

NASA's Rocket to the Moon

Story length 8:18 minutes

QUEST SUBJECTS

Life Science
Biology
Health
Environment

Earth Science
Geology
Weather
Astronomy

Physical Science
Physics
Chemistry
Engineering

CA SCIENCE STANDARDS

Grade 5

Earth Science
5. The solar system consists of planets and other bodies that orbit the Sun in predictable paths. (b)

Grade 8

Earth in the Solar System
4. The structure and composition of the universe can be learned from studying stars and galaxies and their evolution. (d, e)

Grades 9-12

Physics: Motion/Forces
1. Newton's laws predict the motion of most objects. (f, g)

Conservation of Energy and Momentum
2. The laws of conservation of energy and momentum provide a way to predict and describe the movement of objects. (d)

PROGRAM NOTES

Call them demolition derby astrophysicists. NASA scientists in Mountain View are building a spaceship they will deliberately crash into the Moon in 2009, sending up a 40-mile high cloud of debris. Their goal? To find water.



In this segment you'll find...

- ⦿ why NASA is looking for water on the Moon.
- ⦿ how the mission will work and what data they are looking to collect.
- ⦿ what scientists are doing to replicate the LCROSS mission on Earth and why.

TOPIC BACKGROUND

Scientists at NASA Ames Research Center in Mountain View are developing a spacecraft they'll deliberately crash into the Moon as part of an attempt to find water. A second craft will fly through the lunar dust plume released from the crash and send data back to Earth for analysis. NASA plans to return astronauts to the Moon by 2018 as a stepping stone on the way to Mars. Because it's very expensive to launch materials into space (as much as \$15,000 per pound to the Moon), it would be a great advantage to astronauts to have a water supply already in place on the Moon. Two previous lunar missions -- Clementine in 1994 and Lunar Prospector in 1998 -- found indirect but not conclusive evidence of water.



The upcoming **Lunar Crater Observation and Sensing Satellite (LCROSS)** mission will include two spacecraft: Centaur, which will crash first, and a Shepherding Spacecraft, which will collect and transmit data to Earth and then crash into the Moon. After LCROSS makes a flyby of the Moon, it will complete two large, 40-day orbits around Earth in order to change trajectory. The Centaur's target is a permanently shadowed crater on the Moon's south side. It will impact at a 70-degree angle and a velocity of 1.56 miles (2.5 kilometers) per second. The steep angle and high speed will create a plume of lunar soil 40 miles high. The Shepherding Spacecraft will fly through the plume, take measurements with infrared cameras and spectrometers and send data back to Earth. This spacecraft will also crash into the Moon, sending up yet another dust plume to be recorded by satellites and telescopes. Scientists will search the data sent back from the LCROSS equipment for signs of water. Onboard spectrometers will separate light beams reflected from the dust cloud into bands of color that NASA scientists can analyze for the signature barcodes of water vapor, water ice and water bound in minerals. Scientists have a lot to do before the mission launches. They are simulating the lunar impacts using a special vertical gun to fire small objects into a vacuum chamber containing simulated Moon dust. These studies will help to determine characteristics of the lunar impact, so that scientists can be sure the plume will be large enough. It has to rise above the edge of the crater and into the sunlight for data to be successfully collected.

Media Enhance Education

Video and audio can be powerful tools for meaningful learning. It all depends on you, the educator. The key to using media effectively is preparation. Make the most of learning opportunities by encouraging students to become active viewers and listeners. Pick and choose from the suggested questions and activities to offer an engaging media experience.

Questioning

Oftentimes, teachers and students become frustrated during a media segment when students can't find the answers to a long list of questions. Provide a limited number of questions or topics for students. This focuses their attention during a media segment, helps to keep them engaged and generally results in higher quality answers. QUEST Ed. has provided a number of options for focus questions ranging from fact based to opinions, as well as "big picture" ideas. These questions are listed in order of increasing complexity of thought.

PRE-VIEWING

- What do you already know about the Moon?
- What would you look for if you went to the Moon?
- Why do you think scientists want to study the Moon?
- The NASA scientists are looking for water on the Moon. Why might it be important to find water?
- Do a week-long Moon observation/sketching activity. Look for and draw the Moon each night for a week. Before the segment, draw what you think the Moon looks like up close.

VIEWING FOCUS

NOTE: You may choose to watch the television segment twice with your students: once to elicit emotional responses and get an overview of the topic and again to focus on facts and draw out opinions.

- Record any facts you find interesting while you watch.
- What two questions are NASA scientists trying to answer with the LCROSS mission?
- Explain how the mission will work.
- What is the purpose of shooting small objects into simulated lunar soil?
- Why do scientists want to build a Moon base? Do you agree with doing this?
- The LCROSS mission is described as "a study in complexity." Can you think of something that could go wrong that would concern NASA scientists?
- Do you think the United States should continue to fund the study of space?

POST-VIEWING – Links to activities mentioned here can be found on the following page.

- **Review** students' answers to the Viewing Focus Questions.
- **Explore biographies** of the NASA scientists working on the LCROSS mission in the "Biographies" section of the LCROSS Education Web site. Pick two scientists working on the mission and compare/contrast their job responsibilities.
- **Simulate a crash** like NASA scientists are doing with the vertical gun. Look at the impact of an object on the Moon in the "Make a Crater" activity on the Lunar Prospect mission activities.
- **Design and build** a full-size or scale model of an Earth-based research station that will support living adaptively and working efficiently on the Moon in the "Lunar Research Station Design Challenge" on the LCROSS Education Web site.
- **Submit questions** to the NASA scientists working on LCROSS on the LCROSS Education Web site.

LESSON PLANS / ACTIVITIES

LCROSS Education Web site NASA

<http://lcross.arc.nasa.gov/education.htm>

- Featuring scientist biographies, “Exploring the Moon Educator Guide,” “Lunar Research Station Design Challenge” curriculum and an interactive investigation into habitable worlds

Lunar Prospector mission activities NASA

<http://lunar.arc.nasa.gov/education/activities/index.htm>

- Activities include “Make a Crater,” “Lunar Landforms,” “Phases of the Moon” and more.

Moon Phase Simulation Chabot Space and Science Center

<http://www.chabotspace.org/vsc/planetarium/theMoon/Moonphases/default.asp>



- See a simulation of the orbital motion of the Moon around Earth and how the Moon’s phase changes depending on its position.

EDUCATOR WORKSHOPS

Moon Struck for teachers of grades 3-8; Chabot Space and Science Center

<http://www.chabotspace.org/registration/workshop/>



- Using hands-on classroom activities and media, we’ll explore our nearest neighbor, the Moon. We’ll model the Moon’s orbital motions, its changing phases and eclipse cycles, and the cratering process. We’ll also investigate the Moon’s origins, geology and the historic Apollo missions and our current return plans. And we’ll learn the importance of the Moon to cultures throughout human history.

ARTICLES / READING

Crash Landing on the Moon (7/28/06)

http://science.nasa.gov/headlines/y2006/28jul_crashlanding.htm

- An overview of the mission; article and audio

NASA Ames Spacecraft to Smash into a Pole of the Moon in Search of Ice (8/16/06)

<http://www.nasa.gov/centers/ames/research/exploringtheuniverse/lcross.html>

- NASA’s press release on the mission; article

NASA’s Big Chore: Dusting on the Moon (1/22/07)

<http://www.npr.org/templates/story/story.php?storyId=6907833>

- NPR’s program, **Morning Edition**, discusses the trouble with lunar dust and provides links to other NPR stories about the Moon; transcript and audio

Look for the



indicating resources from QUEST partner organizations

QUEST QUAD

FIELD NOTES



Go outside and ...

- 🔍 Observe the Moon
 - Make notes on its position, size and shape and sketch the Moon for one week to a month.
- 🔍 Look for evidence of water in your own neighborhood
 - What clues in the environment tell you that water has been present, even if it hasn't rained recently and there's no water on the ground?

FIELD TRIP



Visit ...

- 🔍 Chabot Space and Science Center 
10000 Skyline Blvd., Oakland 94619 www.chabotspace.org
 - Browse the photos of the Moon in the Astrophoto Gallery.
 - Attend free telescope viewing on Friday and Saturday nights (weather permitting).
 - Experience the "One Giant Leap: A Moon Odyssey" exhibit.
 - Enroll your students in the Moonstruck field trip program.
<http://www.chabotspace.org/vsc/teacher/schoolvisit/default.asp>
- 🔍 The California Academy of Sciences 
875 Howard St, San Francisco 94103
www.calacademy.org
 - See a real Moon rock and to find out more about the moons of Saturn and Jupiter in the Astrobiology exhibit

FIELD RESEARCH




Find out more about...

- 🔍 The history of missions to the Moon
 - Visit the NASA Web site to learn more about the beginnings of the U.S. space program and lunar missions.
- 🔍 What scientists can use water on the Moon for besides drinking
 - Research how they may be able to split water to release hydrogen for rocket fuel.

FIELD TEST



Experiment with...

- 🔍 Building your own telescope 
 - Participate in Chabot Space and Science Center's Telescope Makers' Workshop
<http://www.chabotspace.org/visit/telescopeworkshop.asp>
- 🔍 Crater size and shape
 - Drop your own "spacecraft" marbles of different sizes and weights into baking soda or fine sand to see how the craters differ.
 - Test the impact at different angles and speeds to see what components of the crater change.

VISIT OUR PARTNERS

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[Lawrence Hall of Science](#)

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[The Tech Museum of Innovation](#)

[UC Berkeley Museum of Paleontology](#)

OTHER WAYS TO PARTICIPATE IN QUEST



LOG ON

kqed.org/quest



LISTEN

**KQED 88.5 FM San Francisco &
89.3 FM Sacramento
Fridays at 6:30am and 8:30am**



WATCH

**KQED Channel 9
Tuesdays at 7:30pm**

CREDITS

Centaur image courtesy of NASA

Full Moon image courtesy of Carl Jung, Chabot Space and Science Center