

Life Support Systems

Purpose

To design and build models of life support systems for a settlement on the Moon.

Background [also see "Teacher's Guide" Pages 14, 15]

A future lunar base will have to be a self-contained habitat with all the life support systems necessary for the survival of people, animals, and plants. In this series of activities, the students will be designing and building models of nine life support systems which are crucial to our successful settlement of the Moon.

The nine life support systems are:

- "Air Supply,"
- "Communications,"
- "Electricity,"
- "Food production and delivery,"
- "Recreation,"
- "Temperature control,"
- "Transportation,"
- "Waste management," and
- "Water supply."

This activity is based on the Marsville activity on life support systems developed by the Challenger Center and is used with permission.

Preparation

Review and prepare materials listed on the student sheets. Separate student activity sheets are included for each of the nine life support systems. Spaces for answers are not provided on all sheets, so students will need extra paper.

In Class

After dividing students into teams, you may want to have each person assume a role on the team, e.g., organizer, recorder, researcher, builder, artist, writer, etc. Distribute a student activity sheet to each team.

Life Support Systems

Each team must define the requirements of their system, exploring how these requirements are currently being met on Earth. Team members will research the limitations and/or opportunities posed by the Moon's environment. The "Moon ABCs Fact Sheet" and maps of the Moon should be used as resource materials.

Each team will decide how the system will operate and what it will contain. A key part of the problem-solving process is the students' ability to evaluate the system solution in terms of whether it provides the greatest good and least harm to the persons and things affected.

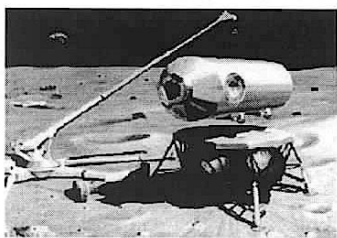
Each model of a life support system must incorporate at least four facts from the "Moon ABCs Fact Sheet."

Models do not have to function physically, but each team member must be able to explain how the models should function.

Wrap-up

Have each team share what they have learned with the entire class.

1. Did the students find that the Moon's environment placed limits on their designs of life support systems?
2. Did the students find opportunities for development on the Moon that could not happen on Earth?
3. Summarize the aspects and conditions of the Moon which make life support such a challenge.



Air Supply

Purpose

To design and build a model air supply system for a human settlement on the Moon.

Key Words

atmosphere

photosynthesis

Materials

"Moon ABCs Fact Sheet"

construction materials
such as cardboard boxes
and tubes, blocks, hoses,
straws, string, pins, rubber
bands, tape, etc.

Procedure

1. The atmosphere of Earth is a combination of several gases; review them from the "**Moon ABCs Fact Sheet.**" What gas do humans and animals need to breathe in?

2. What primary gas do humans and animals breathe out?

3. What is photosynthesis?

4. During the process of photosynthesis, what gas must green plants take in ?

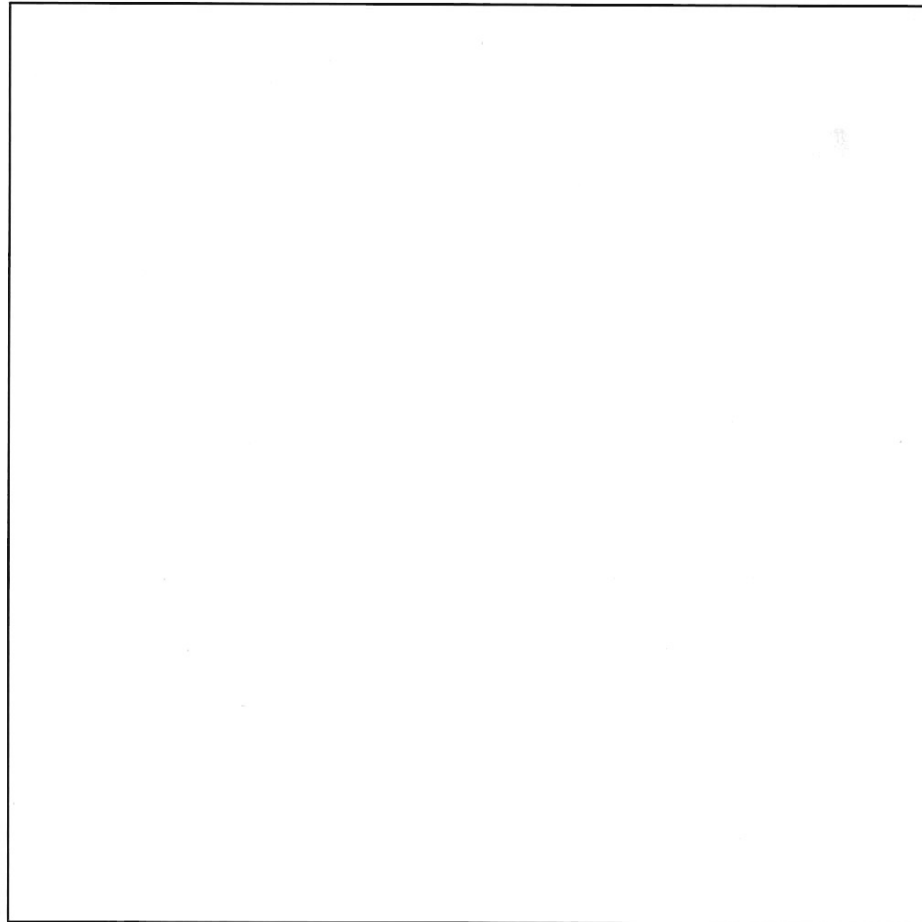
5. What gas do the green plants produce?

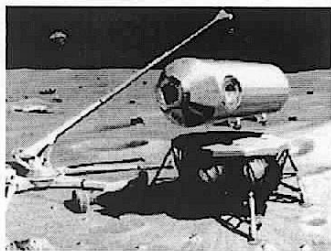
6. A process called electrolysis can separate water into hydrogen gas and oxygen gas. Another process is being developed which can extract oxygen from rocks and soil that contain it. Do you think these processes could be useful on the Moon? How?

Air Supply

7. Review the "Moon ABCs Fact Sheet." Will the Moonbase settlers automatically be able to breathe the atmosphere or will special provisions need to be made?
8. Design an air supply system to be used by the Moonbase inhabitants which will rely on oxygen and carbon dioxide available only from the Moon's resources. You may assume that ample electricity will be available.
9. Construct a model of this system based on your design. It must include the application of at least four facts from the "Moon ABCs Fact Sheet." For example, how will the Moon's gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon's gravity is only 1/6th of Earth's gravity.

**Sketch of
my model**





Communications

Purpose

To design and construct a model of a communications system to be used by people living and working on the Moon.

Key Words

communications

Materials

"Moon ABCs Fact Sheet"

construction materials such as cardboard boxes and tubes, blocks, hoses, straws, string, pins, rubber bands, tape, etc.

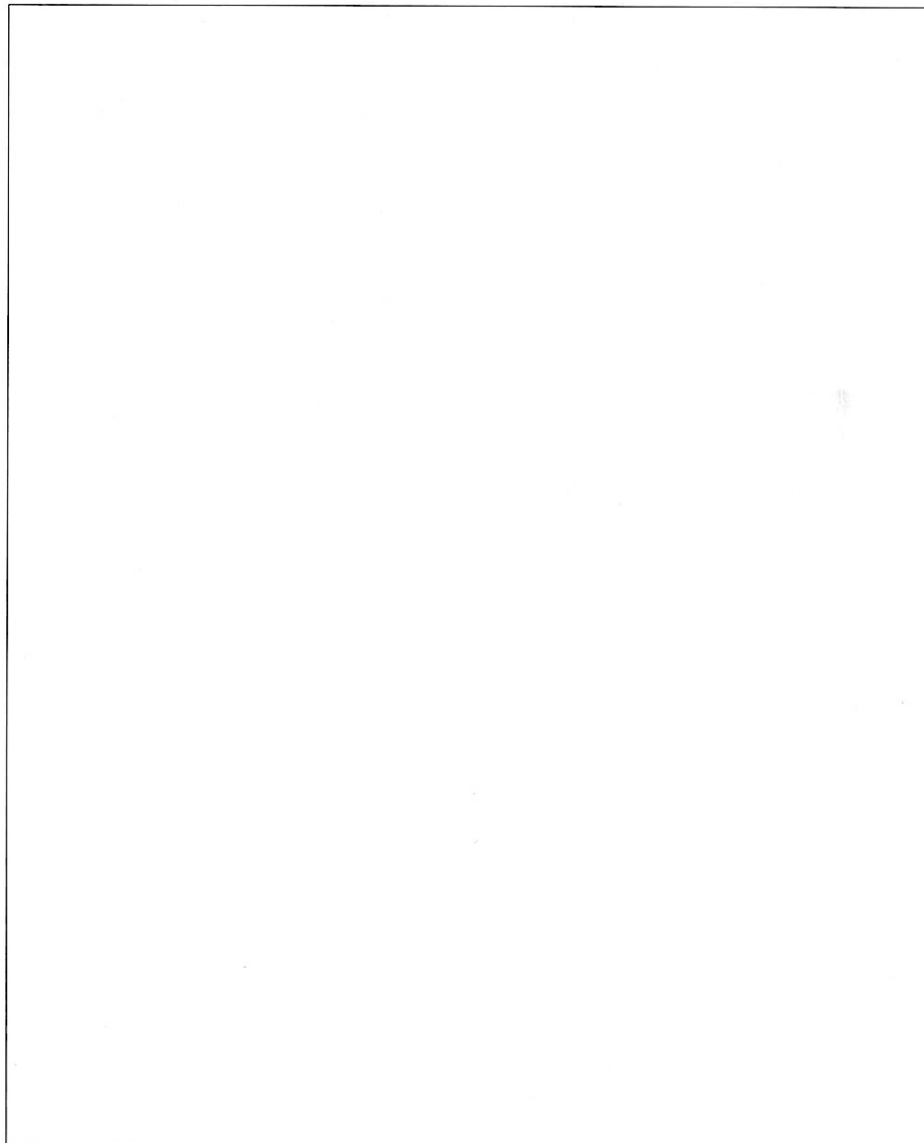
Procedure

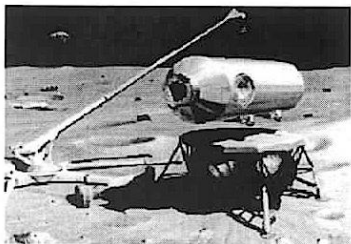
1. What different ways do we have of communicating with each other here on Earth? Do some methods work better short distance than long distance? What are the strong points of each of these methods? What limitations does each have?
2. Why do you think communication would be important in each of the following situations:
 - Between Moonbase settlers within their constructed settlement,
 - Between settlers in the settlement and those conducting missions elsewhere on the surface of the Moon,
 - Between Moonbase and Earth (How long does it take for a radio signal to travel the distance between Earth and the Moon?)
3. Review the facts you have learned about the Moon. Do you think any of the communications methods on Earth (from Question 1) would be impractical on the Moon? Why or why not? Which communications methods on Earth do you think would be particularly useful on the Moon? What features of these methods might you have to modify?
4. Design a communications system to be used by the Moonbase inhabitants which will have components to satisfy the different situations listed in Question 2. You may assume that ample electricity will be available.

Communications

5. Construct a model of this system based on your design. It must include the application of at least four facts from the **“Moon ABCs Fact Sheet.”** For example, how will the Moon’s gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon’s gravity is only 1/6th of Earth’s gravity.

**Sketch of
my model**





Electricity

Purpose

To design and build a model electrical power supply system for a human settlement on the Moon.

Key Words

electricity

solar power

nuclear energy

Materials

"Moon ABCs Fact Sheet"

construction materials such as cardboard boxes and tubes, blocks, hoses, straws, string, pins, rubber bands, tape, etc.

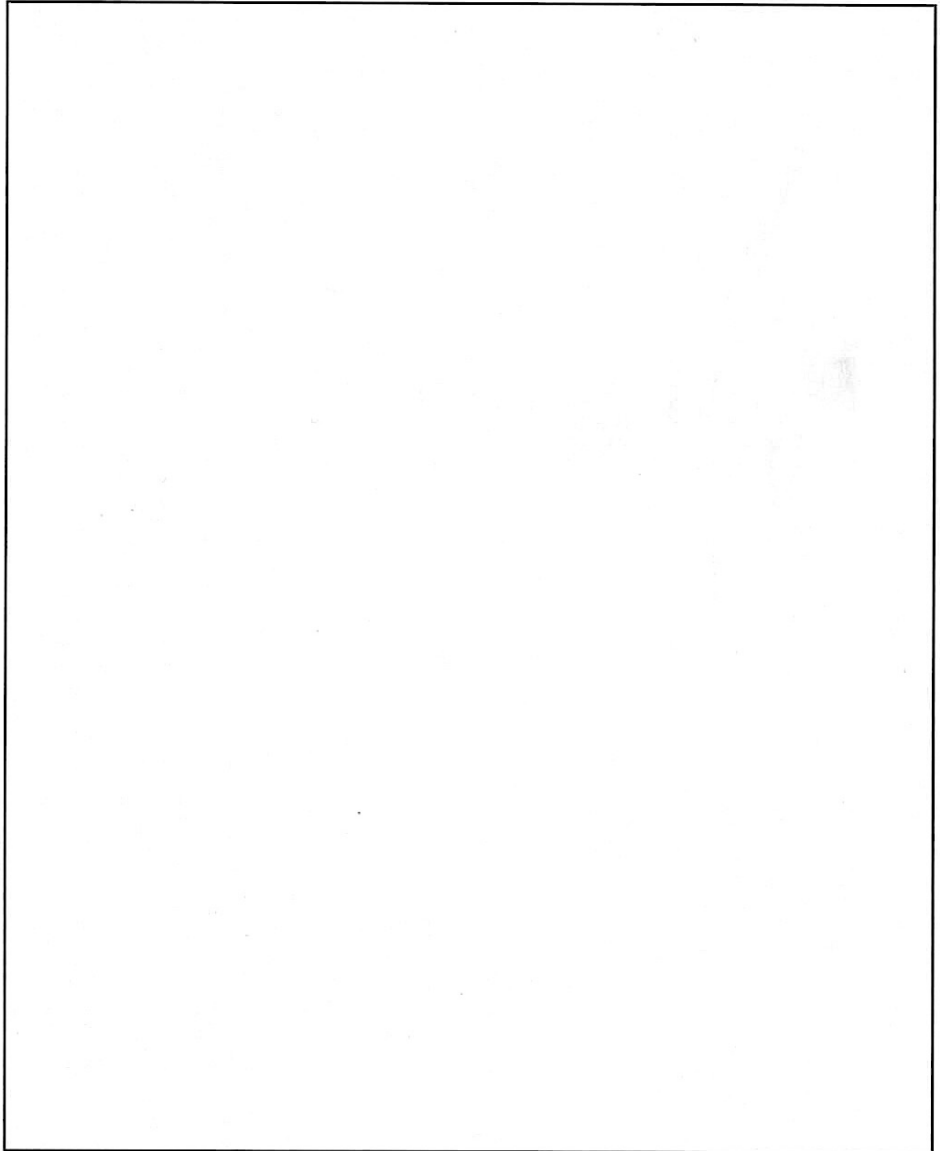
Procedure

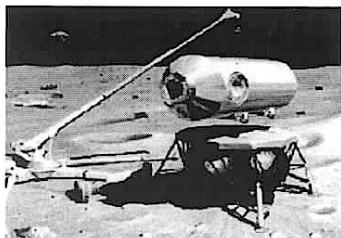
1. Think of all the things you do during a regular school day, from the minute you wake up until the time you go to sleep. List each activity which requires electricity.
2. What other activities in your town, city, or state use electricity?
3. What is the source of the electric power for your town or city? Is it a steam generating plant that burns natural gas, oil, or coal? Is it a nuclear-fission plant?
4. List other ways to produce electricity.
5. How is electricity transmitted from the generating plant to other places?
6. Review the facts you have learned about the Moon. Do you think the lack of atmosphere, natural gas, oil, and coal on the Moon would affect the production of electricity? How? Would materials have to be shipped from Earth? Should the lunar settlement rely on materials shipped from Earth? Your team's job is to supply the electricity needed by the life support systems at the Moonbase.
7. Review the "**Moon ABCs Fact Sheet.**" Design an electrical power generating plant and transmission system for the Moonbase inhabitants. Important issues to consider include pollution, radioactive waste storage, length of daylight on the Moon, and power storage.

Electricity

8. Construct a model of this system based on your design.
It must include the application of at least four facts from the
“Moon ABCs Fact Sheet.”

**Sketch of
my model**





Food Production

Purpose

To design and build a model of a food production and delivery system for a human settlement on the Moon.

Key Words

food groups

nutrition

consumption

self-sustaining

Materials

food groups chart

"Moon ABCs Fact Sheet"

construction materials
such as cardboard boxes
and tubes, blocks,
hoses, straws, string,
pins, rubber bands, tape,
etc.

Procedure

1. Review the basic food groups. What are examples of food in each group. What basic jobs for the body does each group perform? Make a chart on a separate paper with your answers.
2. With your class, make a list of the foods and liquids everyone consumed in the past 24 hours. Organize your list in the following way: Put each food group in a different column; then cross out all the items you consider "junk food" and cross out each item made from an animal which must eat another animal to live.
3. We know that, with the exception of carnivores, animals eat plants. But what do green plants "eat" in addition to carbon dioxide, sunlight, and water? Include in your answer a discussion of the nitrogen cycle.
4. It is likely that space in the Moonbase will be limited. Protein sources like cattle and vegetable sources like corn require substantial space for production. Reviewing your list from Question 2, what are other sources of protein which take less space? What fruits and vegetables could be produced in limited space?

Food Production

5. Review the “**Moon ABCs Fact Sheet**” to determine what conditions of sunlight exist. Remember that other teams are responsible for providing you with a water supply (which will probably have to be used cautiously or rationed,) with electricity, with a temperature control system in the constructed Moonbase, and with an air supply of carbon dioxide and oxygen for plants and animals you wish to grow. Remember also that all original stocks of plants and animals must be transported from Earth. With these reminders, your task is to design a food production and delivery system in the Moonbase which will:
 - a) supply the inhabitants with all of their nutritional needs,
 - b) be self-sustaining without additional stock from Earth, and
 - c) provide products appealing enough that the inhabitants will enjoy eating their meals.
6. Construct a model of this system based on your design. It must include the application of at least four facts from the “Moon ABCs Fact Sheet.” For example, how will the Moon’s gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon’s gravity is only 1/6th of Earth’s gravity.



Recreation

Purpose

To design and build a model of recreational facilities for a human settlement on the Moon.

Key Words

entertainment

sedentary lifestyle

active lifestyle

Materials

"Moon ABCs Fact Sheet"

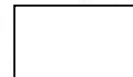
construction materials
such as cardboard boxes
and tubes, blocks,
hoses, straws, string,
pins, rubber bands, tape,
etc.

Procedure

1. What value does entertainment have?

2. What do you do for entertainment? Brainstorm other forms of entertainment which people enjoy doing.

3. Reviewing your list from Question 2, what activities require you to consider the physical environment? What features of the environment does each activity depend upon?



Recreation

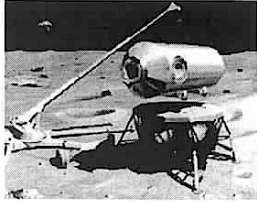
4. What value do you think entertainment would have on the Moon? (Would the Moonbase settlers need entertainment?)

5. Review the “**Moon ABCs Fact Sheet.**” Which of the recreational activities on your list do you think would be possible on the Moon? Include in your answer which activities would be the most practical and popular.

6. Remembering that the Moon has features different from those of Earth, what might be applied to developing new forms of recreation?

7. Design recreational facilities for the Moonbase inhabitants which satisfy any special recreational needs you think they will have and include some new forms of recreation based on the “Moon ABCs Fact Sheet.” You may assume that ample electricity will be available.

8. Construct a model or models of the facilities based on your design. It must include the application of at least four facts from the “Moon ABCs Fact Sheet.” For example, how will the Moon's gravity affect your designs?



Temperature Control

Purpose

To design and build a model temperature control system for a human settlement on the Moon.

Key Words

Fahrenheit

Celcius

Materials

"Moon ABCs Fact Sheet"

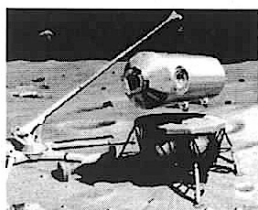
construction materials such as cardboard boxes and tubes, blocks, hoses, straws, string, pins, rubber bands, tape, etc.

Procedure

1. Review the clothes you and your classmates wear during each season of the year, both indoors and outdoors. You may want to write this information on a chalk board or paper.
2. How many degrees does the temperature have to change for you to switch from shorts to jeans, from bare hands to gloves, or to add a shirt over a swimming suit?
3. What effect do Sun, clouds, wind, and your own activity level have on the temperature choices you just made?
4. What are the coldest and hottest temperatures you ever experienced?
5. What is the number of degrees between these two extremes you felt?
6. Besides your selection of clothing, what other precautions did you take to protect your body?
7. Think back to a severe hot spell or cold snap your town experienced or that you heard about. List the effects of these temperature extremes on soil, plants, animals, buildings, water use, and electrical use.
8. What different environments on Earth (both indoor and outdoor) could be uncomfortable or actually dangerous to us if we did not control the temperature to which our bodies were exposed?

Temperature Control

9. What different ways do we have of controlling the temperature on Earth?
10. Review the “**Moon ABCs Fact Sheet.**” How do temperatures on the Moon compare with temperatures on Earth? Will the Moonbase inhabitants be able to exist without special temperature controls on the surface of the Moon? How about in their constructed Moonbase settlement?
11. Design a temperature control system to protect the Moonbase inhabitants and their possessions/equipment both on the surface of the Moon and in their settlement. You may assume that ample electricity will be available.
12. Construct a model of this system based on your design. It must include the application of at least four facts from the “Moon ABCs Fact Sheet.” For example, how will the Moon’s gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon’s gravity is only 1/6th of Earth’s gravity.



Transportation

Purpose

To design and build a model transportation system for a human settlement on the Moon.

Key Words

transportation

Materials

“Moon ABCs Fact Sheet”

construction materials such as cardboard boxes and tubes, blocks, hoses, straws, string, pins, rubber bands, tape, etc.

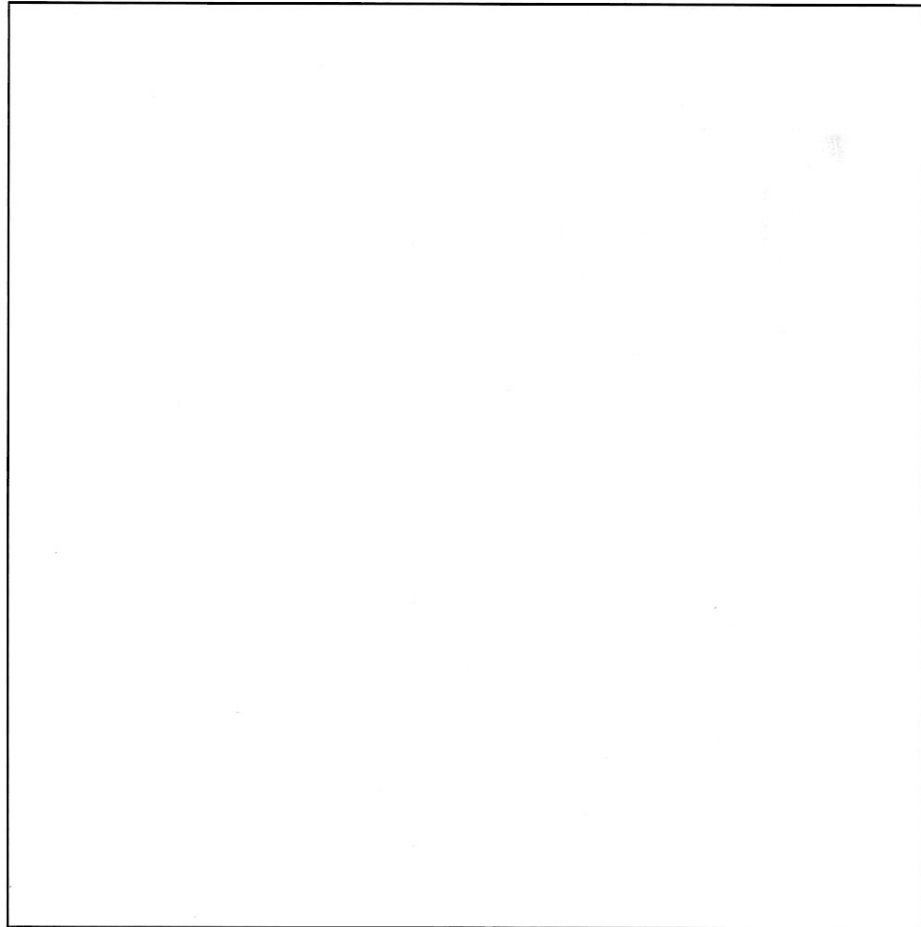
Procedure

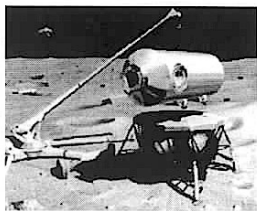
1. What are some different ways we transport people and goods on Earth?
2. What physical features of Earth do these methods require in order to function?
3. Write down the strong points and limitations of each transportation system you listed in Question 1.
4. What do you think would need to be transported on the Moon in each of the following situations:
 - a) within the Moonbase settlement,
 - b) between the settlement and other points on the Moon.
5. Review the “**Moon ABCs Fact Sheet.**” Do you think any of the transportation methods on Earth (from Question 1) would be impractical on the Moon? Why or why not?
6. Which transportation methods on Earth do you think would be particularly useful on the Moon? What features might you have to modify?
7. Design a transportation system to be used by the Moonbase inhabitants which will have components to satisfy the different situations they could encounter (Question 4). For this activity you may assume that some of the basic construction materials you need will be transported from Earth to the settlement. You may also assume that ample electricity will be available.

Transportation

8. Construct a model of this system based on your design. It must include the application of at least four facts from the "Moon ABCs Fact Sheet." For example, how will the Moon's gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon's gravity is only 1/6th of Earth's gravity.

**Sketch of
my model**





Waste Management

Purpose

To design and build a model waste management system for a human settlement on the Moon.

Key Words

recycling

biodegradable materials

nondegradable

self-sustaining

Materials

"Moon ABCs Fact Sheet"

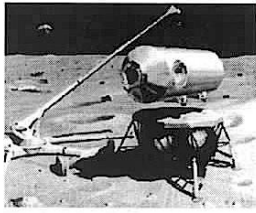
construction materials
such as cardboard boxes
and tubes, blocks,
hoses, straws, string,
pins, rubber bands, tape,
etc.

Procedure

1. Your school, in many ways, is like a miniature town. It has a system for governance, health care, traffic control, a work schedule for its inhabitants, recreation, AND waste disposal. To get a better idea of how much waste your school generates every week, find out how many students plus teachers, administrators, other staff (and animals, if any) are regularly in the buildings.
2. Next, interview the cafeteria staff and the custodial staff for the answers to these questions:
 - (a) What gets thrown away?
 - (b) How many pounds get thrown away every week? Calculate how many pounds of trash this is for every person in the school.
 - (c) Are there any items which can be recycled before disposal? If yes, what are the recycled items?
 - (d) What items are biodegradable?
 - (e) What is the garbage/trash packed in for removal?
 - (f) Where is it taken?
 - (g) According to building codes, how many toilets must there be to accommodate all the people?
3. Waste is a "hot" topic in our society. Why? Discuss what you know about the following phrases: Excessive packaging, landfills, toxic waste, disposable plastic goods, nondegradable material, water pollution, and air pollution.

Waste Management

4. In movies like those starring “Indiana Jones,” well preserved, ancient artifacts are often found in the desert. Scientists also find preserved artifacts in polar ice; for example, mastodons or ancient people. Why aren’t they decayed?
5. Review the “**Moon ABCs Fact Sheet.**” The Moonbase must be an enclosed, self-sustaining settlement. Just like your school, it must perform the basic functions of a town. Other teams are responsible for designing and constructing several other types of systems (air supply, communications, electricity, food production and delivery, recreation, temperature control, transportation, and water supply). Your team’s job is to dispose of the waste which could be generated by these systems. Design a waste disposal system for the Moonbase. Be sure to decide what importance, if any, will be given to biodegradable materials, recycling, and the Moon outside of the constructed settlement.
6. Construct a model of this system based on your design. It must include the application of at least four facts from the “Moon ABCs Fact Sheet.” For example, how will the Moon’s gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon’s gravity is only 1/6th Earth’s gravity.



Water Supply

Purpose

To design and build a model water supply system for a human settlement on the Moon.

Key Words

water conservation
drought

Materials

“Moon ABCs Fact Sheet”
construction materials
such as cardboard boxes
and tubes, blocks,
hoses, straws, string,
pins, rubber bands, tape,
etc.

Procedure

1. Think of all the things you do during a regular school day, from the minute you wake up until the time you go to sleep. List each activity which involves water.
2. Are there any water activities you could eliminate for a day? a week? longer?
3. What other activities in your town use water? Could any of those activities be eliminated?
4. During a dry summer, have you ever heard a public announcement that “water conservation measures are in effect”? What activities are affected by this announcement?
5. Imagine if summer drought continued for years, then how could water be conserved for people? for animals? for crops? for businesses?
6. Review the “**Moon ABCs Fact Sheet.**” Where is the water on the Moon and in what form or forms does it exist?
7. Design a water supply system to be used by the Moonbase inhabitants which will rely only on water available from the Moon’s resources. You may assume that ample electricity will be available.

Water Supply

8. Construct a model of this system based on your design. It must include the application of at least four facts from the "Moon ABCs Fact Sheet." For example, how will the Moon's gravity affect the design of your system? Maybe your system will be very heavy but still portable by only a few Moonbase workers because the Moon's gravity is only 1/6th of Earth's gravity.

**Sketch of
my model**

