System

Students should add this part to the side or back of their lunar growth chamber. It should be the same length or width of the chamber and not protrude out more than 6". The height should be 2". This will allow students easy access to their batteries and switches.

Student

Student

Student

Finishing Touches

Students should pick off all the excess glue strings after they are done with their chambers.

Student

The instructor may want to provide time for the students to paint the outside of their chambers and electrical circuit containers. It is important to remind the students not to paint the wires and light sockets. Wires may be disconnected. If the instructor would prefer, students can paint their chambers and electrical circuit containers before the light system is attached.

Student

Girl

Completed Lunar Growth Chambers

Students will experience success and achievement when their lunar growth chambers are completed!

Girl

Evaluating the Lunar Growth Chambers

Engineering Worksheet 6 allows students to evaluate their lunar growth chambers, electrical circuits and their watering systems. Students should be expected to measure their chambers and document their information on this worksheet.

Student

Student

Planting the Seeds

Potting soil, seeds, paper cups and rulers are the items needed when the students plant their seeds. Basil seeds grow very quickly!

Boy

Student

Using a small paper cup, students can fill their "pots" up with soil.

The instructor may want to read the directions on the back of the seed packet so students know how deep to plant their seeds.

Student

Student

Students should count the number of seeds they are given so they can document the amount.

Once the seeds begin to grow, students can measure the height of the first sprout. Have students place a toothpick by their first sprout so they know which one to measure each time they observe their plants.

Student

Students should water their plants when their soil is dry. Students can use small paper cups to pour water into their syringes. They should use the measurement on the syringe to write how much water they used. Some students may have a difficult time holding the syringe and pouring the water in, so the instructor may want each student to have a partner when watering.

Girl

Girl

Students can place a thermometer into their chambers to compare the temperature before the light is turned on and after it has been on for a while.

Basil seeds grow quickly. Many will germinate within 6 to 10 days.

Plants

Standards for Technological Literacy Program Responsibility Matrix

KEY

4 = Benchmark must be covered in detail, lessons and assessments cover this content
3 = Benchmark is covered, but topics and lessons do not center on them
2 = Topics and lessons refer to previous knowledge and integrate content covered
1 = Topics and lessons refer to previous knowledge

		Course Total	172	232	212	147	166	202	154	97	182	236	209	187
			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
The Nature of Technology														
STL-1	**Understanding the characteristics and scope of technology**	**8**	**12**	**12**	**16**	**7**	**10**	**8**	**12**	**10**	**9**	**10**	**11**	
A	The natural world and human-made world are different.	4												
B	All people use tools and techniques to help them do things.	4												
C	Things that are found in nature differ from things that are human-made in how they are produced and used.		4											
D	Tools, materials, and skills are used to make things and carry out tasks.		4											
E	Creative thinking and economic and cultural influences shape technological development.		4											
F	New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology.			4	4	4								
G	The development of technology is a human activity and is the result of individual or collective needs and the ability to be creative.			3	4									
H	Technology is closely linked to creativity, which has resulted in innovation.			3	4									
I	Corporations can often create demand for a product by bringing it onto the market and advertising it.			2	4	3								
J	The nature and development of technological knowledge and processes are functions of the setting.						4	2	2	4	3	4	4	
K	The rate of technological development and diffusion is increasing rapidly.						2	4	3					
L	Inventions and innovations are the results of specific, goal-oriented research.						2	2	3	3	4	4	4	
M	Most development of technologies these days is driven by the profit motive and the market.						2		4	3	2	2	3	

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
The Nature of Technology														
STL-2	**Understanding the core concepts of technology**	**20**	**28**	**21**	**10**	**33**	**114**	**0**	**0**	**33**	**33**	**33**	**36**	
A	Some systems are found in nature, and some are made by humans.		4											
B	Systems have parts or components that work together to accomplish a goal.		4											
C	Tools are simple objects that help humans complete tasks.		4											
D	Different materials are used in making things.		4											
E	People plan in order to get things done.		4											
F	A subsystem is a system that operates as a part of another system.			4										
G	When parts of a system are missing, it may not work as planned.			4										
H	Resources are the things needed to get a job done, such as tools and machines, materials, information, energy, people, capital, and time.			4										
I	Tools are used to design, make, use, and assess technology.			4										
J	Materials have many different properties.			4										
K	Tools and machines extend human capabilities, such as holding, lifting, carrying, fastening, separating, and computing.			4										
L	Materials have many different properties.			4										
M	Technological systems include input, processes, output, and, at times, feedback.				4		3							
N	Systems thinking involves considering how every part relates to others				4		3							
O	An open-loop system has no feedback path and requires human intervention, while a closed-loop system uses feedback.						4							
P	Technological systems can be connected to one another.				3		4							
Q	Malfunctions of any part of a system may affect the function and quality of the system.					3	4							
R	Requirements are the parameters placed on the development of a product or system.					3	4							
S	Trade-off is a decision process recognizing the need for careful compromises among competing factors.					4								
T	Trade-off is a decision process recognizing the need for careful compromises among competing factors.				4		3							
U	Different technologies involve different sets of processes.				3		4							

Standards for Technological Literacy Program Responsibility Matrix

KEY

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-2	**Understanding the core concepts of technology (continued)**		**20**	**28**	**21**	**10**	**33**	**14**	**0**	**0**	**33**	**33**	**33**	**36**
V	Controls are mechanisms or particular steps that people perform using information about the system that causes systems to change.				3		4							
W	Systems thinking applies logic and creativity with appropriate compromises in complex real-life problems.										4	4	4	4
X	Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.							4				3	4	
Y	The stability of a technological system is influenced by all of the components in the system, especially those in the feedback loop.							3			4	4	3	4
Z	Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.							3			4	2	2	4
AA	Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development.										4	4	4	4
BB	Optimization is an ongoing process or methodology of designing or making a product and is dependent on criteria and constraints.										3	4	3	4
CC	New technologies create new processes.							4			4	3	4	4
DD	Quality control is a planned process to ensure that a product, service, or system meets established criteria.										3	3	2	4
EE	Management is the process of planning, organizing, and controlling work.										3	2	3	4
FF	Complex systems have many layers of controls and feedback loops to provide information.										4	4	4	4

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-3	**Understanding the relationships among technologies and connections with other fields of study**	**4**	**8**	**6**	**5**	**12**	**11**	**5**	**7**	**12**	**10**	**10**	**12**
A	The study of technology uses many of the same ideas and skills as other subjects.	4											
B	Technologies are often combined.		4										
C	Various relationships exist between technology and other fields of study.		4										
D	Technological systems often interact with one another.			3	2	4							
E	A product, system, or environment developed for one setting may be applied to another setting.				3	4							
F	Knowledge gained from other fields of study has a direct effect on the development of technological products and systems.			3		4							
G	Technology transfer occurs when a new user applies an existing innovation developed for one purpose in a different function.						3	2		4	4	3	4
H	Technological innovation often results when ideas, knowledge, or skills are shared within a technology, among						3			4	3	4	4
I	Technological ideas are sometimes protected through the process of patenting.						2		3	4			4
J	Technological progress promotes the advancement of science and mathematics.						3	3	4		3	3	
Technology and Society													
STL-4	**Understanding the cultural, social, economic and political effects of technology**	**4**	**8**	**14**	**11**	**3**	**2**	**13**	**10**	**6**	**7**	**8**	**4**
A	The use of tools and machines can be helpful or harmful.	4											
B	When using technology, results can be good or bad.		4										
C	The use of technology can have unintended consequences.		4										
D	The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use.			4									
E	Technology, by itself, is neither good nor bad, but decisions about the use of products and systems can result in desirable or undesirable consequences.			4	3	3							
F	The development and use of technology poses ethical issues.			3	4								
G	Economic, political, and cultural issues are influenced by the development and use of technology.			3	4								
H	Changes caused by the use of technology can range from gradual to rapid and from subtle to obvious.							4		2	3	4	
I	Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.						2	3	4				
J	Ethical considerations are important in the development, selection, and use of technologies.							3	2	4	4	4	4
I	The transfer of a technology from one society to another can cause cultural, social, economic, and political changes affecting both societies to varying degrees.							3	4				

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STL-5	**Understanding the effects of technology on the environment**	**4**	**8**	**8**	**6**	**9**	**3**	**18**	**6**	**11**	**13**	**13**	**11**
A	Some materials can be reused and/or recycled.	4											
B	Waste must be appropriately recycled or disposed of to prevent unnecessary harm to the environment.		4										
C	The use of technology affects the environment in good and bad ways.		4										
D	The management of waste produced by technological systems is an important societal issue.			4		3							
E	Technologies can be used to repair damage caused by natural disasters and to break down waste from the use of various products and systems.				3	4							
F	Decisions to develop and use technologies often put environmental and economic concerns in direct competition with one another.			4	3	2							
G	Humans can devise technologies to conserve water, soil, and energy through such techniques as reusing, reducing and recycling.								4	3	2	2	3
H	When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.							3		4	2	3	4
I	With the aid of technology, various aspects of the environment can be monitored to provide information for decisionmaking.							4			2		
J	The alignment of technological processes with natural processes maximizes performance and reduces negative impacts on the environment.							4				2	
K	Humans devise technologies to reduce the negative consequences of other technologies. 3 4 3 3 4							3		4	3	3	4
L	Decisions regarding the implementation of technologies involve the weighing of trade-offs between predicted positive and negative effects on the environment.						3	4	2		4	3	
STL-6	**Understanding the role of society in the development and use of technology**	**4**	**8**	**13**	**12**	**2**	**4**	**10**	**2**	**4**	**3**	**3**	**4**
A	Products are made to meet individual needs and wants.	4											
B	Because people's needs and wants change, new technologies are developed, and old ones are improved to meet those changes.		4										
C	Individual, family, community, and economic concerns may expand or limit the development of technologies.		4										
D	Throughout history, new technologies have resulted from the demands, values, and interests of individuals, businesses, industries, and societies.			4									
E	The use of inventions and innovations has led to changes in society and the creation of new needs and wants.			3	4								
F	Social and cultural priorities and values are reflected in technological devices.			3	4								
G	Meeting societal expectations is the driving force behind the acceptance and use of products and systems.			3	4	2							
H	Different cultures develop their own technologies to satisfy their individual and shared needs, wants, and values.							4					
I	The decision whether to develop a technology is influenced by societal opinions and demands, in addition to corporate cultures.							3	2	4			4
J	A number of different factors, such as advertising, the strength of the economy, the goals of a company, and the latest fads contribute to shaping the design of and demand for various technologies.						4	3			3	3	

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The Nature of Technology														
STL-7 Understanding the influence of technology on history		**4**	**4**	**6**	**12**	**4**	**28**	**22**	**9**	**0**	**3**	**3**	**0**
A	The way people live and work has changed throughout history because of technology.		**4**										
B	People have made tools to provide food, to make clothing, and to protect themselves.			**4**									
C	Many inventions and innovations have evolved by using slow and methodical processes of tests and refinements.				**3**	**4**							
D	The specialization of function has been at the heart of many technological improvements.				**3**	**4**							
E	The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships.						**4**						
F	In the past, an invention or innovation was not usually developed with the knowledge of science.					**4**							
G	Most technological development has been evolutionary, the result of a series of refinements to a basic invention..								**4**				
H	The evolution of civilization has been directly affected by, and has in turn affected, the development and use of tools and materials.									**3**	**4**			
I	Throughout history, technology has been a powerful force in reshaping the social, cultural, political, and economic landscape.									**4**	**3**			
J	Early in the history of technology, the development of many tools and machines was based not on scientific knowledge but on technological know-how.								**4**					
K	The Iron Age was defined by the use of iron and steel as the primary materials for tools.								**4**	**3**				
L	The Middle Ages saw the development of many technological devices that produced long-lasting effects on technology and society								**4**	**3**				
M	The Renaissance, a time of rebirth of the arts and humanities, was also an important development in the history of technology.								**4**	**3**				
N	The Industrial Revolution saw the development of continuous manufacturing, sophisticated transportation and communication systems, advanced construction practices, and improved education and leisure time.								**4**	**3**				
O	The Information Age places emphasis on the processing and exchange of information.								**4**	**3**	**2**		**3**	**3**

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Design														
STL-8	**Understanding the attributes of design**		8	8	11	10	3	13	2	0	15	16	15	15
A	Everyone can design solutions to a problem.		4											
B	Design is a creative process.		4											
C	The design process is a purposeful method of planning practical solutions to problems.			4										
D	Requirements for a design include such factors as the desired elements and features of a product or system or the limits that are placed on the design.			4										
E	Design is a creative planning process that leads to useful products and systems.				3	4	3							
F	There is no perfect design.				4	3								
G	Requirements for a design are made up of criteria and constraints.				4	3								
H	The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype.							4			3	4	4	3
I	Design problems are seldom presented in a clearly defined form.							3			4	4	3	4
J	The design needs to be continually checked and critiqued, and the ideas of the design must be redefined and improved.							3			4	4	4	4
K	Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.							3	2		4	4	4	4

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STL-9	**Understanding engineering design**		**8**	**12**	**11**	**10**	**0**	**13**	**2**	**0**	**14**	**10**	**10**	**15**
A	The engineering design process includes identifying a problem, looking for ideas, developing solutions, and sharing solutions with others.		4											
B	Expressing ideas to others verbally and through sketches and models is an important part of the design process.		4											
C	The engineering design process involves defining a problem, generating ideas, selecting a solution, testing the solution(s), making the item, evaluating it, and presenting the results.			4										
D	When designing an object, it is important to be creative and consider all ideas.			4										
E	Models are used to communicate and test design ideas and processes.			4										
F	Design involves a set of steps, which can be performed in different sequences and repeated as needed.				4	3								
G	Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum.				3	4								
H	Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions.				4	3								
I	Established design principles are used to evaluate existing designs, to collect data, and to guide the design process.							4			3	4	3	3
J	Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.							3			4	3	3	4
K	A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.							3			4	3	4	4
L	The process of engineering design takes into account a number of factors.							3	2		3			4

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STL-10	**Understanding the role of troubleshooting, R&D, etc. in problem-solving**		**8**	**12**	**9**	**10**	**6**	**4**	**7**	**11**	**3**	**14**	**14**	**3**
A	Asking questions and making observations helps a person to figure out how things work. .		4											
B	All products and systems are subject to failure. Many products and systems, however, can be fixed.		4											
C	Troubleshooting is a way of finding out why something does not work so that it can be fixed.			4										
D	Invention and innovation are creative ways to turn ideas into real things.			4										
E	The process of experimentation, which is common in science, can also be used to solve technological problems.			4										
F	Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system.				3	2	4							
G	Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it.				3	4	2							
H	Some technological problems are best solved through experimentation.				3	4								
I	Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace.							4			3	3	3	3
J	Technological problems must be researched before they can be solved.								4	3		4	4	
K	Not all problems are technological, and not every problem can be solved using technology.									4		4	3	
L	Many technological problems require a multidisciplinary approach.								3	4		3	4	

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Abilities for a Technological World														
STL-11	**Abilities to apply the design process**	**12**	**16**	**10**	**19**	**3**	**18**	**3**	**4**	**16**	**18**	**18**	**17**
A	Brainstorm people's needs and wants and pick some problems that can be solved through the design process.	**4**											
B	Build or construct an object using the design process.	**4**											
C	Investigate how things are made and how they can be improved.	**4**											
D	Identify and collect information about everyday problems that can be solved by technology, and generate ideas and requirements for solving a problem.		**4**										
E	The process of designing involves presenting some possible solutions in visual form and then selecting the best solution(s) from many.		**4**										
F	Test and evaluate the solutions for the design problem.		**4**										
G	Improve the design solutions.		**4**										
H	Apply a design process to solve problems in and beyond the laboratory-classroom.			**3**	**4**								
I	Specify criteria and constraints for the design.			**3**	**4**								
J	Make two-dimensional and three-dimensional representations of the designed solution.				**4**								
K	Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed.				**4**								
L	Make a product or system and document the solution.			**4**	**3**	**3**							
M	Identify the design problem to solve and decide whether or not to address it.							**3**	**4**				
N	Identify criteria and constraints and determine how these will affect the design process.						**4**			**3**	**4**	**3**	**3**
O	Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.						**4**			**3**	**4**	**4**	**3**
P	Evaluate the design solution using conceptual, physical, and mathematical models at various intervals of the design						**3**			**3**	**3**	**4**	**4**
Q	Develop and produce a product or system using a design process.						**3**			**4**	**4**	**4**	**4**
R	Evaluate final solutions and communicate observation, processes, and results of the entire design process, using verbal, graphic, quantitative, virtual, and written means, in addition to three-dimensional models.						**4**			**3**	**3**	**3**	**3**

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STL-12	**Abilities to use and maintain technological products and systems**		**12**	**16**	**8**	**3**	**13**	**20**	**0**	**0**	**0**	**11**	**11**	**0**
A	Discover how things work.		4											
B	Use hand tools correctly and safely and be able to name them correctly.		4											
C	Recognize and use everyday symbols.		4											
D	Follow step-by-step directions to assemble a product.			4										
E	Select and safely use tools, products, and systems for specific tasks.			4										
F	Use computers to access and organize information.			4										
G	Use common symbols, such as numbers and words, to communicate key ideas.			4										
H	Use information provided in manuals, protocols, or by experienced people to see and understand how things work.				4		3							
I	Use tools, materials, and machines safely to diagnose, adjust, and repair systems.						4							
J	Use computers and calculators in various applications.				4	3	2							
K	Operate and maintain systems in order to achieve a given purpose.						4							
L	Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.							4				3	3	
M	Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it.							4				4	4	
N	Troubleshoot, analyze, and maintain systems to ensure safe and proper function and precision.							4						
O	Operate systems so that they function in the way they were designed.							4						
P	Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.							4				4	4	

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STL-13 Abilities to assess the impact of products and systems			**8**	**12**	**9**	**3**	**16**	**4**	**15**	**11**	**1**	**9**	**9**	**1**
A	Collect information about everyday products and systems by asking questions.		4											
B	Determine if the human use of a product or system creates positive or negative results.		4											
C	Compare, contrast, and classify collected information in order to identify patterns.			4										
D	Investigate and assess the influence of a specific technology on the individual, family, community, and environment.			4										
E	Examine the trade-offs of using a product or system and decide when it could be used.			4										
F	Design and use instruments to gather data.				3		4							
G	Use data collected to analyze and interpret trends in order to identify the positive or negative effects of a technology.					3								
H	Identify trends and monitor potential consequences of technological development.				3		4							
I	Interpret and evaluate the accuracy of the information obtained and determine if it is useful.				3		4							
J	Collect information and evaluate its quality.							4	3	2	1	2	2	1
K	Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.								4	3		3	3	
L	Use assessment techniques, such as trend analysis and experimentation to make decisions about the future development of technology.								4	3		4		
M	Design forecasting techniques to evaluate the results of altering natural systems.								4	3			4	

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The Designed World														
STL-14	**Understanding of and abilities to select and use medical technologies**	**12**	**12**	**14**	**0**	**8**	**4**	**4**	**4**	**0**	**0**	**12**	**0**
A	Vaccinations protect people from getting certain diseases.		**4**											
B	Medicine helps people who are sick to get better.		**4**											
C	There are many products designed specifically to help people take care of themselves.		**4**											
D	Vaccines are designed to prevent diseases from developing and spreading; medicines are designed to relieve symptoms and stop diseases from developing.			**4**										
E	Technological advances have made it possible to create new devices, to repair or replace certain parts of the body, and to provide a means for mobility.			**4**										
F	Many tools and devices have been designed to help provide clues about health and to provide a safe environment.			**4**										
G	Advances and innovations in medical technologies are used to improve healthcare.				**4**									
H	Sanitation processes used in the disposal of medical products help to protect people from harmful organisms and disease, and shape the ethics of medical safety.				**4**									
I	The vaccines developed for use in immunization require specialized technologies to support environments in which a sufficient amount of vaccines are produced.				**3**		**4**							
J	Genetic engineering involves modifying the structure of DNA to produce novel genetic make-ups.				**3**		**4**							
K	Medical technologies include prevention and rehabilitation, vaccines and pharmaceuticals, medical and surgical procedures, genetic engineering, and the systems within which health is protected and maintained.								**4**				**4**	
L	Telemedicine reflects the convergence of technological advances in a number of fields, including medicine, telecommunications, virtual presence, computer engineering, informatics, artificial intelligence, robotics, materials science, and perceptual psycho							**4**					**4**	
M	The sciences of biochemistry and molecular biology have made it possible to manipulate the genetic information found in living creatures.									**4**			**4**	

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STL-15 Understanding of and abilities to select and use agricultural and biotechnologies			**8**	**12**	**12**	**4**	**4**	**4**	**4**	**7**	**4**	**0**	**16**	**4**
A	The use of technologies in agriculture makes it possible for food to be available year round and to conserve resources.		**4**											
B	There are many different tools necessary to control and make up the parts of an ecosystem.		**4**											
C	Artificial ecosystems are human-made environments that are designed to function as a unit and are comprised of humans, plants, and animals.			**4**										
D	Most agricultural waste can be recycled.			**4**										
E	Many processes used in agriculture require different procedures, products, or systems.			**4**										
F	Technological advances in agriculture directly affect the time and number of people required to produce food for a large population.				**4**									
G	A wide range of specialized equipment and practices is used to improve the production of food, fiber, fuel, and other useful products and in the care of animals.						**4**							
H	Biotechnology applies the principles of biology to create commercial products or processes.					**4**								
I	Artificial ecosystems are human-made complexes that replicate some aspects of the natural environment.				**4**									
J	The development of refrigeration, freezing, dehydration, preservation, and irradiation provide long-term storage of food and reduce the health risks caused by tainted food.				**4**									
K	Agriculture includes a combination of businesses that use a wide array of products and systems to produce, process, and distribute food, fiber, fuel, chemical, and other useful products.							**4**					**4**	
L	Biotechnology has applications in such areas as agriculture, pharmaceuticals, food and beverages, medicine, energy, the environment, and genetic engineering.								**4**	**3**			**4**	
M	Conservation is the process of controlling soil erosion, reducing sediment in waterways, conserving water, and improving water quality.									**4**			**4**	
N	The engineering design and management of agricultural systems require knowledge of artificial ecosystems and the effects of technological development on flora and fauna.										**4**		**4**	**4**

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STL-16 Understanding of and abilities to select and use energy and power technologies			**8**	**8**	**12**	**0**	**8**	**12**	**6**	**3**	**17**	**20**	**0**	**17**
A	Energy comes in many forms.		4											
B	Energy should not be wasted.		4											
C	Energy comes in different forms.			4										
D	Tools, machines, products, and systems use energy in order to do work.			4										
E	Energy is the capacity to do work.				4									
F	Energy can be used to do work, using many processes.						4							
G	Power is the rate at which energy is converted from one form to another or transferred from one place to another, or the rate at which work is done.				4									
H	Power systems are used to drive and provide propulsion to other technological products and systems.						4							
I	Much of the energy used in our environment is not used efficiently.				4									
J	Energy cannot be created nor destroyed; however, it can be converted from one form to another.							4			3	4		3
K	Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.							4			3	4		3
L	It is impossible to build an engine to perform work that does not exhaust thermal energy to the surroundings.								4		3	4		3
M	Energy resources can be renewable or nonrenewable.							1	2	3	4	4		4
N	Power systems must have a source of energy, a process, and loads.							3			4	4		4

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		Course Total	172	232	212	147	166	202	154	97	182	236	209	187
			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-17 Understanding of and abilities to select and use information and communication technologies			**12**	**16**	**13**	**4**	**8**	**16**	**8**	**8**	**7**	**0**	**24**	**7**
A	Information is data that has been organized.		4											
B	Technology enables people to communicate by sending and receiving information over a distance.		4											
C	People use symbols when they communicate by technology.		4											
D	The processing of information through the use of technology can be used to help humans make decisions and solve problems.			4										
E	Information can be acquired and sent through a variety of technological sources, including print and electronic media.			4										
F	Communication technology is the transfer of messages among people and/or machines over distances through the use of technology.			4										
G	Letters, characters, icons, and signs are symbols that represent ideas, quantities, elements, and operations.			4										
H	Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human.				3		4							
I	Communication systems are made up of a source, encoder, transmitter, receiver, decoder, and destination.				3		4							
J	The design of a message is influenced by such factors as the intended audience, medium, purpose, and nature of the message.				4									
K	The use of symbols, measurements, and drawings promotes clear communication by providing a common language to express ideas.				3	4								
L	Information and communication technologies include the inputs, processes, and outputs associated with sending and receiving information.							4					4	
M	Information and communication systems allow information to be transferred from human to human, human to machine, machine to human, and machine to machine.							4					4	
N	Information and communication systems can be used to inform, persuade, entertain, control, manage, and educate.							1	4	4			4	
O	Communication systems are made up of source, encoder, transmitter, receiver, decoder, storage, retrieval, and destination.							4					4	
P	There are many ways to communicate information, such as graphic and electronic means.								4	4	4		4	3
Q	Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.							3			4		4	4

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-18 Understanding of and abilities to select and use transportation technologies			**12**	**8**	**4**	**4**	**11**	**4**	**8**	**0**	**4**	**16**	**0**	**4**
A	A transportation system has many parts that work together to help people travel.		4											
B	Vehicles move people or goods from one place to another in water, air, or space and on land.		4											
C	Transportation vehicles need to be cared for to prolong their use.		4											
D	The use of transportation allows people and goods to be moved from place to place.			4										
E	A transportation system may lose efficiency or fail if one part is missing or malfunctioning or if a subsystem is not working.			4										
F	Transporting people and goods involves a combination of individuals and vehicles.				4		3							
G	Transportation vehicles are made up of subsystems, such as structural, propulsion, suspension, guidance, control, and support, that must function together for a system to work effectively.						4							
H	Governmental regulations often influence the design and operation of transportation systems.					4								
I	Processes, such as receiving, holding, storing, loading, moving, unloading, delivering, evaluating, marketing, managing, communicating, and using conventions are necessary for the entire transportation system to operate efficiently.						4							
J	Transportation plays a vital role in the operation of other technologies, such as manufacturing, construction, communication, health and safety, and agriculture.							4				4		
K	Intermodalism is the use of different modes of transportation, such as highways, railways, and waterways as part of an interconnected system that can move people and goods easily from one mode to another.								4			4		
L	Transportation services and methods have led to a population that is regularly on the move.								4			4		
M	The design of intelligent and non-intelligent transportation systems depends on many processes and innovative techniques										4	4		4

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-19 Understanding of and abilities to select and use manufacturing technologies			**8**	**12**	**12**	**8**	**4**	**10**	**15**	**3**	**14**	**24**	**0**	**15**
A	Manufacturing systems produce products in quantity.		4											
B	Manufactured products are designed.		4											
C	Processing systems convert natural materials into products.			4										
D	Manufacturing processes include designing products, gathering resources, and using tools to separate, form, and combine materials in order to produce products.			4										
E	Manufacturing enterprises exist because of a consumption of goods.			4										
F	Manufacturing systems use mechanical processes that change the form of materials through the processes of separating, forming, combining, and conditioning them.				4									
G	Manufactured goods may be classified as durable and non-durable.				4									
H	The manufacturing process includes the designing, development, making, and servicing of products and systems.						4							
I	Chemical technologies are used to modify or alter chemical substances.					4								
J	Materials must first be located before they can be extracted from the earth through such processes as harvesting, drilling, and mining.				4									
K	Marketing a product involves informing the public about it well as assisting in selling and distributing it.					4								
L	Servicing keeps products in good operating condition.								4					
M	Materials have different qualities and may be classified as natural, synthetic, or mixed.							4	3		3	4		3
N	Durable goods are designed to operate for a long period of time, while non-durable goods are designed to operate for a short period of time.										4	4		4
O	Manufacturing systems may be classified into types, such as customized production, batch production, and continuous production.							3			3	4		4
P	The interchangeability of parts increases the effectiveness of manufacturing processes.							3			4	4		4
Q	Chemical technologies provide a means for humans to alter or modify materials and to produce chemical products.								4			4		
R	Marketing involves establishing a product's identity, conducting research on its potential, advertising it, distributing it, and selling it.								4	3		4		

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			K-2	3-5	Exploring Technology	Invention & Innovation	Systems	Foundations	Impacts	Issues	Technological Design	Advanced Design Applications	Advanced Technological Applications	Engineering Design
STL-20 Understanding of and abilities to select and use construction technologies			**8**	**12**	**7**	**0**	**12**	**8**	**4**	**0**	**11**	**20**	**0**	**11**
A	People live, work, and go to school in buildings, which are of different types: houses, apartments, office buildings, and schools.		**4**											
B	The type of structure determines how the parts are put together.		**4**											
C	Modern communities are usually planned according to guidelines.			**4**										
D	Structures need to be maintained.			**4**										
E	Many systems are used in buildings.			**4**										
F	The selection of designs for structures is based on factors such as building laws and codes, style, convenience, cost, climate, and function.				**4**									
G	Structures rest on a foundation.				**3**		**4**							
H	Some structures are temporary, while others are permanent.						**4**							
I	Buildings generally contain a variety of subsystems.						**4**							
J	Infrastructure is the underlying base or basic framework of a system.							**4**				**4**		
K	Structures are constructed using a variety of processes and procedures.							**4**				**4**		
L	The design of structures includes a number of requirements.										**4**	**4**		**4**
M	Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use.										**3**	**4**		**3**
N	Structures can include prefabricated materials										**4**	**4**		**4**

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