We Choose Space!

Educator Guide

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Abstract:
This packet is an educational guide for the planetarium show “We Choose Space”, produced by the Houston Museum of Natural Science under subcontract from the Louisiana Art and Science Museum with funding from NASA’s Office of Space Exploration. This comprehensive teacher packet will provide activities for teachers to complete prior to the show and follow-up activities. The audio and script of the show were analyzed to determine which standards were covered and referenced in the show. In order to make this guide applicable to teachers in Texas and beyond both National Core Curriculum Standards in Science and Texas Essential Knowledge and Skills for Science were listed. A multiple choice pre- and post- show questionnaire was designed based the content of the show. Each lesson provided references a multi-grade TEK, which generally also corresponds to a federal standard. The composition of the lessons is based on the material presented in the show. These lessons can be adapted to varying grade and ability levels. This educational guide also includes the script of the show, with annotations as to interactive questions you can discuss with the students during the show (pausing the show as needed for discussion). We also include a hotlist of additional resources. The additional resources can be used for both the teacher, to familiarize themselves with material prior to the show, and students.

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Standards Alignment

National Core Curriculum Standards in Science

http://www.nap.edu/catalog.php?record_id=4962

K-4 Standards:

- The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described. (K-4 Standard, p. 134)

- Objects in the sky have patterns of movement. The sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The moon moves across the sky on a daily basis much like the sun. The observable shape of the moon changes from day to day in a cycle that lasts about a month. (K-4 Standard, p. 134)

- (Motions and Forces) The position and motion of objects can be changed by pushing or pulling. The size of the change is related to the strength of the push or pull. (K-4 Standard, p. 127)

- Resources are things that we get from the living and nonliving environment to meet the needs and wants of a population. (K-4 Standard, p. 140)

- 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. (K-4 Standard, p. 140)

5-8 Standards: (Page 154)

- (Transfer of Energy, p. 155): The sun is a major source of energy for changes on the earth's surface.

- (Living Systems, p. 157) An organism's behavior evolves through adaptation to its environment. How a species moves, obtains food, reproduces, and responds to danger are based in the species' evolutionary history.

- (Earth, p. 160) The earth is the third planet from the sun in a system that includes the moon, the sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The sun, an average star, is the central and largest body in the solar system. (5-8 Standard)

- (Earth, p. 161) Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the solar system. Gravity alone holds us to the earth's surface and explains the phenomena of the tides. (5-8 Standard)

- (Earth, p. 161) Most objects in the solar system are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses. (5-8 Standard)

- (Earth, p. 161) The sun is the major source of energy for phenomena on the earth's surface, such as growth of plants, winds, ocean currents, and the water cycle. Seasons result from variations in the amount of the sun's energy hitting the surface, due to the tilt of the earth's rotation on its axis and the length of the day. (5-8 Standard)

- (Science and Technology, p. 166) Technological designs have constraints. Some constraints are unavoidable, for example, properties of materials, or effects of weather and friction; other constraints limit choices in the design, for example, environmental protection, human safety, and aesthetics.

- (Personal Health, p. 168) Natural environments may contain substances (for example, radon and lead) that are harmful to human beings. Maintaining environmental health involves establishing or monitoring quality standards related to use of soil, water, and air.

9-12 Standards: (Page 154)

- (Forces, p. 180) Gravitation is a universal force that each mass exerts on any other mass. The strength of the gravitational attractive force between two masses is proportional to the masses and inversely proportional to the square of the distance between them.

- (Matter, energy and organization, p. 186) The distribution and abundance of organisms and populations in ecosystems are limited by the availability of matter and energy and the ability of the ecosystem to recycle materials.

- (Environmental Quality, p. 198) Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.

TEKS - Texas Essential Knowledge and Skills for Science

http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html

- Elementary Concepts Covered: 1.6A, 2.8D, 3.6A, 3.7C, 4.7C, 4.9A, 5.7C, and 5.8D
- Elementary Content Referenced: 1.8B, 2.6C, and 3.8C
- Middle School Concepts Covered: 6.11B, 6.11C, 7.9A, and 8.6C
- Middle School Content Referenced: 6.8B, 7.5A, 7.10A, and 8.11B
- High School Astronomy Content Referenced: 4D, 8C, 14A, 14B, and 14E
- High School Earth and Space Science Content Referenced: 3E, 5D, 11D, and 12C

In parenthesis at the end of each standard is the scene in the movie where the standard is specifically addressed.

Elementary Science Standards

First Grade

(6) Force, motion, and energy. The students knows that force, motion, and energy are related and are a part of everyday life. The student is expected to:
- (A) identify and discuss how different forms of energy such as light, heat, and sound are important to everyday life. (D1)

(8) Earth and space. The student knows that the natural world includes the air around us and objects in the sky. The student is expected to:
- (B) observe and record changes in the appearance of objects in the sky such as clouds, the Moon, and stars, including the Sun; (A7)

Second Grade

(6) Force, motion, and energy. The student knows that forces cause change and energy exists in many forms. The student is expected to:
- (B) observe and record changes in the appearance of objects in the sky such as clouds, the Moon, and stars, including the Sun; (A7)

(8) Earth and space. The student knows that there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:
- (D) observe, describe, and record patterns of objects in the sky, including the appearance of the Moon. (A7)

Third Grade

(6) Force, motion, and energy. The student knows that forces cause change and that energy exists in many forms. The student is expected to:

(A) explore different forms of energy, including mechanical, light, sound, and heat/thermal in everyday life; (D1)

(7) Earth and space. The student knows that Earth consists of natural resources and its surface is constantly changing. The student is expected to:
(C) identify and compare different landforms, including mountains, hills, valleys, and plains; and (A5)

(8) Earth and space. The student knows there are recognizable patterns in the natural world and among objects in the sky. The student is expected to:
(C) construct models that demonstrate the relationship of the Sun, Earth, and Moon, including orbits and positions; and

Fourth Grade

(7) Earth and space. The students know that Earth consists of useful resources and its surface is constantly changing. The student is expected to:
(C) identify and classify Earth's renewable resources, including air, plants, water, and animals; and nonrenewable resources, including coal, oil, and natural gas; and the importance of conservation. (D1)

(9) Organisms and environments. The student knows and understands that living organisms within an ecosystem interact with one another and with their environment. The student is expected to:
(A) investigate that most producers need sunlight, water, and carbon dioxide to make their own food, while consumers are dependent on other organisms for food; (D1)

Fifth Grade

(5) Matter and energy. The student knows that matter has measurable physical properties and those properties determine how matter is classified, changed, and used. The student is expected to:
(C) demonstrate that some mixtures maintain physical properties of their ingredients such as iron filings and sand; and (B3)

Middle School

Sixth Grade

(8) Force, motion, and energy. The student knows force and motion are related to potential and kinetic energy. The student is expected to:
(B) identify and describe the changes in position, direction, and speed of an object when acted upon by unbalanced forces; (D1)

(11) Earth and space. The student understands the organization of our solar system and the relationships among the various bodies that comprise it. The student is expected to:

(B) understand that gravity is the force that governs the motion of our solar system;(B2)

Seventh Grade

(5) Matter and energy. The student knows that interactions occur between matter and energy. The student is expected to:

(A) recognize that radiant energy from the Sun is transformed into chemical energy through the process of photosynthesis;(D1)

(9) Earth and space. The student knows components of our solar system. The student is expected to:

(A) analyze the characteristics of objects in our solar system that allow life to exist such as the proximity of the Sun, presence of water, and composition of the atmosphere; and (D1)

(10) Organisms and environments. The student knows that there is a relationship between organisms and the environment. The student is expected to:

(A) observe and describe how different environments, including microhabitats in schoolyards and biomes, support different varieties of organisms; (D1)

Eighth Grade

(6) Force, motion, and energy. The student knows that there is a relationship between force, motion, and energy. The student is expected to:

(C) investigate and describe applications of Newton's law of inertia, law of force and acceleration, and law of action-reaction such as in vehicle restraints, sports activities, amusement park rides, Earth's tectonic activities, and rocket launches. (D1)

(11) Organisms and environments. The student knows that interdependence occurs among living systems and the environment and that human activities can affect these systems. The student is expected to:

(B) investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition; (D1)

Astronomy:

(4) Science concepts. The student recognizes the importance and uses of astronomy in civilization. The student is expected to:

(D) explain the contributions of modern astronomy to today's society, including the identification of potential asteroid/comet impact hazards and the Sun's effects on communication, navigation, and high-tech devices.(A3, A4, A5, and C2)

(8) Science concepts. The student knows the reasons for the seasons. The student is expected to:
- (C) recognize that the angle of incidence of sunlight determines the concentration of solar energy received on Earth at a particular location; and

(14) Science concepts. The student recognizes the benefits and challenges of space exploration to the study of the universe. The student is expected to:
- (A) identify and explain the contributions of human space flight and future plans and challenges; (A3, A4, and A5)
- (B) recognize the advancement of knowledge in astronomy through robotic space flight; (C2)
- (E) demonstrate an awareness of new developments and discoveries in astronomy.(C6)

Earth and Space Science

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:
- (E) explore careers and collaboration among scientists in Earth and space sciences; (C6 and C7)

(5) Earth in space and time. The student understands the solar nebular accretionary disk model. The student is expected to: (B2)
- (D) explore the historical and current hypotheses for the origin of the Moon, including the collision of Earth with a Mars-sized planetesimal;

(11) Solid Earth. The student knows that the geosphere continuously changes over a range of time scales involving dynamic and complex interactions among Earth's subsystems. The student is expected to:
- (D) interpret Earth surface features using a variety of methods such as satellite imagery, aerial photography, and topographic and geologic maps using appropriate technologies; and (C5)

(12) Solid Earth. The student knows that Earth contains energy, water, mineral, and rock resources and that use of these resources impacts Earth's subsystems. The student is expected to:
- (C) discriminate between renewable and nonrenewable resources based upon rate of formation and use; (D1)

Next Generation Science Standards (DRAFT)

(A revision of A Framework for K-12 Science Education)
http://www.nap.edu/catalog.php?record_id=13165

Note: many of these standards are demonstrated but not discussed specifically. Teachers can use the video to start a discussion of these topics.

ESS2.E: Biogeology
§ Plants and animals (including humans) depend on the land, water, and air to live and grow. They in turn can change their environment (e.g., the shape of land, the flow of water).

ESS3.A: Natural Resources
§ Living things need water, air, and resources from the land, and they try to live in places that have the things they need. Humans use natural resources for everything they do: for example, they use soil and water to grow food, wood to burn to provide heat or to build shelters, and materials such as iron or copper extracted from the earth to make cooking pans.

PS3.B: Conservation of Energy and Energy Transfer
§ Sunlight warms Earth's surface. (a)

ETS2.B: Interactions of Engineering, Technology, Science, Society, and the Natural Environment
§ People depend on various technologies in their lives; human life would be very different without technology.

ESS1.B: Earth and the Solar System
§ Seasonal patterns of sunrise and sunset can be observed, described, and predicted.

ESS2.A: Earth Materials and Systems
§ _Wind and water can change the shape of the land. The resulting landforms, together with the materials on the land, provide homes for living things. (b),(c),(d)

ESS2.C: The Roles of Water in Earth's Surface Processes
§ _Water is found in the ocean, rivers, lakes, and ponds. Water exists as solid ice and in liquid form. It carries soil and rocks from one place to another and determines the variety of life forms that can live in a particular location.

LS2.A: Interdependent Relationships in Ecosystems
§ _Animals depend on their surroundings to get what they need, including food, water, shelter, and a favorable temperature. Animals depend on plants or other animals for food. (a)

§ _Plants depend on air, water, minerals (in the soil), and light to grow. (b)

ETS2.B: Interactions of Engineering, Technology, Science, Society, and the Natural Environment
§ _When new technologies become available, they can bring about changes in the way people live and interact with one another.

ESS3.A: Natural Resources
§ _All materials, energy, and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not.

PS2.B: Types of Interactions
§ _The gravitational force of Earth acting on an object near Earth's surface pulls that object towards the planet's center.

ESS1.A: The Universe and Its Stars
§ _Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.

ESS1.B: Earth and the Solar System
§ _The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them. This system appears to have formed from a disk of dust and gas, drawn together by gravity.

ESS3.A: Natural Resources
§ _Humans depend on Earth's ocean, atmosphere, and biosphere for many different resources. Fresh water and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of weather-and climate-related processes. (

ESS3.A: Natural Resources
§ _Resource availability has guided the development of human society. Resource availability affects geopolitical relationships and can limit development. (a)
§ _All forms of energy production and other resource extraction have associated economic, social, environmental, and geopolitical costs and risks as well as benefits. New technologies and social regulations can change the balance of these factors. (b)
§ _As the global human population increases and people's demands for better living conditions increase, resources considered readily available in the past, such as land for agriculture or drinkable water, are becoming scarcer and more valued.

ESS3.C: Human Impacts on Earth Systems
§ _The sustainability of human societies and the biodiversity that supports them

requires responsible management of natural resources.

PS2.A: Forces and Motion
§ _The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. (b),(f)
§ _The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (d)

PS4.C: Information Technologies and Instrumentation
§ _Appropriately designed technologies (e.g., radio, television, cell phones, wired and wireless computer networks) make it possible to detect and interpret many types of signals that cannot be sensed directly. Designers of such devices must understand both the signal and its interactions with matter.

Crosscutting:
Influence of Engineering, Technology, and Science on Society and the Natural World
Every human-made product is designed by applying some knowledge of the natural world and is built by using natural materials. Therefore, taking natural materials to make things impacts the environment.

Pre- and Post-Program Questionnaire

The pre- and post- show questionnaire is intended to serve as a measure of effectiveness of both the show itself and the supplemental material. Prior to any information about the show being provided to students they should take the pre-show questionnaire. This should serve as an accurate gauge of their prior knowledge.

Upon completion of viewing the show and the activities on the following pages, students should be given the same questionnaire. By comparing the pre-show and post-show scores, the overall effectiveness of the program can be determined. If these are used, we would appreciate giving the results to Dr. Reiff (reff@rice.edu).

Name ________________________________

We Choose Space! **Questionnaire**

1) Which U.S. President announced, at Rice University that we would travel to the moon?
   a) John F. Kennedy
   b) Lyndon B. Johnson
   c) Dwight D. Eisenhower
   d) Richard M. Nixon

2) Which country was the first to put a human into space?
   a) The United States
   b) Italy
   c) The Soviet Union
   d) Japan

3) A young Earth was formed from which of the following?
   a) accretion
   b) condensation
   c) planetesimals
   d) all of the above

4) Which of the following theories is the accepted idea of how our moon formed?
   a) fission
   b) impact
   c) capture
   d) co-formation

5) Which celestial object is responsible for Earth's tides?
   a) Sun
   b) comets
   c) Moon
   d) asteroids

6) What is the duration of time an astronaut can stay on the International Space Station?

a) 6 months
b) 6 weeks
c) 1 year
d) 6 years

7) What is the main source of power for the International Space Station?

a) nuclear power
b) solar power
c) rocket fuel
d) oxygen

8) The areas that contain trapped ice on the Moon are:

a) the poles
b) the near side
c) the far side
d) the craters

9) Sixty five million years ago Earth had an impact with what type of object that destroyed over half of all species?

a) comet
b) meteor
c) planet
d) asteroid

10) What energy fuel on the moon could power tomorrow's nuclear fusion reactors on Earth?

a) hydrogen
b) solar
c) helium 3
d) oxygen

11) The flying human in the lunar habitat is most like
    a) an eagle
    b) a bat
    c) a flying squirrel
    d) a moth

12) Creating a human-rated habitat on the moon will likely be
    a) expensive
    b) difficult to construct
    c) not in the near future
    d) all of the above

13) If someone is born on and grows up on the Moon, what might happen if they visit Earth?
    a) they will be stronger and have weaker bones than folks who grew up on Earth
    b) they will be weaker and have weaker bones than folks who grew up on Earth
    c) they will be stronger and have stronger bones than folks who grew up on Earth
    d) they will be weaker and have stronger bones than folks who grew up on Earth

14) One of the most important things that we have learned from the space program is
    a) that Earth is the planet best suited for us to live in so we should take care of it
    b) that the Moon would be easy to colonize
    c) that a space station can be created quickly and inexpensively
    d) that we should use up all our oil on energy and not develop solar energy

15) How does the gravity on the Moon compare to the gravity on Earth?
    a) less gravity on the Moon
    b) more gravity on the Moon
    c) the same amount of gravity
    d) there is no gravity on the Moon

16) How often is there a sunrise on the space station?
    a) every 24 hours
    b) every 90 hours
    c) every 24 minutes
    d) every 90 minutes

We Choose Space!
Questionnaire Answer Key

1) a – John F. Kennedy

2) c – The Soviet Union

3) d – all of the above

4) b – impact

5) c – Moon

6) a – 6 months

7) b – solar power

8) a – the poles

9) d – asteroid

10) c – helium 3

11) c – a flying squirrel

12) d – all of the above

13) b – they will be weaker and have weaker bones than folks who grew up on Earth

14) a – that earth is the planet best suited for us to live in so we should take care of it

15) a – less gravity on the moon

16) d – every 90 minutes

Discussion Questions

(the show may be stopped at break points for group discussion
or you can discuss these after the show.)

Technology:

1. How has the technology of space travel changed in the past forty years? Is it more or less comfortable to go into space? More or less dangerous?
2. How many years did it take to build the space station? How long do you think it would take to build it on earth? What challenges must be faced by construction crews in space?
3. Do you think the lunar biosphere is realistic? What kind of less expensive habitat might you imagine for a first building on the Moon?

Habitats and Environments:

1. What things do people absolutely need to have in their environment to survive on the moon?
2. What things are very important, but not essential?
3. How do you decide what is worth the weight of taking up into space?

Gravity:

1. Why is the moon's surface gravity so much less than Earth's? If the moon were more dense (same mass but smaller radius), would its gravity be bigger or smaller?
2. When you become fully adapted to life on the Moon, will you still be able to jump as high as you did when you first arrived?
3. What other effects will low gravity have on plants and animals?

Space Exploration:

1. What should be the next destination for humans to travel to? Why?
2. Why are robotic missions so much more cost-effective than human exploration?
3. In what circumstances are humans better explorers than robots?

Science and Society:

1. What kinds of jobs would be needed in a space colony?
2. What kinds of jobs would NOT be needed in a lunar colony?
3. Would children born on the Moon be able to visit Earth?

Discussion questions during the show:

1: When we went to the moon, income taxes were higher. Would you pay higher income taxes to return to the Moon or travel to Mars?

2: What space events occurred the year you were born?

3: Would you like to go to space as a tourist? How much would you pay for a week in space?

4: Some argue that without the Moon we would not have metals near the surface and so no life. What would the Earth be like without a Moon? Would the day be longer or shorter?   (A: shorter. The tides have caused the Earth's spin to slow down)

5. Why are the wheels on the lunar rover made of mesh? Is the lunar surface rocky, marshy or dusty? (A: dusty over rocks. The mesh allows the dust to fly off and not cling to the wheels. Gives good traction with little weight)

6. Some people argue that the lunar landings were faked. Can you see evidence in these movies that the gravity they are experiencing on the Moon is less than on Earth? (A: The dust they kick up falls slowly; when they trip they fall slowly)

7. What kinds of supplies do astronauts on the ISS need to live? How much of their food, air and water is recycled?

8. What kinds of scientific experiments are best done in space? (A: experiments that need a free-fall (weightless) environment)

9. What kinds of things can commercial space transport companies do that NASA cannot? (A: NASA cannot take tourists, for example, but commercial space operators can.)

10. What would be the advantage to take off from the space station instead of the Earth's surface when traveling to the Moon or Mars? (A: You can bring up your fuel separately and not have to make such a huge rocket to take off from Earth. You need less energy to leave the ISS orbit than to leave the surface of Earth.)

11. What would be the advantage to use the lunar surface as a base for radio telescopes (and X-ray and gamma-ray telescopes?)   A: No atmosphere or ionosphere to absorb the signals from space.

12: Why is having a base at the south pole good for energy? (A: If you have a base exactly at the south pole, the sun will just travel around your horizon every day. No *night means you won't have to store solar energy in batteries. Most places on the Moon have 14 days of sunlight then 14 days of darkness.*)

13: *What items would you need for a closed biosphere? What things would be recycled? What things would have to come from Earth?*

Lesson 1: *We Choose Space!*

Compare and Contrast the Sun, Earth, and Moon

Science standard: Identify and compare the physical characteristics of the Sun, Earth, and Moon.

Objective: Students will list the physical characteristics of the Sun, Earth, and Moon. Students will be able to identify characteristics that are similar between the Sun, Earth, and Moon. Students will be able to identify characteristics of the Sun, Earth, and Moon differentiating them from each other.

Procedures:

1. Independent Practice – Give each student a "Compare and Contrast the Sun, Earth, and Moon" worksheet. Ask them to fill out the worksheet for a given period of time. They should try and list as many characteristics under each category as possible.
2. Pair/Share – In groups of 2 or 3, students should share their answers. They should add any information that their group members share but is not on their worksheet.
3. Class Discussion – As a class complete the compare and contrast worksheet (either on a larger piece of paper, whiteboard, or transparency) together. Have students add any new answers that are not on their individual worksheets.

Assessment: Students will complete the assessment worksheet independently

Name_______________________________

Lesson 1: *We Choose Space!*

Compare and Contrast the Sun, Earth, and Moon

Directions: In the table below, list characteristics that are unique to the Sun, Earth, and Moon in the appropriate columns.

Sun	Earth	Moon

Lesson 1: *We Choose Space!*

Compare and Contrast the Sun, Earth, and Moon **Answer Key**

Directions: In the table below, list characteristics that are unique to the Sun, Earth, and Moon in the appropriate columns.

Sun	Earth	Moon
Yellow Star Composed of gases (mostly hydrogen and helium) Produce energy through nuclear fusion Produces its own light Relatively stationary object Has a magnetic field	Atmosphere rich in oxygen and nitrogen Orbits a star Has life on it Reflects light from the Sun Has a magnetic field Liquid water on the surface Length of day 24 hours	Orbits a planet Does not produce its own visible light Has ice trapped at the poles Has no atmosphere Reflects lights from the sun Length of day 29 days

Name ____

Lesson 1: *We Choose Space!*

Compare and Contrast the Sun, Earth, and Moon Assessment

Directions:

1. Put a number "1" in the boxes next to the characteristics below that are unique to the Sun.
2. Put a number "2" in the boxes next to the characteristics below that are unique to Earth.
3. Put a number "3" in the boxes next to the characteristics below that are unique to Moon.
4. If a fact is applicable to more than one object place all the numbers in the box.

	Orbits a planet		Atmosphere rich in hydrogen and helium
	Composed of gases (mostly hydrogen and helium)		Orbits a star
	Has life on it		Has no atmosphere
	Produces its own light		Produce energy through nuclear fusion
	Length of day 24 hours		Reflects light from the Sun
	Relatively stationary object		Yellow Star
	Has a magnetic field		Has ice trapped at the poles
	Does not produce its own visible light		Atmosphere rich in nitrogen and oxygen
			Length of day 29 days

Lesson 1: *We Choose Space!*

Compare and Contrast the Sun, Earth, and Moon Assessment **Answer Key**

Directions:

1. Put a number "1" in the boxes next to the characteristics below that are unique to the Sun.
2. Put a number "2" in the boxes next to the characteristics below that are unique to Earth.
3. Put a number "3" in the boxes next to the characteristics below that are unique to Moon.
4. If a fact is applicable to more than one object place all the numbers in the box.

3	Orbits a planet
1	Composed of gases (mostly hydrogen and helium)
2	Has life on it
1	Produces its own light
2	Length of day 24 hours
1	Relatively stationary object
1, 2	Has a magnetic field
2, 3	Does not produce its own visible light

1	Atmosphere rich in hydrogen and helium
2	Orbits a star
3	Has no atmosphere
1	Produce energy through nuclear fusion
2, 3	Reflects light from the Sun
1	Yellow Star
2, 3	Has ice trapped at the poles
2	Atmosphere rich in nitrogen and oxygen
3	Length of day 29 days

Lesson 2: *We Choose Space!*

Space Exploration Timeline

Standard: Describe the history and future of space exploration, including the types of equipment and transportation needed for space travel.

Objective: Students will explore the history and future of space exploration by creating a timeline that documents important events in the history of space exploration.

Procedures:

1. Independent Practice – Have students brainstorm to create a list of significant events in the history of space exploration.
2. Class Discussion – Using the student generated ideas, create a master list of space events.
3. Paired Work – Assign each student pair a five year period, beginning with 1960, to research.
4. Class work – All students should work together to create an accurate timeline of the history of space exploration on one piece of butcher paper.

Assessment: Students will be assessed on the accuracy of their individual portion of the timeline and information presented regarding their assigned time period.

Lesson 2: *We Choose Space!*

Space Exploration Timeline

Instructions: You will be assigned a 5 year span of time. Your task is to include all significant space exploration events during that time period.

Presentation Guidelines

- You must include at least 10 pictures
- Everyone in your group must speak
- Length 5-10 minutes
- Missions/projects occurring during your time period
- Spacecraft used
- Astronauts aboard
- Mission highlights

Sources: You must include and properly site at least 5 sources, two of which must be print (journal, magazine, book, etc). Your works cited page must either be emailed or printed and handed in to me.

Name____

Some significant events that might help to start your research: John F. Kennedy's speech, Mercury project, Gemini program, Apollo program, Skylab project, Apollo/Soyuz missions, Space Shuttle program, Sputnik mission, Hubble Telescope

Dates____

Name of Mission/project:____________________________________

Space Craft Used____

____

Astronauts Aboard:_______________________________________

____

Mission Highlights: _______________________________________

Lesson 2: *We Choose Space!*

Space Exploration Timeline

Grading Rubric for Project

Category	Criteria	Points Possible	Points Earned
Organization	Information is presented in a logical sequence	5	
	Project emailed or brought in on time	5	
	Presentation appropriately sites five references	5	
Content	Appropriate number of pictures	10	
	Presentation contains scientifically accurate material	5	
	Presentation contains appropriate scientific terms	5	
Presentation	Speaker maintains good eye contact with audience	5	
	Speaker uses a clear voice	5	
	Presentation shows obvious preparation and practiced delivery	10	
	Length of the presentation is within the assigned time requirement	5	
	Total	60	

Lesson 3: *We Choose Space!*

What's happening in the sky?

Standard: Observe, describe, and record patterns of objects in the sky, including the appearance of the moon.

Objective: Students will compare and contrast a changing sky by making daytime and nighttime observations.

Procedure:

1. Class Discussion – As a class, discuss with students the differences in the appearance of the sky when they go outside during daylight hours versus nighttime hours.
2. Independent Practice – During class time go outside and have students make an accurate sketch of what the sky looks like. *Remind students never to look directly at the sun!
3. Independent Practice – Have students continue to make observations every day, one during daylight hours and one after dark, for a period of at least two weeks. If you desire to have daytime moon observations, start your 2 weeks at first quarter moon and go through third quarter. (Reproduce this page as needed)
4. Independent Practice – During the time students are making observations have students research various myths about the Sun and Moon. Students should choose at least 2 myths about both the Sun and Moon to summarize. The following website is a great resource for myths, http://www.windows2universe.org/mythology/planets/Earth/moon.html.
5. Conclusion – At the conclusion of the observations students should understand that the Sun is in approximately the same place every day when observed at the same time. They should also conclude that the Moon is in different locations and different portions of the Moon are lit over the two week period.

Assessments: Writing across the curriculum – Using the elements of their myth summaries students should compose their own myth about the Sun or Moon.

Lesson 3: *We Choose Space!*

What's happening in the sky?

Directions: In the boxes below make a sketch of the Sun and Moon in the sky each day. Try to observe the Moon at the same time every evening. Include the ground in your picture, indicate the direction of view, and place the object as accurately above the ground as possible.

Date: ________	Date: ________	Date: ________	Date: ________
Time: ________	Time: ________	Time: ________	Time: ________
Date: ________	Date: ________	Date: ________	Date: ________
Time: ________	Time: ________	Time: ________	Time: ________
Date: ________	Date: ________	Date: ________	Date: ________
Time: ________	Time: ________	Time: ________	Time: ________

Name____

Lesson 3: *We Choose Space!*

What's happening in the sky?

Directions: Using the web, research myths about the Sun and Moon. Summarize at least two myths about the Sun and Moon.

Myth 1:____

Myth 2:____

Myth 3:____

Myth 4:____

Name____

Lesson 3: *We Choose Space!*

What's happening in the sky?

Directions: Using the ideas that you have summarized from your research, create your own myth about the Sun or Moon. Remember your myth should tell how the Sun or Moon was created.

Lesson 4: *We Choose Space!*

Living on the Moon

Standard: Identify and classify Earth's renewable resources, including air, plants, water, and animals; and nonrenewable resources, including coal, oil, and natural gas; and the importance of conservation.

Objective: Students will demonstrate their knowledge of Earth's renewable and nonrenewable resources and their importance to humans by designing a lunar habitat.

Procedures:

1. Explore prior knowledge – Discuss the difference between renewable and nonrenewable resources. Nonrenewable resources are resources that will not be replenished in our lifetime.
2. Independent Practice – Give each student an "Earth's Resources: Renewable vs. Nonrenewable" worksheet. Students should list as many of the resources as possible in each column. They should also indicate what the resource provides for humans.
3. Class Discussion – Discuss the worksheet and have students fill in any incomplete answers.
4. Paired Work – Students should generate a list of resources that they will need to build their habitat on the Moon. In addition to listing those resources, they should also list possible sources.

Assessment: Students will design a lunar habitat.

Name ________________________________

Lesson 4: *We Choose Space!*

Living on the Moon

Directions: In the table below, list renewable and nonrenewable resources as well what each resource provides for humans.

Renewable Resources	**Nonrenewable Resources**

Lesson 4: *We Choose Space!*

Living on the Moon **Answer Key**

Directions: In the table below, list renewable and nonrenewable resources as well what each resource provides for humans.

Renewable Resources	Nonrenewable Resources
Air – for humans to breathe Plants – provide oxygen for humans, provide food for humans and animals Water – necessary for humans and animals to survive Animals – provide food for humans, responsible for helping to maintain soil composition	Coal – used to fuel power plants and factories Oil – refined into many products including gasoline Natural Gas – used both in households and commercially for heating, cooling, and cooking

Lesson 4: *We Choose Space!*

Living on the Moon

Directions: Your task is to design a lunar habitat. Now that you know what resources we have on Earth, you should have an understanding of what you will need to survive on the Moon. Additionally, after watching *We Choose Space!,* you should now have ideas as to how those resources could be made available on the moon. Below list what you will need to survive and how it will be provided. You also need to create a visual of your habitat. Your visual may be a drawing, 3-D model, or computer generated model.

What you need in your habitat	How will it be provided

Lesson 4: *We Choose Space!*

Living on the Moon

Grading Rubric for Project

	Minimal Progress – 3 points	**Progressing toward Mastery – 5 points**	**Meets Mastery – 7 points**	**Exceeds Mastery – 10 points**
Habitat: Identifies the basic needs 1. Air 2. Food 3. Water 4. Shelter	Unable to determine habitat. Or is very inappropriate for humans.	The habitat is identifiable. May lack details such as food source, or water, etc.	Habitat uses some different materials. The habitat is identifiable. Includes sources for food, water and shelter.	Project uses many different types of materials to show lunar habitat. Includes detailed sources for food, water, and shelter.
Neatness and Creativity	Habitat shows no effort of neatness or creativity.	Habitat is put together but shows some signs of damage or lack of effort towards neatness. Used few materials creatively.	The habitat is slightly messy. But effort towards neatness and creativity are apparent in use of materials.	The habitat is neat and creative. Materials were used in innovative ways.
Oral Presentation	Did not speak clearly.	You needed help with portions of your presentation. Most students could hear you.	Everyone could hear you. You did your presentation with no help. Presentation was smooth and clear.	You presented with no errors in a smooth, clear voice. You used expression when presenting. You were able to answer questions about your animal.

Lesson 5: *We Choose Space!*

Design of a lifetime

Standard: Investigate how organisms and populations in an ecosystem depend on and may compete for biotic and abiotic factors such as quantity of light, water, range of temperatures, or soil composition.

Objective: Students will investigate and understand how organisms depend on and compete for biotic and abiotic factors in an ecosystem by studying International Space Station experiments.

Procedures:

1. Class discussion – Review the parts of an investigation with students including: indentifying the problem, independent and dependent variables, abiotic and biotic factors, and results.
2. Independent practice – Students should use http://www.nasa.gov/mission_pages/station/research/experiments/Expedition.html to research and summarize at least 2 investigations that have been conducted on the International Space Station. Students should fill out the worksheet associated with their research.

Assessment – Students will complete a verbal design project

Name____

Directions: Use http://www.nasa.gov/mission_pages/station/research/experiments/Expedition.html to research experiments that have been conducted on the International Space Station. You must identify the parts of 3 experiments.

Name of experiment:________________________________

Problem:________________________________

Dependent Variable:________________________________

Independent Variable:________________________________

Biotic Factors:________________________________

Abiotic Factors:________________________________

Results:________________________________

Name of experiment:________________________________

Problem:________________________________

Dependent Variable:________________________________

Independent Variable:________________________________

Biotic Factors:________________________________

Abiotic Factors:________________________________

Results:________________________________

Lesson 5: *We Choose Space!*
Design of a lifetime

Now that you have learned about the parts of an experiment and how organisms and populations depend on and may compete for biotic and abiotic factors, I would like you to use your imagination to design an experiment to be conducted on the International Space Station. You are only designing an experiment: **you are not actually going to conduct the experiment**. With that in mind, you may investigate anything that you can possibly dream of. Please use this page as a rough draft to identify all the proper portions of an experiment. Your final proposal must be typed and turned in.

Total 25 points- 15 for content and originality, 10 for proper scientific design

Title of Experiment: ____

Problem: ____

Materials:____

Hypothesis:____

____

Procedures:____

____

____

____

____

____

____

____

References:

Fix, John D. *Astronomy: Journey to the Cosmic Frontier*. Boston: McGraw-Hill Higher Education, 2004. Print.

Pasachoff, Jay M. *Stars and Planets*. Boston, MA: Houghton Mifflin, 2000. Print.

Windows to the Universe, <http://www.windows2universe.org/>.

"Building Blocks to Space." *BJ's Science*. Web. <http:*camillasenior.homestead.com/**Building_Blocks_to_Space**.pdf*>

Texas Administrative Code (TAC), Title 19, Part II, Chapter 112. Texas Essential Knowledge and Skills for Science http://ritter.tea.state.tx.us/rules/tac/chapter112/index.html

Appendix A

Additional Resources

The following online resources can be used to find more information about topics covered in the show:

NASA sites:

Human Exploration Directorate:
http://www.nasa.gov/directorates/heo/home/index.html
http://www.nasa.gov/exploration/home/index.html

Office of Space Flight:
http://spaceflight.nasa.gov/

Space settlements:
http://settlement.arc.nasa.gov/

NASA for students
http://www.nasa.gov/audience/forstudents/index.html

NASA TV:
http://www.nasa.gov/multimedia/nasatv/index.html

The Space Place A NASA website with spaced based games and activities.
http://spaceplace.nasa.gov/menu/space/

Other sites:

We Choose Space!
The show and additional resources can be found here.
http://tinyurl.com/wechoosespace

SpaceX – Commerical Space company
http://www.spacex.com/

Rice Space Institute
http://rsi.rice.edu/

Our other planetarium shows, with their scripts and activities:
http://www.spaceupdate.com/?planetarium_shows.html

Appendix B

WE CHOOSE SPACE!

Script of the Show with discussion questions

You may choose to pause the show
or discuss the show with your class afterwards

Discussion Questions	**Introduction (President Kennedy and Jim Bratton)**
Q: When we went to the moon, income taxes were higher. Would you pay higher income taxes to return to the Moon or travel to Mars?	*(Date: 1962)* *"We choose to go to the Moon… We choose to go to the Moon… We choose to go to the Moon in this decade and do the other things, not because they are easy, but because they are hard".* *(Date: 45 years later)* ***Opening CREDITS – We Choose Space– as told by Scott Parazynski, Tom Jones, Walter Cronkite***
SCENE A2: *Q: What space events occurred the year you were born?*	**Part A: Our History of Choices (Scott Parazynski)** Welcome aboard, I'm Scott Parazynski. I was born the year that President Kennedy first made his commitment to space. Because of that commitment, I had the incredible opportunity to see the Earth from space, working up there outside the Station, repairing a torn solar array.
SCENE A3: (1:15)	*(Date: 1961)* In 1961, Yuri Alekseyevich Gagarin of the Soviet Union became the first man in space as he orbited the Earth in his Vostok 1 capsule – an incredible achievement that really inspired the world.
Q: Would you like to go to space as a tourist? How much would you pay for a week in space?	*(Date: 2001)* Only forty years later, Dennis Tito rode a Russian Soyuz spacecraft to the orbiting International Space Station. Six more tourists followed in the next decade. The International Space Station remains a choice for both astronauts and tourists until at least 2020.
Scene A4: (1:59)	*(Date: 1961)* In 1961, Astronaut Alan Shepard became the first American to reach space. He spent five weightless minutes out there in his Freedom 7 capsule with all the world cheering him on. Now over 50 years later, the children and grandchildren of Admiral Shepard's generation can book a suborbital spaceflight on a commercial space ship.
SCENE A5 (2:30) Apollo 8 orbiting Moon with Earth Rise followed by spacecraft approaching the Moon 24 December 1968	*(Date: 1968)* In 1968, Apollo 8 astronauts, Frank Borman, Jim Lovell, and Bill Anders became the first humans to orbit the Moon, showing us our own Earth, rising above the barren lunar surface. Now a commercial firm is designing trips to orbit the Moon while private companies and governments plan missions to the lunar surface.
SCENE A7 (3:02)	The night sky teases us with places we can almost touch. On a

	clear evening, we often see the Moon, the brightest celestial object in our night sky. At full Moon, we can identify where all six of the Apollo missions landed. On many nights we can also find the International Space Station orbiting above, now the night sky's second brightest object. With a small telescope, you can even see its huge solar panels. From my perch on orbit I really enjoyed looking at the Earth below, thinking that there might even be someone looking up at me.
SCENE A8 (3:45)	The International Space Station and the Moon are our first ports of call. Famous space reporter, Walter Cronkite takes us back 4 billion years, to witness the launch of the Moon, our first space station, and then shares the joy of the Apollo astronauts exploring the lunar surface. *(Date: 4 Billion years ago)*
SCENE B2 (4:03) Birth of the Moon	**PART B: Yesterday's Moon (Walter Cronkite, Gene Cernan)** More than four billion years ago, a young Sun's gravity brought little order to its unruly solar system. Too many tiny worlds shared the same flattened disk. Some colliding rocks coalesced into boulders, mountains and then into worlds. Meanwhile another world also was forming in an orbit crossing the Earth's. A collision was inevitable. It was just a matter of time. And the universe always has had plenty of time.
Q: Some argue that without the Moon we would not have metals near the surface and so no life. What would the Earth be like without a Moon? Would the day be longer or shorter?	With each orbit, the early Moon raised tides that flooded and then drained Earth's coastlines and stirred the depths of its ocean -- supplying energy and motion to mix the primordial stew from which the building blocks of life would emerge. Gradually life, carried on the tides, climbed from the sea onto the land.... and in time learned to walk, to dream, and to reach for the Moon overhead. *(Date: 1969-1972)* *"Here men from the planet Earth first set foot upon the Moon, July 1969, AD. We came in peace for all mankind."*
SCENE B3 (05:30)	Imagine being the first geologists on a huge unexplored world full of rocks, dust and unsolved mysteries. The lunar soil is rocky debris crushed by meteorite impacts into a substance that clings to everything it touches - turning space suits a dingy gray.
Q: Why are the wheels made of mesh? Is the lunar surface rocky,	To go farther and see more, NASA invented a battery-powered rover with wire mesh wheels - capable of exploring the Moon and perhaps becoming a prototype for tomorrow's lunar dune

marshy or dusty?	buggies. *"This is really a rock and roll ride, isn't it? I've never been on a ride like this before. Boy oh boy! I'm glad they've got this great suspension system on this thing."… "Yahoo. Golly, this is so great you can't believe it!"*
Astronauts exploring Moon (06:23)	Imagine being the first humans on this barren world ... the first to see a place, kick a rock, stir up dust or leave footprints and rover tracks in its timeless soil. All expressions are inadequate, the experience of a lifetime wrapped in a few precious hours, in a place to which you can never return.
Astronauts walking on Moon *Q: Some people argue that the lunar landings were faked. Can you see evidence in these movies that the gravity they are experiencing is less than on Earth?* (07:04)	*"I was strolling on the Moon one day in the merry, merry month of December, no May, when then much to my surprise, a pair of funny eyes, te dum, te dum, te dum"* *"Oh this is a neat way to travel. Isn't this great! tum te dum dum dum tum te dum dum dum tum te dum dum dum. I like to skip along. Not me boy. Gene, I'm going to take that SEB number two and my camera and I'm heading home. OK, Boy is this fun."* Gene Cernan, the last man to walk on the Moon, remembers… *(Date: 1972)* *"I slowly pivoted, trying to see everything, and was overwhelmed by the silent, majestic solitude. Not so much as a squirrel track to indicate any sort of life, not a green blade of grass to color the bland, stark beauty, not a cloud overhead nor the slightest hint of a brook or stream. But I felt comfortable, as if I belonged here. From where I stood on the floor of that beautiful mountain-ringed valley, the Moon seemed frozen in time."* *(Date: 2012)*
SCENE B5 (07:37) *Q: What kinds of supplies do astronauts on the ISS need to live? How much of their food, air and water is recycled?* **SCENE C1 (08:30)**	**PART C: Visiting the International Space Station(Tom Jones)** The dramatic Apollo Moon landings showed us that exploring space is incredibly exciting and that we can achieve almost impossible goals in a record time. I'm Tom Jones, a veteran space walker and your tour guide for the International Space Station, the largest and most complex structure ever built in space. In the International Space Station, we are like fish in an enclosed aquarium, but we're much more delicate and demanding. Our aquarium in space must hold in our atmosphere, maintain our life support, and provide enough room for us to live and work.

Beauty shot of the completed ISS as we circle around it. (08:57) **SCENE C2 (09:37)** Construction of ISS – same camera angles, timed to work with the narration Solar cell array Destiny Lab Quest and Pirs airlocks (10:18) Truss construction (10:27) Delivering Harmony Moving the truss Zoom into P6 truss (11:04) Harmony Columbus JEM Tranquility (11:30) Cupola (11:45) Leonardo Nauka	The completed Space Station is a human habitat as large as a five-bedroom house, spanning an area the size of a large soccer field. Here we have created an environment that can keep astronauts healthy and productive for six months at a time. Construction of the International Space Station began in 1998 with the Zarya cargo module, providing electrical power and flight control. After the Unity node joined Zarya, the Zvezda module followed in 2000, adding living quarters and environmental systems. Soon afterward, shuttle crews attached the first solar cell arrays atop the Unity node. *(Date: 2001)* In 2001, my Space Shuttle mission brought up the Destiny Science Lab. I participated in three space walks to attach the Lab to the station. With the addition of the Quest and Pirs airlocks, astronauts could do spacewalks to repair and maintain the Station. *(Date: 2006)* Construction of the Station's solar arrays took many years. The completed truss spans 100 meters and supports 2,500 square meters of solar panels that can deliver over 100 kilowatts of electrical power. *(Date: 2007)* In 2007, Scott's Space Shuttle mission delivered the Station's second connector node, called Harmony, and relocated the P6 solar cell array. Then astronauts placed the Harmony node in the front of the Destiny science lab to serve as the central connecting hub for the European and Japanese laboratories. *(Date: 2008)* The European Space Agency's Columbus science lab arrived first. *(Date: 2009)* Then the Japanese Experiment Module, called Kibo, was attached to the other side of the Harmony node. Kibo has a robotic arm and a platform for experiments outside the Station. *(Date: 2010)* The third node, Tranquility, arrived in 2010, carrying an advanced life support system to recycle wastewater and generate oxygen, as well as the station's magnificent Cupola observatory. *(Date: 2011)* 2011 brought the Leonardo module to store spare parts and supplies. The Russian Multipurpose Laboratory Module

SCENE C3 (11:59) Astronaut out of airlock	completes assembly of the International Space Station. An astronaut exiting the Quest air lock, on the side of the Unity node, gives us a sense of the scale of our outpost in space.
SCENE C4 Pull out to show ISS, zoom into docking port	Constructed by 15 nations working together for nearly 30 years, the International Space Station is a symbol of a space race turned toward international cooperation. It has hosted astronaut crews from many nations since the year 2000, including space tourists, who paid their own way.
SCENE C5 (12:37)	Let me take you on a snapshot tour inside this multi-room scientific condominium in space, beginning at the entrance to the Harmony node. From this port, we see the Columbus module to our left, the Japanese Kibo lab to our right and straight-ahead the U.S. Destiny laboratory – inviting us deeper into the Space Station.
(13:37) *Q: What kinds of scientific experiments are best done in space?*	Astronauts in these labs conduct research on space-produced materials and the changing Earth below. Sleeping compartments also ring the Harmony node. When you're floating in space, the orientation of your bedroom really doesn't matter. Beyond Destiny, we enter the Unity node, and beyond it the original Zarya and Zvezda modules. The kitchen and dining table, where we prepare food and eat together, is part of Zvezda.
(14:14) Video sequence of airlock	The Unity node also connects to an airlock, storing spacesuits used for spacewalks outside the Station.
Fisheye zoom into cupola	From Unity, we can explore the Tranquility node. This module's cupola observatory is a favorite place for astronauts to gather. Its round central window is the largest on the station. We can watch Europe pass below us in darkness, then soar into sunlight above northern Africa and the Nile River.
Cupola orbit movie (14:40)	Every 90 minutes, we return to the same place in our orbit, but the Earth in that time has turned beneath us – delivering a different, breathtaking view of our planet. Half of every orbit is sunlit, the other half dark, with a sunrise and a sunset every 90 minutes. This ever-changing view touches an astronaut's soul like no other part of the space experience.
SCENE C6 (15:22)	

Soyuz and Progress *Q: What kinds of things can commercial space transport companies do that NASA cannot?* *Q: What would be the advantage to take off from the space station instead of the Earth's surface when traveling to the Moon or Mars?*	From the cupola, we see Russian Soyuz and Progress vehicles bringing astronauts and supplies to the Station. Replacing the Space Shuttle, are the ships of private companies. Commercial contractors like SpaceX with its cone-shaped Dragon capsule, can carry both supplies and passengers. Soon small shuttles may also ferry humans to the space station. Larger spacecraft may dock at the Space Station before journeys to the Moon, a nearby asteroid, or to Mars. We can even foresee inflatable structures, like those of Bigelow Aerospace, forming a commercial space station. Space could become a very busy place.
SCENE C8 (16:17) Moon with Cronkite	Decades after reporting the Apollo Moon landings, veteran newsman Walter Cronkite, embraced a new vision for a future Moon colony. His lunar base combines current research with his own experience sharing the joy of the Apollo astronauts, as they explored the Moon.
(16:40) **SCENE D1 HRPict.** Shuttle descending toward Moon (17:05) *Q: What would be the advantage to use the lunar surface as a base for radio telescopes (and X-ray and gamma-ray telescopes?)* *Q: Why is having a base at the south pole good for energy? (If you have a base exactly at the south pole, the sun will just travel around your horizon every day. No night means you won't have to store solar energy in*	**PART D: Tomorrow's Moon Colonies (Walter Cronkite)** Perhaps the space stations of today will ultimately lead to a return to Earth's largest space station, the Moon. Rocky asteroids and icy comets have crashed into the Moon and pockmarked its face. Each comet impact also delivered water ice to this dry world. At the poles, colonies in perpetual twilight can mine the Moon for this trapped ice. The Moon's far side is quiet and undisturbed by radio noise blaring from Earth. In these silent, wide-open spaces, rows of radio dishes made from lunar materials capture images of distant galaxies … and listen for signals from distant alien worlds. Astronauts will mine surface rocks for oxygen to breathe and to use as rocket fuel. They can cast its soil into beams, rods, plates, tubes and glass fibers. The Moon has solar energy with no atmosphere to block sunlight during the long lunar day. Solar power stations, made of lunar materials, will collect sunlight and beam the energy to Earth as microwaves. The Moon is rich in an energy fuel called Helium 3, produced in the sun's core. For billions of years, this stardust has fallen on the

batteries.)	Moon while Earth's atmosphere blocks it from settling on Earth. The Moon's Helium 3 can fuel tomorrow's nuclear fusion reactors on Earth. The Moon protects the genome of life. The greatest threat to life on Earth is probably the impact of an asteroid or comet. Such a direct hit destroyed more than half of the species on Earth 65 million years ago. An Earth impact will not damage ecosystems on the Moon.
Q: What items would you need for a closed biosphere? What things would be recycled? What things would have to come from Earth? (19:19)	The Moon can support an enclosed terrestrial biosphere - complete with plants and animals - for oxygen, food, and companionship. Life on the Moon may become so pleasant that visitors dread returning to the oppressive gravity pull of Earth - a force that increases their Moon weight six-fold. Here a 120 pound human weighs only 20 pounds and can jump six times higher than on Earth. In a pressurized dome, humans wearing wings can actually fly.
(20:24) Interior Olympics – pole vaulter, gymnast	The lunar Olympic games will break all terrestrial records -- featuring pole vaults of more than 120 feet, long jumps more than 180 feet, weightlifting more than an Earth-ton, and graceful gymnasts leaping six times higher than they can on Earth.
SCENE D2 (21:03) Exterior of Moon colony with landing pad. Show a spacecraft lifting off pad and flying toward Earth	Welcome to the future Moon: sustainable, self-sufficient, and profitable: - a producer of solar power and fusion fuel - a source of raw materials to build, launch, and fuel tomorrow's space ships - a home for the first humans to call another world home~~.~~
SCENE E1 (21:25) Launch of Atlantis	*(Date: 2011)* **PART E: In Summary** The launch of Atlantis, the last flight of the Space Shuttle, begins a new chapter in space exploration.
SCENE E2: Future collage	Human spaceflight in this century will depend on young people, private companies, and governments around the world choosing space travel for themselves, their children, and their countries.
SCENE E3: (21:53) Fly out of ISS	In the spirit of President Kennedy, we once again choose space, not because it is easy, but because it is hard, and because meeting its challenges is our destiny.
Roll credits	