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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Engineering Portfolio

Lunar Plant Growth Chamber

Name _____

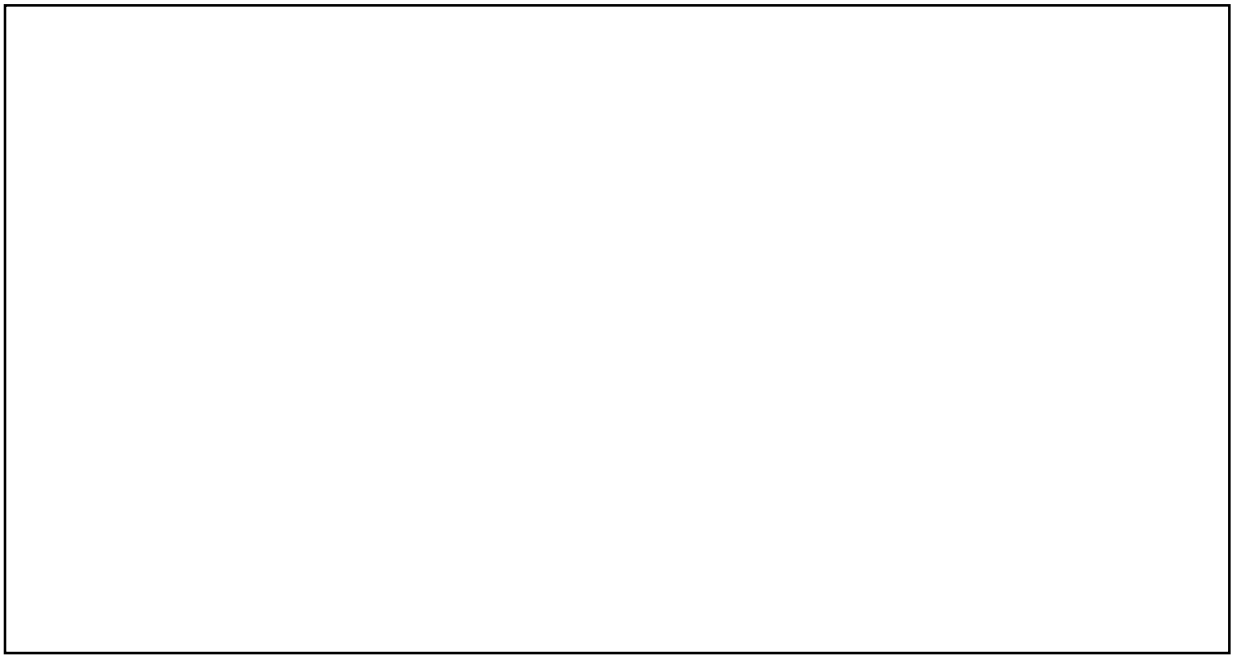
Engineering Worksheet 1

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?