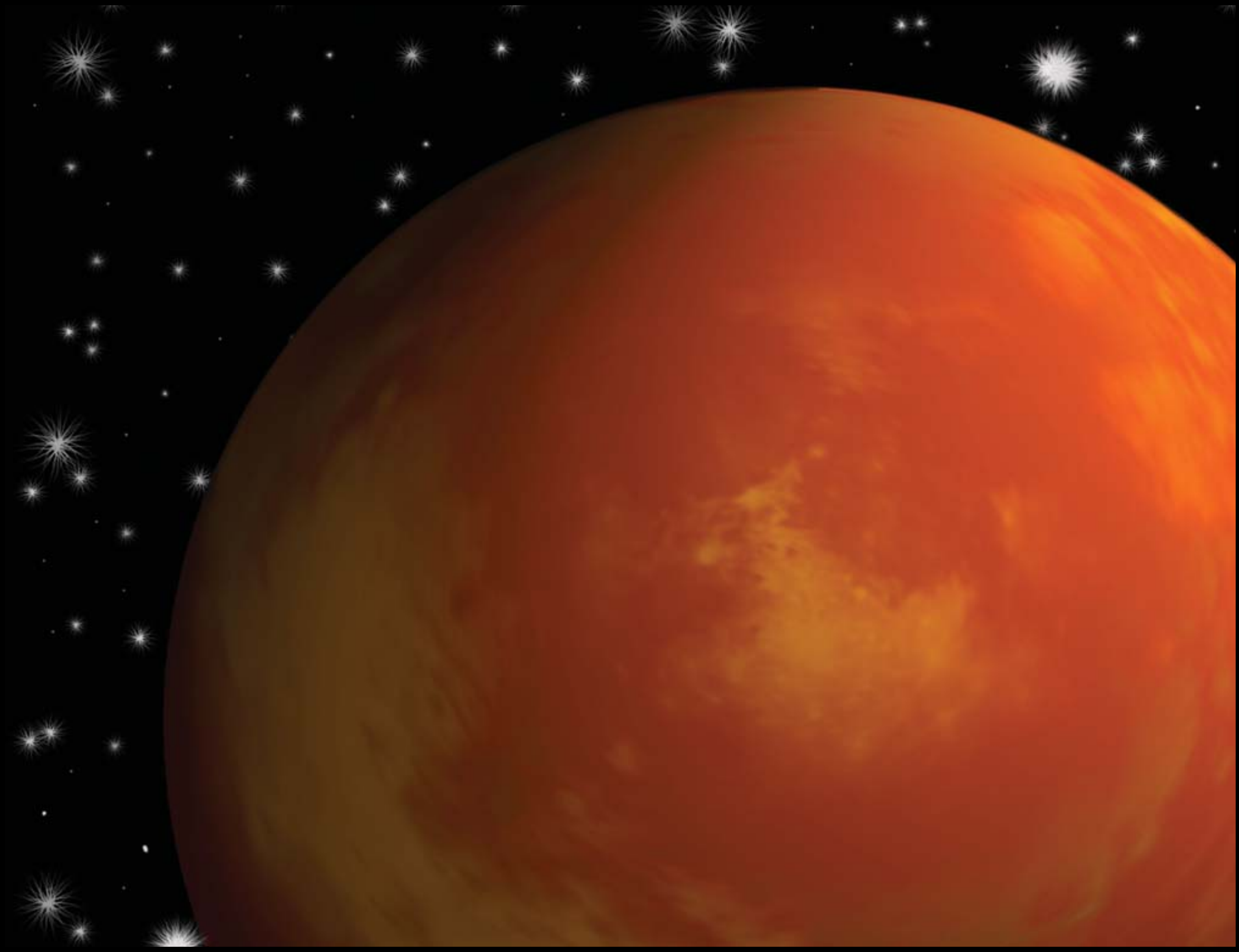
Cambridge Core Science Series: Space Science

YESTERDAY THE MOON, TOMORROW MARS?



Cambridge Educational

Teacher's Guide

Introduction

This Teacher's Guide provides information to help you get the most out of *Yesterday the Moon, Tomorrow Mars?*, the sixth program in the Cambridge Educational *Space Science* video series. The contents of this guide will allow you to prepare your students before using the program and to present follow-up activities to reinforce the program's key learning points.

Yesterday the Moon, Tomorrow Mars? gives a brief history from the American perspective of the race to put the first human beings into space and on the moon. The program details each of the major space projects including Mercury, Gemini, Apollo, and the Space Shuttle. The program further describes current efforts to explore Mars and plans for future missions to Mars and to the moon.

The *Space Science* video program series consists of eight titles:

- The Planets
- The Sun and Stars
- Just How Big Is Space?
- The Invisible Universe
- Black Holes, Pulsars, and Other Odd Bodies
- Yesterday the Moon, Tomorrow Mars?
- Living in Space
- Is Anybody Out There?

Learning Objectives

By viewing *Yesterday the Moon, Tomorrow Mars?,* students will be able to:

- Relate the history of manned space flight
- Describe the importance of space exploration—both manned and robotic
- Identify early pioneers in spaceflight and space exploration
- Describe recent NASA activities associated with the exploration of Mars
- Describe proposed space exploration missions to Mars and to the moon

Educational Standards

This program series correlates with the National Science Education Standards for grades 9-12. The content of this program has been aligned with the following educational standards from this publication:

Science as Inquiry Standards

CONTENT STANDARD A: As a result of activities in grades 9-12, all students should:

- Develop an understanding of scientific concepts
- Understand and appreciate "how we know" what we know in science
- Understand the nature of science
- Develop the skills necessary to become independent inquirers about the natural world
- Develop the dispositions to use the skills, abilities, and attitudes associated with science

History and the Nature of Science Standards

CONTENT STANDARD G: As a result of activities in grades 9-12, all students should:

- Develop understanding of science as a human endeavor
- Develop understanding of the history of science
- Develop an understanding of the nature of scientific knowledge

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English Language Arts Standards

The activities in this Teacher's Guide were created in compliance with the National Standards for the English Language Arts from the National Council of Teachers of English.

- Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.
- Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Standards for the English Language Arts, by the International Reading Association and the National Council of Teachers of English, Copyright 1996 by the International Reading Association and the National Council of Teachers of English. Reprinted with permission.

This program series also coordinates with the following *Benchmarks for Science Literacy* by the American Association for the Advancement of Science for grades 9 through 12:

The Scientific World View

By the end of the 12th grade, students should know that:

- Scientists assume that the universe is a vast single system in which the basic rules are the same everywhere. The rules may range from very simple to extremely complex, but scientists operate on the belief that the rules can be discovered by careful, systematic study.
- From time to time, major shifts occur in the scientific view of how the world works. More often, however, the changes that take place in the body of scientific knowledge are small modifications of prior knowledge. Change and continuity are persistent features of science.
- No matter how well one theory fits observations, a new theory might fit them just as well or better, or might fit a wider range of observations. In science, the testing, revising, and occasional discarding of theories, new and old, never ends. This ongoing process leads to an increasingly better understanding of how things work in the world but not to absolute truth. Evidence for the value of this approach is given by the improving ability of scientists to offer reliable explanations and make accurate predictions.

Scientific Inquiry

By the end of the 12th grade, students should know that:

- Investigations are conducted for different reasons, including to explore new phenomena, to check on previous results, to test how well a theory predicts, and to compare different theories.
- Hypotheses are widely used in science for choosing what data to pay attention to and what additional data to seek, and for guiding the interpretation of the data (both new and previously available).

- Sometimes, scientists can control conditions in order to obtain evidence. When that is not possible for practical or ethical reasons, they try to observe as wide a range of natural occurrences as possible to be able to discern patterns.
- There are different traditions in science about what is investigated and how, but they all have in common certain basic beliefs about the value of evidence, logic, and good arguments. And there is agreement that progress in all fields of science depends on intelligence, hard work, imagination, and even chance.
- Scientists in any one research group tend to see things alike, so even groups of scientists may have trouble being entirely objective about their methods and findings. For that reason, scientific teams are expected to seek out the possible sources of bias in the design of their investigations and in their data analysis. Checking each other's results and explanations helps, but that is no guarantee against bias.
- In the short run, new ideas that do not mesh well with mainstream ideas in science often encounter vigorous criticism. In the long run, theories are judged by how they fit with other theories, the range of observations they explain, how well they explain observations, and how effective they are in predicting new findings.
- New ideas in science are limited by the context in which they are conceived; are often rejected by the scientific establishment; sometimes spring from unexpected findings; and usually grow slowly, through contributions from many investigators.

Program Overview

Yesterday the Moon, Tomorrow Mars? describes the history of space exploration, both unmanned and manned, from the earliest days of Sputnik to the modern age of reusable spacecraft. The program looks at the possibility of returning human beings to the Moon and eventually sending manned missions to Mars.

Main Topics

Topic 1: The U.S. Manned Space Program
The space race began in 1957 with the Soviet Union's launching of Sputnik. The United States quickly followed, developing a manned space program that ushered in a period of tremendous scientific achievements.

Topic 2: Project Mercury
Project Mercury was NASA's first high-profile manned space program. On April 9, 1959, NASA introduced the seven men chosen to be the first U.S. voyagers into space. Mercury astronaut Alan Shepard was the first American in space on May 5, 1961. After only one Project Mercury flight, President Kennedy challenged the fledgling space program to put human beings on the Moon before the end of the decade.

Topic 3: Project Gemini
On December 7, 1961, NASA announced Project Gemini, a plan to extend the manned spaceflight program by developing and launching a two-man spacecraft. The Gemini IV Mission provided the first opportunity for an American to go outside a spacecraft in orbit. Gemini added nearly 1,000 hours of spaceflight experience in the period between the Mercury and Apollo Projects, and showed us that astronauts could remain healthy in space for days, and even weeks.

Topic 4: Project Apollo

Beginning in 1962, Project Apollo extended NASA's human spaceflight efforts to the moon. On July 16, 1969, Apollo 11 lifted off on the first expedition to explore another planetary body. On July 20, 1969, Neil Armstrong took humankind's first steps on the moon. The Apollo Project was a tremendous success. Over the course of several missions, Project Apollo put twelve American astronauts on the surface of the moon, collected nearly 850 pounds of lunar rock and soil, deployed a number of lunar surface experiments, and provided thousands of photos.

Topic 5: Where Have We Gone Since the Moon?

In 1973, Skylab was launched to prove humans could live and work in space for extended periods, and to expand our knowledge of solar astronomy. Over a six-month period, three 3-person crews occupied the Skylab workshop for a total of 171 days, 13 hours. During that time it was the site of nearly 300 scientific and technical experiments.

Topic 6: The Space Transportation System

In 1981 NASA resumed its efforts to develop a reusable spacecraft with the Space Transportation System. The Space Shuttle, as it came to be known, has been used over the years to launch myriad satellites and spacecraft destined for the far reaches of space. It has also transported crews and supplies to and from the International Space Station.

Topic 7: Next Step Mars?

While we cannot yet send astronauts to Mars, we have made progress in exploring the planet through the use of robotic missions, such as Mars Odyssey, the Mars Exploration Rovers, and the Mars Reconnaissance Orbiter. Manned missions to the moon are expected in the near future, with possible manned missions to Mars after that. There are still many technological challenges to be solved before we can safely send a manned mission to Mars.

Fast Facts

- Mercury was NASA's first high-profile program to determine if humans could survive in space.
- Project Gemini was established in 1962. It added sixteen astronauts to the original seven selected for Project Mercury.
- Project Gemini included ten manned space flights. Gemini IV marked the first American spacewalk.
- The Apollo 11 Mission put the first human being on the surface of the moon.
- During Project Apollo's six moon landing missions, 850 pounds of lunar rock and soil were collected and brought back to Earth, twelve astronauts visited the surface of the moon, and thousands of photographs were taken.
- The Space Shuttle was conceived of in 1972 but did not become operational until 1981. Four flights were completed in its first year of operation.
- The Space Shuttle has been used to launch satellites, spacecraft, the Hubble Telescope, and the Compton Gamma Ray Observatory.
- Each Space Shuttle flight costs between $400 million and $1 billion. The Space Shuttle has never lived up to its promise of inexpensive, reusable transportation into space.

- The Mars Exploration Rovers, Spirit and Opportunity, landed on the surface of the planet in January 2004.

- Robotic exploration missions to the moon are planned for as early as 2008, with human missions to follow between 2015 and 2020.

Vocabulary Terms

astronaut: The American term for a person who travels in any type of spacecraft.

Hubble Space Telescope: A high-powered telescope that orbits the Earth and provides high-resolution images. It was named for Edwin Hubble, an early-20th-century astronomer.

lander: A spacecraft that is capable of landing on another planetary body, but does not have the capability of travel on the surface.

NASA: The National Aeronautics and Space Administration, which succeeded the National Advisory Committee for Aeronautics in 1958.

orbit: The path of an object that moves around a second object.

satellite: A smaller body or object that revolves around a second body. A satellite can be natural, such as Earth's moon, or manmade.

Pre-Program Discussion Questions

1. Why do you think humanity has historically been fascinated with the moon and lunar travel?

2. Why do you believe Mars more than any other planet has been the subject of so many books and movies?

3. Do you believe that people today could be fooled with a broadcast similar to Orson Welles' "War of the Worlds"? Why or why not?

4. How soon will we send another human mission to the moon? How about a human mission to Mars? How will the challenges involved in sending a human mission to the moon differ from those involved in sending one to Mars?

5. What do you think we can learn from future human space missions to the moon? What experiments and investigations would you would want to conduct?

Post-Program Discussion Questions

1. What were the political, social, and economic conditions underlying the "Space Race" and the development of the U.S. Manned Space Program?

2. How would you assess the value of the Space Shuttle program? Would you continue the program? Why or why not?

3. What are some of the challenges that must be solved before a human mission can be sent to Mars? How is a human mission to the moon different from one to Mars?

4. Is the expense of a manned space flight to Mars justifiable given our recent experience with robotic missions? If so, how would you justify the costs?

4. Who do you believe was the most influential person in space exploration in the last 50 years? Why? Who do you think is the most famous? Why might these two answers differ from one another?

5. What movie or television program have you seen that you think most accurately reflects the reality of manned space exploration? Explain.

Group Activities

Mercury 7
Divide the class into seven groups and assign each group one of the original seven Mercury astronauts. Have each group develop a profile of the astronaut, detailing his accomplishments in the period before and after Project Mercury.

Houston, We Have a Problem
Divide students into groups. Assign each group a movie about the space program *that is available from the school library or a local public library* (e.g. *The Right Stuff, Apollo 13*, etc.) and have each group critique the movie for accuracy. This will require each group to research the history of the astronauts and space missions, etc. Have each group present a report that compares and contrasts the movie with the historical record and explain how the movie has altered the manner in which the public remembers the history.

Mission to Mars
Have small groups meet to discuss a planned mission to Mars. Each group should identify up to ten items that will be needed to survive on the planet's surface and ten items to take in case of an emergency either on the planet's surface or in transit from the Earth to Mars. Have each group present their list and rationale for those items selected and those items not selected.

Individual Student Projects

Star Light, Star Bright
Ask students to write a poem or piece of prose about some element of space travel or exploration. Have each student read aloud their writing and then compile the writings into a single volume for distribution to the class.

Wells (H.G.) or Welles (Orson)?
There has been no shortage of writers and entertainers who have presented their ideas about space through their work. Have each student select a person outside of the field of science (i.e. no astronauts, scientists, engineers) who figures prominently in development of our culture's ideas about space travel, and profile their contributions. These figures could include filmmakers, actors, politicians, etc.

Little Green Men
The traditional stereotype of a "Martian" was a little green man who would come to Earth to destroy our civilization. Recent research indicates that there is no life on Mars. Have students reflect on current conditions on Mars that make life on the planet unlikely, and how conditions would need to change in order to allow life as we know it to develop.

Internet Activities

Space Doctor
Have students go to www.bbc.co.uk/science/space/playspace/games/spacedoctor and use the Space Doctor module to see if they have what it takes to keep three astronauts healthy on their trip to Mars. Students may also use the Internet to research and write a brief report on health issues that pertain to spaceflight, such as space motion sickness, muscle loss, osteoporosis, and hypoxia.

3...2...1...Blast Off!
Direct students to http://imedia.ksc.nasa.gov/index1.html or a similar Web site to access the simulations and tours available. The simulations include launches, space station dockings, landings, and rocket booster retrievals. Ask students to report on how their understanding of space exploration was enhanced by these simulations.

Assessment Questions

Q1: True or False: American astronauts were the first in space.
A: False.
Feedback: On April 12, 1961, Soviet Cosmonaut Yuri Gagarin was the first person in space. Alan Shepard was the first American in space on May 5th of the same year.

Q2: Project Mercury resulted in ______ hours in space.
a) 100
b) 78
c) 54
3) 12
A: c.
Feedback: Over the six manned Mercury flights, astronauts logged only 54 hours in space. NASA realized more information would be needed before an attempt to travel to the moon was possible.

Q3: Which of the following were among the Mercury astronauts?
a) Jerrie Cobb
b) Edwin "Buzz" Aldrin
c) Sally Ride
d) Wally Schirra and Deke Slayton
A: d.
Feedback: Schirra and Slayton were two of the original seven Mercury astronauts. The others included Scott Carpenter, Gordon Cooper, John Glenn, Gus Grissom, and Alan Shepard. Buzz Aldrin participated in Project Gemini and Project Apollo. In Project Apollo, he and Neil Armstrong became the first humans to set foot on the moon.

Q4: How fast was the Gemini IV mission spacecraft moving through space during the first space walk?

a) 1,000 miles per hour
b) 8,000 miles per hour
c) 18,000 miles per hour
d) 25,000 miles per hour

A: c.

Feedback: The Gemini IV mission included the first space walk while the craft was moving at 18,000 miles per hour. The space walk lasted 22 minutes.

Q5: True or False: Manned missions to the moon stopped after the near disaster experienced by Apollo 13, the craft captained by Jim Lovell.

A: False

Feedback: The Apollo missions continued through Apollo 17 in December 1972. On a 22-hour expedition to explore the surface of the moon, the crew drove the lunar rover over 20 miles.

Q6: After five years of operation, how many shuttle flights had been completed?

a) 5
b) 24
c) 72
d) 124

A: b.

Feedback: NASA originally expected twenty-four Shuttle flights *per year*, but by the end of its fifth year, only twenty-four flights had been completed.

Q7: True or False: Skylab was occupied for more than three years.

A: False

Feedback: Over the course of three manned missions during 1973, Skylab was occupied for a total of 171 days, 13 hours. In that time the crews completed nearly 300 scientific and technical experiments.

Q8: Which of the following were launched using the Space Shuttle?

a) The Hubble Telescope
b) The Magellan spacecraft to Venus
c) The Chandra Gamma Ray Observatory
d) All of the above

A: d.

Feedback: These missions were all launched using the Space Shuttle. The Space Shuttle also launched the Galileo Mission to Jupiter, the Ulysses spacecraft to study the sun, and the Upper Atmosphere Research Satellite.

Q9: True or False: One of the most significant factors affecting our ability to send a manned mission to Mars is the length of the trip.

A: True

Feedback: The trip could take up to two years in transit, with additional time on the surface of the planet. During all of that time astronauts would be exposed to harmful radiation from the sun and from elsewhere in space. They would also need to take all of the food, water, fuel, and other supplies required for the long trip and the stay on the planet.

Additional Resources

NASA Space Science Education Resource Directory
http://teachspacescience.org/cgi-bin/ssrtop.plex

Science Teacher Lesson Plans
www.ncsu.edu/sciencejunction/terminal/imse/lowres/4/lessons.htm

The International Space Station
www.shuttlepresskit.com/ISS_OVR

SETI Institute
www.seti.org

BBC: Science & Nature: Space and the Solar System
www.bbc.co.uk/science/space/solarsystem

The Nine Planets: A Multimedia Tour of the Solar System
www.nineplanets.org

NASA Hubble Site
http://hubblesite.org

The European Homepage for the NASA/ESA Hubble Space Telescope
www.spacetelescope.org

Additional Resources at www.filmsmediagroup.com

Available from Films Media Group • www.filmsmediagroup.com • 1-800-257-5126

Space Science Video Library

- **DVD #30964**
- **Correlates to National Science Education Standards**
- **User's Guide included**

The *Space Science Video Library* contains 19 video clips on the structure of the universe, star formation and destruction, the solar system, and space exploration. It is part of the complete Discovery Channel/Films for the Humanities & Sciences *Science Video Library*. A User's Guide is included, containing an overview; a numbered index of clips, with brief descriptions and lengths; suggested instructional strategies; and a list of additional resources. A Discovery Channel/FFH&S Production. © 2003.

How Scientists Look at the Sun

- **VHS/DVD-R #34120**
- **Correlates to National Science Education Standards**
- **Produced in association with the Accreditation Board for Engineering and Technology and the Junior Engineering Technical Society.**
- **Viewable/printable Teacher's Guide included**

This *Science Screen Report* explores the Sun's multilayered structure, the forces at work inside it, and the methods by which scientists study it. Detailing the activities of the SOHO spacecraft, the video also explains various solar phenomena: nuclear fusion, the release of neutrinos, oscillation of the photosphere, and the processes by which the Sun may have formed as well as those that will eventually cause its collapse. A viewable/printable teacher's guide is available at www.cambridgeeducational.com. (19 minutes) © 2004.

The Complete Cosmos

- **13-part series**
- **VHS/DVD-R #8622**
- **Preview clip online at www.films.com (Search on 8622)**
- **"Best Educational Program," Radio & Television Golden Laurels, French Senate, 1999**
- **"Special Award," Jules Verne Film Festival, France, 1999**

This unique series is a visual encyclopedia of the planets, the galaxy, and the universe. Rich in awe-inspiring images and meticulous research, it presents information on everything from the reason for seasons, to the Hale-Bopp comet and black holes. A definitive introduction to the study of space and astronomy. The series includes *From Stonehenge to Hubble: Looking to the Stars; Home Star: The Sun and the Planets; Venus and Mars: Earth's Sisters; The Blue Planet and Pale Moon Above; Jupiter and Saturn: Probing the Planets; Uranus, Neptune, and the Milky Way: Dark, Deep Space; Impact! Comets and Asteroids; Celestial Wonders: Eclipses, Auroras, and Light Fantastic; Black Holes, Dark Matte; Space Explorers: A History of the Last Frontier; The Next Step: Of Robots and Space Stations; The Expanding Universe: From Big Bang to Big Crunch?; Spaceship Earth and the Search for Intelligent Life.* (20 minutes each) © 1998.

Space Frontier: The Future of Space Exploration

- **VHS/DVD-R #8622**

By 2019, a colony on the Red Planet—the stuff of science fiction—is expected to become scientific fact. Using computer simulations and interviews with scientists, robotics experts, and officials from NASA and the National Space Society, this program investigates the four main challenges to initiating a self-sustaining colony on Mars. An economical, single-stage, reusable spacecraft must be developed, such as the proposed Venture Star. The effects of long-term low- and zero-gravity living must be studied and counteracted, on the Moon and at the multi-national Alpha space station. The Moon must be developed as a launch platform. And robots must be sent to Mars to prepare for human habitation and create stores of fuel. Once established, a Mars colony will become the jumping-off point for exploring the rest of the solar system and the cosmos beyond. (54 minutes) © 1997.

For information on other programs

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