

## NASA Ames Rocket to the Moon Educator Guide



A resource for using QUEST video in the classroom

Watch it online <http://www.kqed.org/quest/television/view/26> | 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.

## ARTICLES / READING

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

[http://science.nasa.gov/headlines/y2006/28jul\\_crashlanding.htm](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

<b>FIELD NOTES</b> 	<b>FIELD TRIP</b> 
<p><b>Go outside and ...</b></p> <ul style="list-style-type: none"> <li>🔍 Observe the Moon           <ul style="list-style-type: none"> <li>• Make notes on its position, size and shape and sketch the Moon for one week to a month.</li> </ul> </li> <li>🔍 Look for evidence of water in your own neighborhood           <ul style="list-style-type: none"> <li>• 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?</li> </ul> </li> </ul>	<p><b>Visit ...</b></p> <ul style="list-style-type: none"> <li>🔍 Chabot Space and Science Center           <ul style="list-style-type: none"> <li>10000 Skyline Blvd., Oakland 94619 <a href="http://www.chabotspace.org">www.chabotspace.org</a></li> <li>• Browse the photos of the Moon in the Astrophoto Gallery.</li> <li>• Attend free telescope viewing on Friday and Saturday nights (weather permitting).</li> <li>• Experience the "One Giant Leap: A Moon Odyssey" exhibit.</li> </ul> </li> <li>🔍 The California Academy of Sciences           <ul style="list-style-type: none"> <li>875 Howard St, San Francisco 94103 <a href="http://www.calacademy.org">www.calacademy.org</a></li> <li>• See a real Moon rock and to find out more about the moons of Saturn and Jupiter in the Astrobiology exhibit</li> </ul> </li> </ul>
<b>FIELD RESEARCH</b> 	<b>FIELD TEST</b> 
<p><b>Find out more about...</b></p> <ul style="list-style-type: none"> <li>🔍 The history of missions to the Moon           <ul style="list-style-type: none"> <li>• Visit the NASA Web site to learn more about the beginnings of the U.S. space program and lunar missions.</li> </ul> </li> <li>🔍 What scientists can use water on the Moon for besides drinking           <ul style="list-style-type: none"> <li>• Research how they may be able to split water to release hydrogen for rocket fuel.</li> </ul> </li> </ul>	<p><b>Experiment with...</b></p> <ul style="list-style-type: none"> <li>🔍 Building your own telescope           <ul style="list-style-type: none"> <li>• Participate in Chabot Space and Science Center's Telescope Makers' Workshop <a href="http://www.chabotspace.org/visit/telescopeworkshop.asp">www.chabotspace.org/visit/telescopeworkshop.asp</a></li> </ul> </li> <li>🔍 Crater size and shape           <ul style="list-style-type: none"> <li>• Drop your own "spacecraft" marbles of different sizes and weights into baking soda or fine sand to see how the craters differ.</li> <li>• Test the impact at different angles and speeds to see what components of the crater change.</li> </ul> </li> <li>🔍 Robotics and Aeronautics           <ul style="list-style-type: none"> <li>• Girl Scouts, sign up for an exciting 6 days of activities at NASA Ames this summer <a href="http://www.girlscoutsbayarea.org/pages/initiatives/ggt/events.html">www.girlscoutsbayarea.org/pages/initiatives/ggt/events.html</a></li> </ul> </li> </ul>

## VISIT OUR PARTNERS

The Bay Institute

[www.bay.org](http://www.bay.org)

California Academy of Sciences

[www.calacademy.org](http://www.calacademy.org)

Chabot Space and Science Center

[www.chabotspace.org](http://www.chabotspace.org)

East Bay Regional Park District

[www.ebparks.org](http://www.ebparks.org)

Exploratorium

[www.exploratorium.edu](http://www.exploratorium.edu)

Girl Scouts of Northern California

[www.girlscoutsnorcal.org](http://www.girlscoutsnorcal.org)

Golden Gate National Parks Conservancy

[www.parksconservancy.org](http://www.parksconservancy.org)

The J. David Gladstone Institutes

[www.gladstone.ucsf.edu](http://www.gladstone.ucsf.edu)

Lawrence Berkeley National Laboratory

[www.lbl.gov](http://www.lbl.gov)

Lawrence Hall of Science

[www.lawrencehallofscience.org](http://www.lawrencehallofscience.org)

Monterey Bay Aquarium

[www.mbayaq.org](http://www.mbayaq.org)

Monterey Bay Aquarium Research Institute

[www.mbari.org](http://www.mbari.org)

Oakland Zoo

[www.oaklandzoo.org](http://www.oaklandzoo.org)

The Tech Museum of Innovation

[www.thetech.org](http://www.thetech.org)

UC Berkeley Natural History Museums

<http://bnhm.berkeley.edu/>

U.S. Geological Survey

[www.usgs.gov](http://www.usgs.gov)

## MORE EDUCATIONAL RESOURCES FOR USING QUEST MULTIMEDIA TO ENHANCE 21<sup>ST</sup> CENTURY SKILLS IN TEACHING AND LEARNING

### Why Use Multimedia in Science Education?

<http://www.kqed.org/quest/downloads/QUESTWhyMedia.pdf>

- Read about the importance of using multimedia in the 21<sup>st</sup> century science classroom.

### How to Use Science Media for Teaching and Learning

<http://www.kqed.org/quest/downloads/QUESTMediaTips.pdf>

- A collection of tips, activities and handouts to actively engage students with multimedia.

### Science Multimedia Analysis

<http://www.kqed.org/quest/downloads/QUESTMediaAnalysis.pdf>

- Give your students the tools to recognize the purposes and messages of science multimedia.

### Create Online Science Hikes with Google Maps

[http://www.kqed.org/quest/files/download/52/QUEST\\_ExplorationCreation.pdf](http://www.kqed.org/quest/files/download/52/QUEST_ExplorationCreation.pdf)

- Do you like the science hike Explorations on the QUEST site? Use this place-based educational guide to create similar science-based maps with youth.

## OTHER WAYS TO PARTICIPATE IN QUEST



### LOG ON

[www.kqed.org/quest](http://www.kqed.org/quest)



### LISTEN

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



### WATCH

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