AEX

Aerospace Education Excellence

for

Middle School Life Science

Civil Air Patrol

Hands-On Aviation
And Space Activities

Survival on the Moon

Lesson 2

Lesson Reference: Survival! from NASA's Exploration: Then and Now
http://www.nasa.gov/pdf/166504main_Survival.pdf

Objectives:

- Students will analyze and rank items based upon their importance for survival in a particular environment.
- Students will work as a team to come to a consensus about the importance of certain survival items.
- Students will compare team rankings to rankings developed by astronomy experts.
- Students will compare the differences in survival on Earth and the Moon.
- Students will apply the understanding of surviving on the Moon and relate it to surviving on Mars.
- Students will reflect on the activity and synthesize knowledge gained to answer follow-up questions.

National Standards:

Science

- Unifying Concepts and Processes
  - Evidence, models, and explanation
- Content Standard A: Science as Inquiry
  - Abilities necessary to do scientific inquiry
  - Understandings about scientific inquiry
- Content Standard C: Life Science
  - Structure and function of living organisms
  - Interactions of energy and matter
- Content Standard F: Science in Personal and Social Perspectives
  - Science and technology in society
  - Personal health
- Content Standard G: History and Nature of Science
  - Science as a human endeavor

ISTE NETS Technology Standards

- Critical Thinking, Problem Solving, and Decision Making
  - Identify and define authentic problems and significant questions for investigation
  - Collect and analyze data to identify solutions and/or make informed decisions

Background Information: (from http://www.nasa.gov/pdf/166504main_Survival.pdf)

Exploring new worlds is dependent on the survival of explorers and their ability to adapt to new environments. Exploring worlds beyond Earth pushes survival to an entirely new level. In space and on other planets, fulfilling human needs presents great challenges. Survival requires adapting to new environments and finding solutions to new problems. This lesson focuses on learning about the environment of the Moon and choosing items needed to survive. All background information for the students (and teacher) is provided in the Survival on the Moon Scenario handout in this lesson plan.

"Let us continue now with new explorations which are more expansive and more bold voyages which will define us as a space faring civilization." —William Shepherd, Commander, Expedition 1, International Space Station

Materials:

- Survival on the Moon Scenario (1 per student)
- Survival on the Moon Ranking Answer Key (1 per group)
- Survival on the Moon Three-Circle Venn Diagram (1 per group)
- Survival on the Moon Data Collection Form (1 per student)

Advance Lesson Preparation:

Arrange the students into teams of 4-6 people. Make individual copies of the Survival on the Moon Scenario and the Data Collection Form. Make one copy per group of the Survival on the Moon Ranking Answer Key and the Survival on the Moon Three-Circle Venn Diagram. This will help to encourage the group to work together.

Lesson Presentation:

1. Engage the students by discussing a quote related to the idea of exploration: "Exploration is really the essence of the human spirit." This was said by Frank Borman, Commander of the Apollo 8 Mission, which was the first manned mission to orbit the Moon.
2. Conduct a class discussion of exploration by using guiding questions such as the ones listed below.
    a. Can anyone be an explorer? Name some past explorers. (Allow a wide array of answers so that the students understand that anyone can be an explorer.)
    b. Why do you think humans explore?
    c. What are some of the limitations to exploration? (time, resources, money, etc.)
    d. When might exploration lead to settlement? (when there is sufficient food, water, shelter, space, climate, etc.)

e. What are some settlements from history and why were these sites chosen for settlement? (Jamestown, etc.)

f. Where might future settlements be placed and why might these future sites be chosen? (Answers will vary; be sure to discuss the possibility of a settlement on the Moon or Mars.)

3. Draw upon the students' prior knowledge, and as a class, list the essential items for survival here on Earth.
4. Ask the students if they think any items on this list would also be essential for survival on the Moon. Create a list of any additional items that would be needed to survive on the Moon.
5. Distribute the Survival on the Moon Scenario and read it together in class.
6. Now that the students have read about the Moon and the Moon's environment in the scenario, distribute the data collection form and have the students complete the chart. If the students have prior knowledge or research on the Moon, they may use this information to fill in the chart as well.
7. After the students have completed the chart, discuss how this environment would affect survival. An example is that there is little or no oxygen on the Moon. We need oxygen to live. Continue the discussion to help the students understand what they might need to survive in these conditions.
8. Inform the students that they are now all 21st century explorers who are establishing a settlement on the moon.
9. Distribute the list of available items for survival on the moon and review it with the students. Mention to them that some of the items included are not necessarily found when traveling to space, but they may be included in the survival ranking. These items are included to see if the students can determine their importance in a lunar environment. Make sure to discuss any items that may be unfamiliar to the students.
10. Initially have the students independently rank the items listed from 1 to 15, identifying those items that would be the most crucial for human survival in the harsh new environment of the Moon. Items that are ranked with a low number (1-5) are the most important. Items ranked with a high number (10-15) are the least valued. Students should also write a short reason for their rankings. (As an alternative, you could also put the images on index cards and allow the students to sort and rank the items this way.)
11. Divide the students into small groups and have them share their individual rankings with other members of the group. Encourage them to discuss their choices and reasoning. Each team must agree upon a group ranking and record it on their data sheet underneath the chart in the space provided.

12. Ask the team to prepare a way to share their group rankings with the class. This could be in the form of a poster, an overhead transparency, or an electronic spreadsheet on the computer.
13. As the groups are sharing their rankings, make sure to discuss the differences and the reasons for the differences.
14. Tell the students that two NASA scientists developed two different rankings. Distribute the copies of the rankings to the groups. Have the groups carefully examine the reasons that each expert gave for his response. Ask the group to analyze the differences between the experts' ranking and their group's rankings.
15. After the groups have had their discussion, come back together as a class. Talk about why there is not one correct ranking. (Students should realize that the justifications and the explanations for the rankings are more important than the numerical ranking.) Explain that the Ranking Answer Key is based on NASA's scientific information. The scientists who developed the answer keys brought different expertise and understandings to the problem and were specifically asked to complete the rankings independently. Both scientists agreed that they would have made different choices if they had worked as a team to rank the items.
16. Have the students cooperate as a team and complete the Survival on the Moon Three-Circle Venn Diagram to compare the results of the NASA experts to the group's rankings. Students may include any items that are scored plus or minus one number of their choices as an agreement. For example: One expert ranked a magnetic compass as number 14 and one ranked it as a number 15. For the Venn diagram, students should consider the magnetic compass ranking as an agreement. If the group ranked the magnetic compass as a 13, 14, or 15, the item can be placed in the center section where all three circles intersect.
17. Discuss the results of the Venn diagram as a class.
18. Finally, have the students draw on their experiences from the lesson and respond to the follow-up questions on their data collection form.

Summarization:

Discuss the follow-up questions on the data sheet as a class. Be sure that the students state that it is important to know about and prepare for the environment of a new world. Also, if there are prior explorers, it is helpful to know of their experiences. The students should mention challenges such as adapting to new environments and finding solutions to new problems. Essential items that would be needed for the survival of settlers and explorers would be items that help the explorers and settlers travel, navigate, find and store food, offer shelter, find and store water, and protect themselves and their environment, etc. Finally, when talking about the benefits and difficulties related to making decisions as a group, the students should talk about how group decision making brings together more ideas and experiences to help solve a problem. It is sometimes

difficult to build consensus and come to an agreement when working in a group, but ultimately, more minds working together come up with a valuable solution.

Career Connection: (from http://www.onetonline.org/)

Astronomer - Observe, research, and interpret astronomical phenomena to increase basic knowledge or apply such information to practical problems. Sample job titles include Professor, Astronomer, Astronomy Professor, Research Scientist, Associate Professor, Physics and Astronomy Professor, Scientist, Assistant Professor, Astrophysicist, Lunar and Planetary Institute Director.

Anthropologist – Research, evaluate, and establish public policy concerning the origins of humans; their physical, social, linguistic, and cultural development; and their behavior, as well as the cultures, organizations, and institutions they have created. Sample job titles include Professor, Professor of Anthropology, Researcher, Scientist, American Indian Policy Specialist, Anthropologist, Anthropology Instructor, Applied Anthropologist, Behavioral Scientist, and Medical Anthropology Director.

Geographers - Study the nature and use of areas of the Earth's surface, relating and interpreting interactions of physical and cultural phenomena. Conduct research on physical aspects of a region, including land forms, climates, soils, plants, and animals, and conduct research on the spatial implications of human activities within a given area, including social characteristics, economic activities, and political organization, as well as researching interdependence between regions at scales ranging from local to global. Sample job titles include Geographic Information Systems Analyst (GIS Analyst), Geographic Information Systems Program Director (GIS Program Director), Earth Observations Chief Scientist (NASA), Environmental Affairs Corporate Director, Environmental Scientist, GIS Geographer (Geographic Information Systems Geographer), GIS Physical Scientist (Geographic Information Systems Physical Scientist), Research Coordinator, and Scientist.

Evaluation:

- Survival on the Moon Data Collection Form
- Group Venn diagram
- Teacher observation

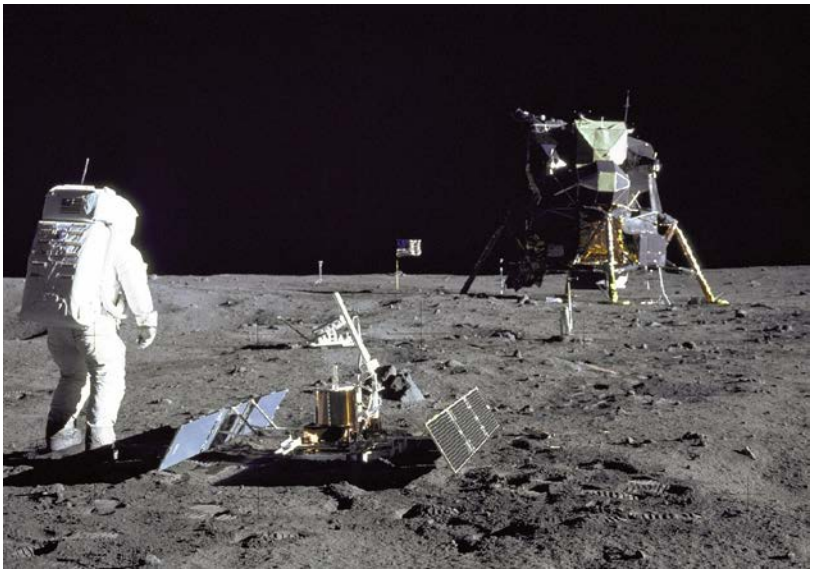
Lesson Enrichment/Extension:

- Learn more about exploration by investigating the transportation needed. Address how vessel design, navigation and propulsion affect exploration.
- Talk specifically about how people adapt to new environments as well as how basic needs are met in new worlds.
- Focus on water and where water is found in the new environment. Talk about how water is important for life as well as how to supply water if none is present in the new environment.
- Look at the area's location, soil and weather and discuss how that affects settlement.

- After the completion of the lesson, allow your students to rank the essential items for survival again and compare the second ranking to the first to see if the students' additional knowledge about exploration changes their ideas about survival.

Associated Websites:

- NASA Educator's Guide: Exploration: Then and Now
  http://www.nasa.gov/audience/foreducators/5-8/features/F_Exploration_Then_and_Now.html
- NASA: Earth's Moon
  http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon
- Can We Survive on the Moon?
  http://discovermagazine.com/2007/mar/can-we-survive-on-the-moon
- Video link of items for Survival on the Moon (Items vary slightly)
  http://vimeo.com/9029566
- Aerospace Team Activity: Survival on the Moon
  http://www.coloradowingcap.org/LinkClick.aspx?fileticket=tLUsNUBkE2c%3D&tabid=811&mid=2905
- Characteristics of the Lunar Environment
  http://www.tsgc.utexas.edu/tadp/1995/spects/environment.html
- Could You Survive a Moon Crash?
  http://www.googlelunarxprize.org/education/learning-guides/could-you-survive-a-moon-crash
- Optional Lesson for Survival on the Moon
  http://www.shurdington.org/Downloads/NASA%20Exercise.pdf
- Interactive Ranking Link for Moon Survival Items
  http://starchild.gsfc.nasa.gov/docs/StarChild/space_level2/activity/problems_space.htm



Astronaut Edwin E."Buzz" Aldrin Jr., Lunar Module pilot, surveys the Apollo 11 landing site on July 20, 1969. He has just deployed the Early Apollo Scientific Experiments Package, with the Passive Seismic Experiment Package next to him. The Lunar Module "Eagle" is in the far right background.
Credit: NASA/Neil A. Armstrong, Lunar Module commander

Survival on the Moon Scenario — Student Handout

The year is 2025 and you are part of a four-member team traveling toward the Moon in the *Orion* spacecraft. *Orion* is a gumdrop-shaped spacecraft designed to carry humans from Earth to the Moon. *Orion* is similar in shape, but larger than the capsules used during the Apollo program. Attached, or docked, to *Orion* is the Lunar Surface Access Module (LSAM), which you will use to land on the Moon.

As your spacecraft enters lunar orbit, you spot the lunar outpost. This outpost has grown, having been built piece by piece during past missions. You are excited to see the outpost. It is located on a crater rim near the lunar south pole, in near-constant sunlight. This location is not far from supplies of water ice that can be found in the cold, permanently shadowed part of the crater.

After transferring into the LSAM and separating from *Orion*, you prepare to descend to the lunar surface. Suddenly, you notice that there is a problem with the thrusters. You land safely, but off course, about 80 kilometers (50 miles) from the lunar outpost. As you look across the charcoal-gray, dusty surface of the Moon, you realize your survival depends on reaching the outpost, finding a way to protect yourself until someone can reach you, or meeting a rescue party somewhere between your landing site and the outpost.

You know the Moon has basically no atmosphere or magnetosphere to protect you from space radiation. The environment is unlike any found on Earth. The regolith, or lunar soil, is a mixture of materials that includes sharp, glassy particles. The gravity field on the Moon is only one-sixth as strong as Earth's. More than 80 percent of the Moon is made up of heavily cratered highlands. Temperatures vary widely on the Moon. It can be as cold as -193°C (-315°F) at night at its poles and as hot as 111°C (232°F) during the day at its equator.

Survival will depend on your mode of transportation and ability to navigate. Your basic needs for food, shelter, water, and air must be considered.

You are challenged to choose items that will help you survive. On the next page, you will find a list of 15 items available to you. Rank these items from 1 to 15 according to their importance to you and your crew. Place the number 1 by the most important item and continue ranking the items to number 15, the least important. Beside each choice, explain why you gave each item the rank it received and how you plan to use the item to help you survive.

Once you have made your own choices, work with your team to come to a consensus. Your survival depends on your ability to work with other team members to determine not only the value of these items, but how to use them as well.

Source: http://www.nasa.gov/pdf/166504main_Survival.pdf

How would you rank these items to survive on the Moon in 2025?

Place the number 1 by the most important item and continue numbering to 15 to indicate the least important item. Beside each item, write your reasons for giving the item its ranking and explain how you plan to use the item to help you survive.

Items that may help you survive on the Moon

Life raft
Self-inflatable floatation device

Rank:

Reason:

Lights with solar-powered re-chargeable batteries
Portable lights powered by solar batteries

Rank: _____

Reason:

Two 45.5-kg (100-pound) tanks of oxygen
Pressurized oxygen tanks

Rank: _____

Reason:

Signal mirror
Handheld mirror

Rank: _____

Reason:

Space blanket
Thin sheet of plastic material coated with metallic reflecting layer

Rank:

Reason:

38 liters (10 gallons) of water
Container of water

Rank: _____

Reason:

First aid kit
Basic first aid kit with pain medication and medicine for infection

Rank: _____

Reason:

Solar-powered radio receiver-transmitte
Communication tool powered by the sun

Rank: _____

Reason:

Food concentrate
Dehydrated food to which water is added

Rank: _____

Reason:

Map of the Moon's surface
Map showing the Moon's terrain

Rank: _____

Reason:

Magnetic compass
Tool that uses a magnetic field to determine direction

Rank: _____

Reason:

15 meters (about 50 feet) of nylon rope
Manufactured rope

Rank: _____

Reason:

Source: http://www.nasa.gov/pdf/166504main_Survival.pdf

Parachute
Large piece of silk cloth

Rank:

_____

Reason:

Space suit repair kit
Materials to repair tiny holes in fabric

Rank:

_____

Reason:

Box of matches
Wooden sticks with sulfur-treated heads

Rank:

_____

Reason:

Quick Reference
List your personal rankings in order from 1-15.
(1= most important; 15 = least important)

1. _____

2. _____

3. _____

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

12. _____

13. _____

14. _____

15. _____

Source: http://www.nasa.gov/pdf/166504main_Survival.pdf

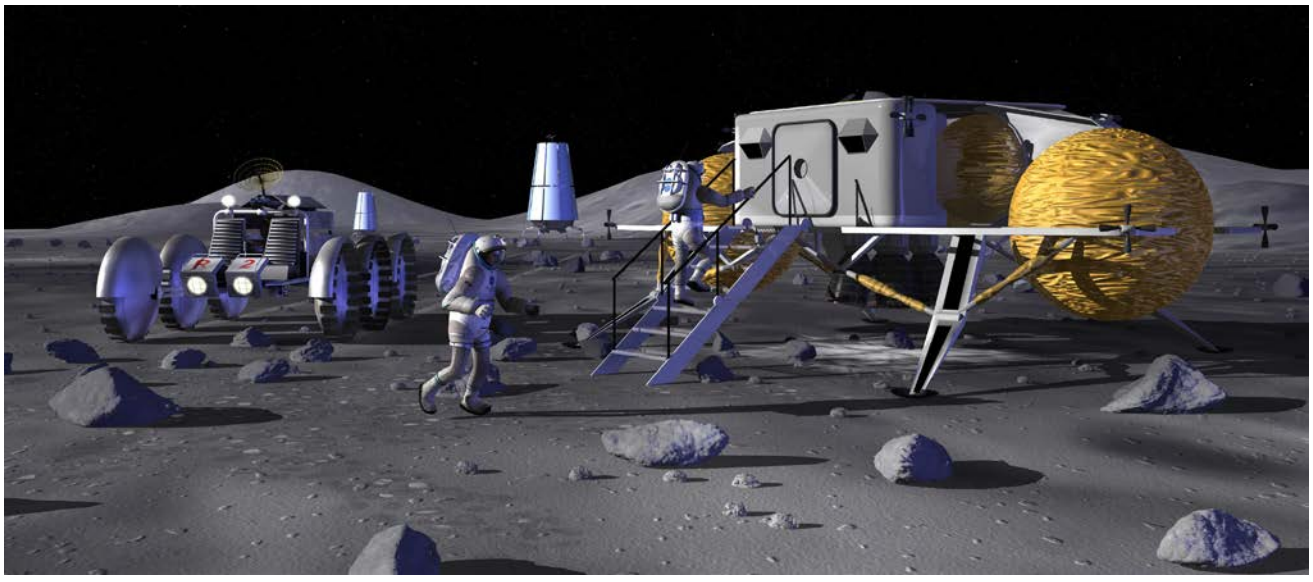
Survival on the Moon Ranking Answer Key Student Handout

Two NASA scientists separately ranked the same items and explained their reasons for their rankings. Dr. Carlton Allen was the first expert. Dr. Allen is the curator and manager of the Astromaterials Research and Exploration Science (ARES) Astromaterials Acquisition and Curation Office. This office is responsible for protecting, preserving, and distributing extraterrestrial samples to help others learn more about solar system exploration. These samples include the Apollo Moon rocks and regoliths, Antarctic meteorites, and particles of solar wind. Dr. Allen's background is in planetary science. The second expert was John Gruener. He is a flight systems engineer at NASA's Johnson Space Center and his background is in aerospace engineering and physical sciences with an emphasis in planetary geology. He has worked as a rocket scientist designing missions to the Moon and Mars, as a space farmer growing plants in advanced life-support systems, and as a planetary scientist studying the rocks and soils on Mars.

Both experts agreed that the type of lander in which you were traveling would determine your course of action if you landed on the wrong place on the Moon. If you were in a two-stage lander (one stage for descent and one stage for ascent, like the Apollo lunar module), they suggested that you terminate the surface mission, head back to orbit, rendezvous with Orion in lunar orbit, and head home.

If returning home was not a choice and you were stuck on the Moon, the experts suggested that you sit tight and wait for someone at the outpost to come and get you. They agreed that the safest thing to do in this situation, as in most emergencies, is to stay put and call for help.

If someone from the outpost cannot reach you, then the experts felt that you had no option other than to try to make it to the outpost. The rankings and explanations below indicate how each expert ranked the items to help you reach the outpost.



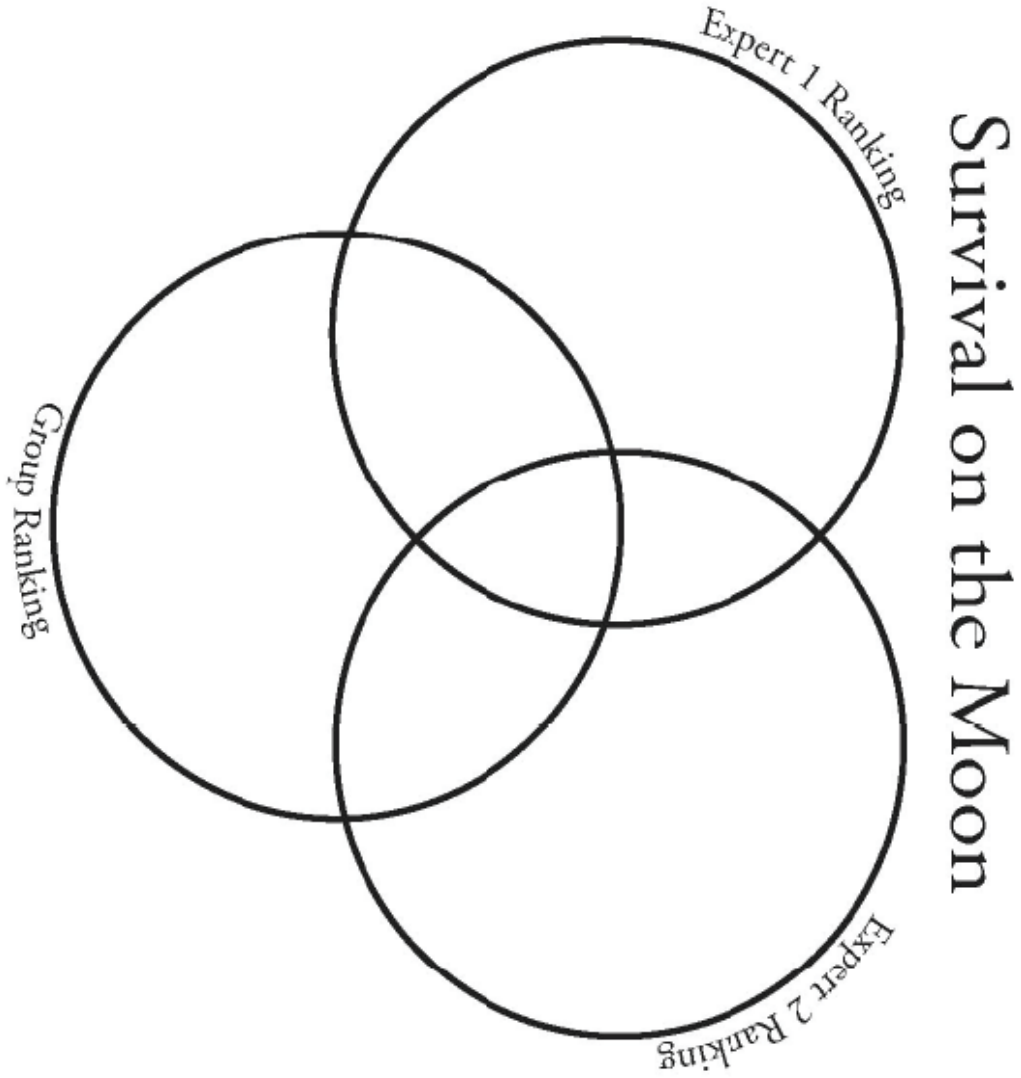
This is an artist's concept of a small lunar outpost. Someday, larger lunar outposts may serve as a backup for civilization in case of a global catastrophe, like an asteroid impact or a pandemic.
Source: NASA at http://www.nasa.gov/centers/goddard/images/content/208292main_lunar_outpost_lgweb.jpg

First Expert's Ranking and Reasons	Second Expert's Ranking and Reasons
1) Two 45.5-kilogram (100-pound tanks of oxygen *"With basically no atmosphere on the Moon, oxygen (O2) to breathe is the most pressing survival need. The average person needs about 0.84 kilograms (a little less than 2 pounds) of O2 per day."*	**1) Two 45.5-kilogram (100-pound) tanks of oxygen** *"Oxygen to breathe is the most important survival need, since the Moon has virtually no atmosphere."*
2) 38 liters (10 gallons) of water *"Though we believe there is some water in the form of ice on the Moon, there is no liquid water. Water is essential to all life. Currently, each astronaut aboard the International Space Station (ISS) uses about 11 liters (3 gallons) of water daily."*	**2) 38 liters (10 gallons) of water** *"Water is another basic survival need for the astronauts. Because there is no liquid water on the Moon, the astronauts will need the water they brought with them to survive."*
3) Food concentrate *"Food concentrate is a good source of food and an efficient way to carry it."*	**3) Food concentrate** *"Although the food concentrate must have water added to be useful, it is lightweight and easy to carry, meeting a third basic need for survival."*
4) Solar-powered radio receiver-transmitter *"Hopefully people from the lunar outpost are looking for you while you are trying to reach them. A solar-powered radio receiver-transmitter is important to maintain this communication."*	**4) Solar-powered radio receiver-transmitter** *"As people from the lunar outpost are looking for you, you should try to reach them. Maintaining communication with your outpost is essential."*
5) First aid kit *"No matter where you are, a first aid kit is a good idea. Be sure you carry pain medication and medicine for infections."*	**5) First aid kit** *"A first aid kit takes up little space and may be important to have in case of illness or injury."*
6) Map of the Moon's surface *"A map of the Moon's surface is your primary way to identify your location and to help you navigate."*	**6) Map of the Moon's surface** *"With no other directional tools available, a map of the Moon's surface is the most important means of finding your way from one location to another."*
7) Space suit repair kit *"You cannot afford to have any tears in your space suit. Your suit protects you from harsh conditions while you make your way to the lunar outpost. The soil of the Moon (regolith) 'sticks' to space suits and equipment. It is very sharp, like tiny fragments of glass or coral, and can cut holes that put your life at risk."*	**7) Space suit repair kit** *"Your space suit protects you from the harsh conditions on the Moon. The sharp soil of the Moon can cut tiny holes in the suit, which may compromise its effectiveness."*

8) 15 meters (about 50 feet) of nylon rope *"The nylon rope is useful in scaling cliffs or craters you may have to cross. To prevent injury or in case you cannot walk, rope is helpful for tying you to others."*	**8) Life raft** *"The life raft makes a great sled for carrying the oxygen and water."*
9) Space blanket *"The space blanket helps reduce heat loss from a person's body. The reflective material reflects about 80 percent of the wearer's body heat back to the body. The reflected side is also used to prevent absorption of sunlight."*	**9) Space blanket** *"The space blanket is used to insulate the oxygen and water from the hot daytime temperatures. Temperatures vary widely on the Moon. It can be as cold as -193°C (-315°F) at night at its poles and as hot as 111°C (232°F) during the day at its equator."*
10) Signal mirror *"The signal mirror is an important way to communicate during the daylight. The Moon's daylight is brighter and harsher than Earth's. There is virtually no atmosphere to scatter the light, no clouds to shade it, and no ozone layer to block the sun burning ultraviolet light."*	**10) 15 meters (about 50 feet) of nylon rope** *"The rope makes dragging the life raft easier or may come in handy when crossing difficult terrain."*
11) Lights with solar-powered rechargeable batteries *"These lights allow for nighttime travel. The nights on the Moon are brighter than nights on Earth, at least on the side of the Moon that is facing Earth. With its clouds and oceans, Earth reflects more light than the dark Moon rocks. Earthlight on the Moon is much brighter than moon-light on Earth."*	**11) Lights with solar-powered rechargeable batteries** *"The lights are helpful if you travel across large shadowed areas. Some areas in the polar regions are permanently dark."*
12) Life raft *"A life raft is of little use for survival on the Moon. Although it could be used to drag heavy items, the sharp regolith would quickly puncture the raft."*	**12) Signal mirror** *"The signal mirror is used as a form of communication if the radio is not working."*
13) Parachute silk *"Compared to other items, this item is of little use."*	**13) Parachute silk** *"Parachute silk comes in handy as a backup sled to the life raft, or as shade."*
14) Magnetic compass *"The Moon has no global magnetic field, which makes a magnetic compass virtually useless."*	**14) Box of matches** *"With little oxygen on the Moon, the matches are useless."*
15) Box of matches *"Matches are virtually useless on the Moon because there is little oxygen."*	**15) Magnetic compass** *"The compass is virtually useless because there is no Moon-wide magnetic field."*

Source: http://www.nasa.gov/pdf/166504main_Survival.pdf

Compare your group's rankings to the expert's rankings. You may consider any item scored plus or minus one number as an agreement. For example: Expert 1 ranked a magnetic compass as number 14 and Expert 2 ranked it as number 15. For the Venn Diagram, the magnetic compass is an agreement. If your group ranked the magnetic compass a 13, 14, or 15, the item should be placed in the center section where all three circles intersect. If one of your group's rankings matched only with Expert 1's ranking, that item would be placed in the space where Expert 1's circle overlaps with the Group Ranking circle. If an item is not a match for any one, that item is placed outside the three circles.



Source: http://www.nasa.gov/pdf/166504main_Survival.pdf

Name: _____

Survival on the Moon Data Collection Form

The Moon and the Moon's Environment

What do we know about the Moon?	How would this affect survival?	What would I need to survive in this environment?
Example: There is little or no oxygen on the Moon.	We need oxygen to live.	To survive, we need a source for oxygen.

Please list your group's rankings by starting with the most important item and ending with the least important item.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____
13. _____
14. _____
15. _____

Follow-up Questions

What must explorers do before traveling to new worlds to prepare for their explorations?

_____

_____

_____

What challenges do explorers face when they travel to new worlds?

_____

_____

_____

_____

What are the most essential items for the survival of explorers and settlers in new worlds?

_____

_____

_____

What are the benefits and difficulties in making decisions as a group?

_____

_____

_____

_____

In addition to building a settlement on the Moon, NASA also plans for humans to travel to Mars. Traveling to Mars and beyond pushes the science of survival to a new level. Discuss what you think NASA will need to know and do before sending astronauts to Mars. Identify some items that would be essential for survival of settlers.

_____

_____

_____

_____

_____

_____