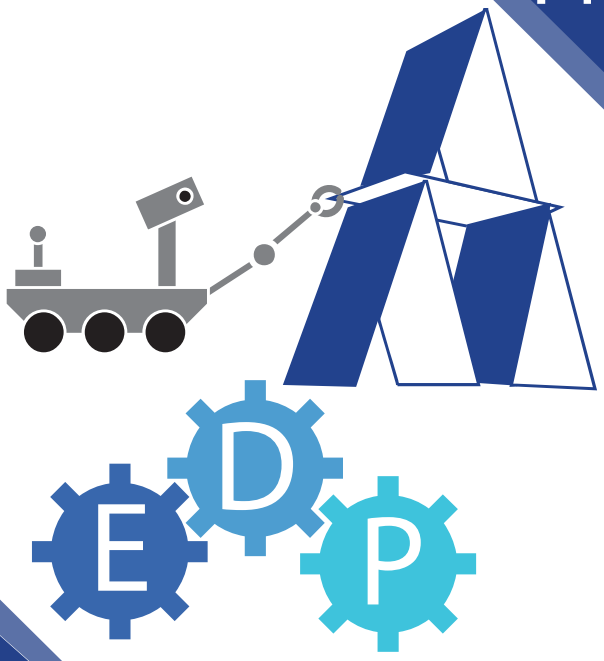
P1

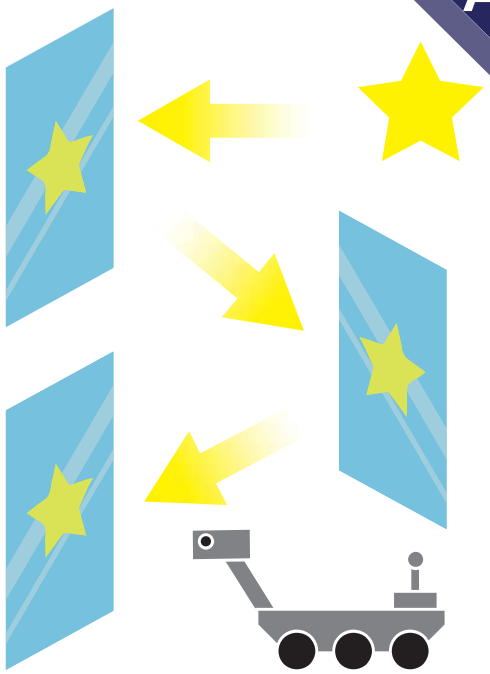


What is Engineering?
Engineering Design Process

P2

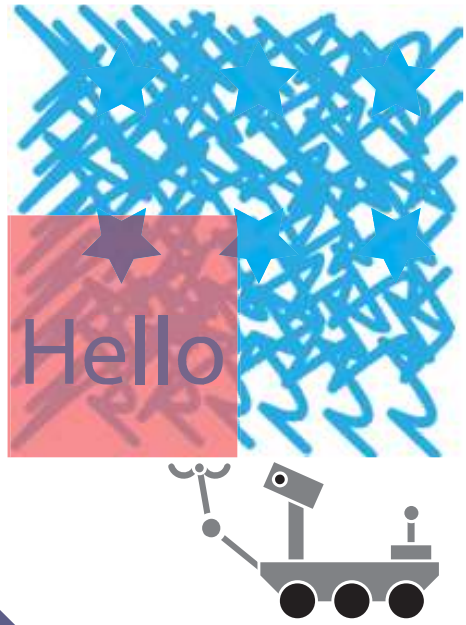
What is Technology?
Technology Solves Problems

A1



Looking Beyond
Properties of Light

A2



Secret Messages
Color Filters

P1 Purpose

Engages youth in an engineering design challenge. Introduces an Engineering Design Process (EDP), criteria, constraints.

Activity Timing

Introduction:	5 min
Identify:	5 min
Create:	20 min
Test & Communicate:	15 min
Reflect:	10 min
Total	55 min

Quick Tips

* Help youth see that they naturally did each of steps of the EDP as they engaged in the design challenge.
* If youth want to fix their designs, highlight the 'Improve' step on the EDP. If you don't have extra time, tell youth they will have a whole period to improve future designs in Activity 5.

Prep Corner (5 minutes)

* Prepare a model antenna. Fold one index card in half widthwise and clip three binder clips to it.
* Arrange 100 index cards, a ruler, and a pair of scissors for each group on the Materials Table.
* Place 4 rolls of masking tape on the Materials Table for groups to share.

Did you know?

Use duct tape much? You probably engineer more than you think. Anytime you design a makeshift tool because you don't have exactly what you need, you are engineering.

Key Terms

* Criteria: Things that you or your design needs to do.
* Constraints: Ways that you or your design are limited.

P2 Purpose

Introduces youth to the definition of technology as anything humans (engineers) design to solve a problem. The Special Report Video sets the context for the entire unit.

Activity Timing

Introduction:	5 min
Investigate:	10 min
Imagine & Improve:	15 min
Video:	10 min
Reflect:	10 min
Total	50 min

Quick Tips

* Don't skip the video! It sets the stage for the entire unit.
* If youth are not familiar with the technologies on the cards, have them work in groups to figure out the pairs together.

Prep Corner (10 minutes)

* Post the Engineering Design Process poster.
* Copy and cut out the Technology Match Cards, pp. 13–23 of the guide: one for each student or group.
* Watch and prepare to play the Engineering Everywhere Special Report video (10:15): www.planets-stem.org.

Did you know?

People can turn almost any thing into technology, if they use it to solve a problem. A rock can be used to grind corn or shaped into an arrowhead.

Key Terms

* Technology: Any thing designed by humans to solve a problem.
* Remote Sensing: To collect information from a distance.

A1 Purpose

Challenges youth to use multiple mirrors to see around obstacles and to create handheld periscopes.

Activity Timing

Introduction:	5 min
Investigating Mirrors:	15 min
Periscopes:	30 min
Reflect:	10 min
Total	60 min

Quick Tips

* Consider assigning roles for group members to keep everyone focused on the challenge.
* If youth are familiar with these concepts, consider setting up the periscopes and obstacle course as stations where they can move freely between activities.

Prep Corner (15 minutes)

* Post the Engineering Design Process poster.
* Set up a sample obstacle course according to Obstacle Course Setup, p. 31 in the Educator Guide.
* Create a Materials Table with the materials listed on p. 25 of the Educator Guide.

Did you know?

NASA engineers use this same technology to send signals to the back side of the moon!

Key Terms

Periscope: A remote sensing technology that uses mirrors to change the path of light in order to see around an object

A2 Purpose

Youth explore how different colored filters work to hide or highlight other colors.

Activity Timing

Introduction:	5 min
Investigate:	25 min
Secret Message:	20 min
Reflect:	5 min
Total	55 min

Quick Tips

* It's very difficult to make indiscernible messages. Focus youth on the difference rather than trying to achieve a truly hidden message.
* If groups finish early, have them use extra folders and tape to combine their optical filters with familiar technologies, like glasses.

Prep Corner (10 minutes)

* Post the Engineering Design Process poster.
* Draw the Optical Filter Investigations chart, p. 36 in the Educator Guide, on chart paper and post it near the EDP poster.
* Create a Materials Table with the materials listed on p. 25 of the Educator Guide.

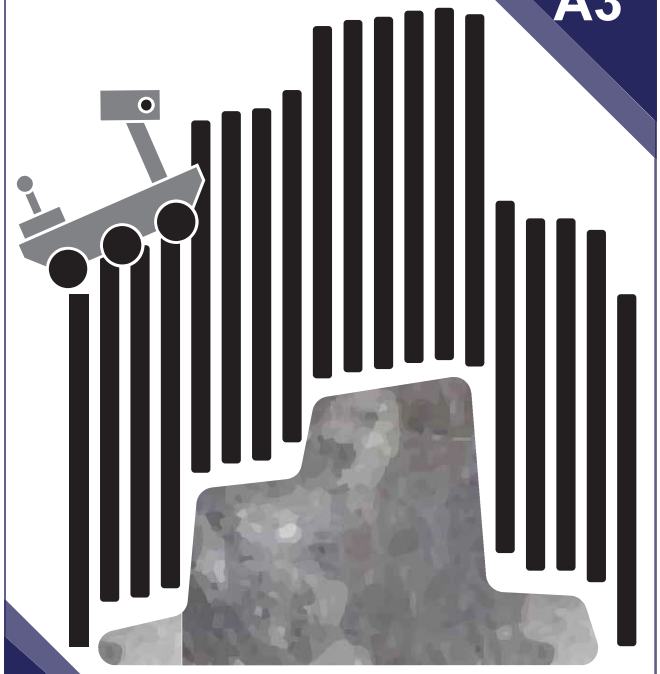
Did you know?

Since Mars is very red, planetary scientists use optical filters to highlight colors they wouldn't see or notice otherwise.

Key Terms

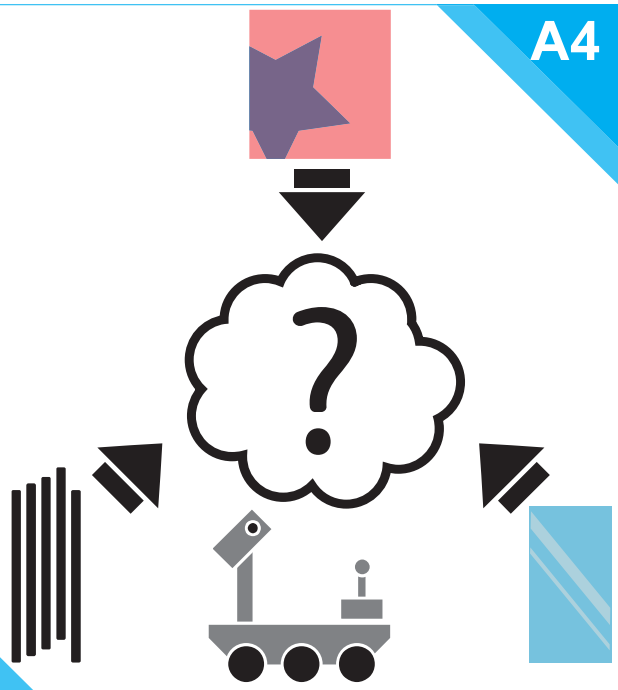
Optical Filter: A technology that manipulates light and color to help reveal visual information

A3



Taking Shape
Topography

A4

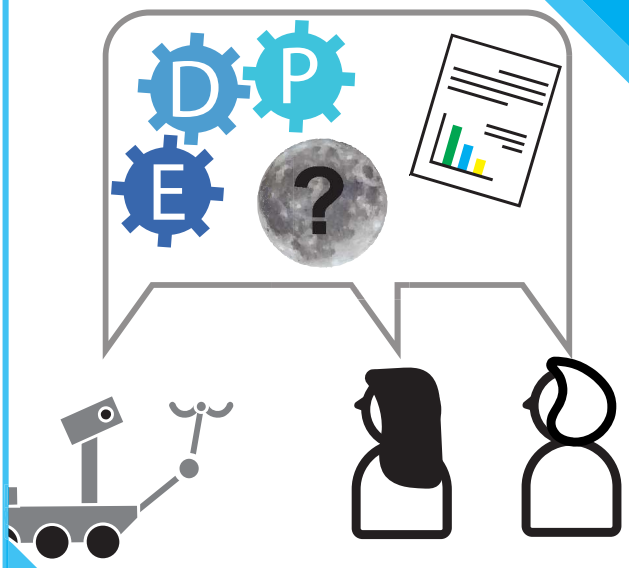


Create a Device
Invent Technology

A5

Improve
Improve Technology

A6



Engineering Showcase
Communicate

A3 Purpose

Youth use straws as a model for LIDAR and record information about a surface. Youth discuss limitations of the model.

Activity Timing

Introduction:	5 min
Investigate:	10 min
Mapping a Test Surface:	30 min
Reflect:	10 min
Total	55 min

Quick Tips

* Consider playing the 4th and 5th Educator Content Video on our website to review LiDAR.
* Encourage youth to try out different materials or combinations to keep the straws together.
* As as alternative to drawing, have groups trace the topography by using the shape of the straw tops held up to paper.

Prep Corner (10 minutes)

* Post the Engineering Design Process poster.
* Bundle a handful of straws together using a rubber band or craft foam and tape, to demonstrate how youth can keep the straws packed together in their model LiDAR device.
* Create a Materials Table with the materials listed on p. 41 of the Educator Guide.

Did you know?

Some animals, such as bats and whales, have evolved the ability to remotely sense their surroundings using sonar, which relies on bouncing sound waves instead of light.

Key Terms

LiDAR: (Light Detection And Ranging): A remote sensing technology that collects data from lasers to map the shape of a landscape

A4 Purpose

Youth apply what they have learned so far to design remote sensing devices to answer a question posed by a scientist.

Activity Timing

Introduction:	5 min
Imagine & Plan:	10 min
Create and Test:	30 min
Reflect:	10 min
Total	55 min

Quick Tips:

* If youth have struggled with previous activities, start them with the Scientist Jaime.
* Emphasize screens model the distance between the moon and the Earth, so youth must design technologies to gather the information remotely. They may not touch the surface nor look behind the screen.

Prep Corner (50 Minutes)

* Post the Engineering Design Process poster.
* Prepare the Mystery Moon sites and Space Screens by following the instructions on pp. 51–53 iof the guide.
* Create a Materials Table with the materials listed in the guide

Did you know?

Failure is a big part of the engineering design process. Engineers sometimes make mistakes on purpose so they can learn how to avoid them later when it's more crucial to get it right.

Key Terms

Data: Information that is collected through scientific investigation

A5 Purpose

Youth improve their device, decide how to display the data, and make a recommendation to the scientist.

Activity Timing

Introduction:	5 min
Final Launch:	35 min
Presenting the Data:	15 min
Reflect:	5 min
Total	60 min

Quick Tips

* Have groups check the size of their devices by placing them on a folded sheet of paper.
* Data visualizations can take many forms including drawings, maps, and graphs.
* Having an authentic audience for the Showcase can inspire youth to think more deeply about their presentations.

Prep Corner (10 Minutes)

* Post the Engineering Design Process poster.
* Arrange the Space Screens according to Space Screen Assembly, p. 52 of the Educator Guide.
* Create a Materials Table with the materials from Activity 4.
* Make copies of the Engineering Showcase invitation, p. 83 in this guide, for youth to distribute to their family and friends.

Did you know?

Data can be communicated in music or visually appealing artforms. Try it yourself, assign a note to each level of the moonscape, and sing or play your findings to the group.

Key Terms

Improve (in engineering): To make a device better than the first build. Examples include something being smaller, lighter, more durable, faster, able to do more things, or collect more kinds of data.

A6 Purpose

Youth prepare a final presentation. They recommend a site using the data they have gathered as evidence.

Activity Timing

Introduction:	5 min
Presentation Preparation:	15 min
Showcase:	20 min
Reveal:	5 min
Reflect:	10 min
Total	55 min

Quick Tips

* If you do not have an opportunity to brief the visitors playing the scientists, have one or more youth provide a summary of the different missions.

* Ask questions to help youth accurately communicate their results.

Prep Corner (10 Minutes)

* Post the Engineering Design Process poster.
* Arrange the Space Screens similar to Activities 4 and 5.
* Create a Materials Table with the materials from Activity 4.
* Invite people from the community (including families and friends of youth) to the Engineering Showcase, and assign roles using the Scientists Cards.

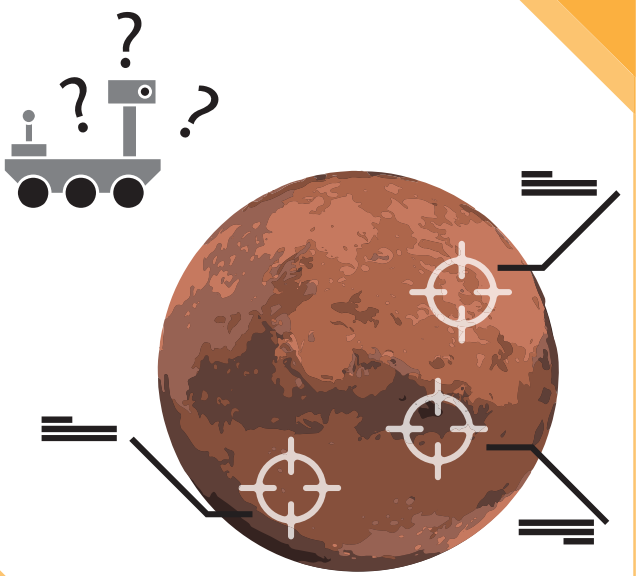
Did you know?

Engineers and Scientists present their discoveries and inventions all the time at professional conferences around the world. In academia this is called Scholarship.

Key Terms

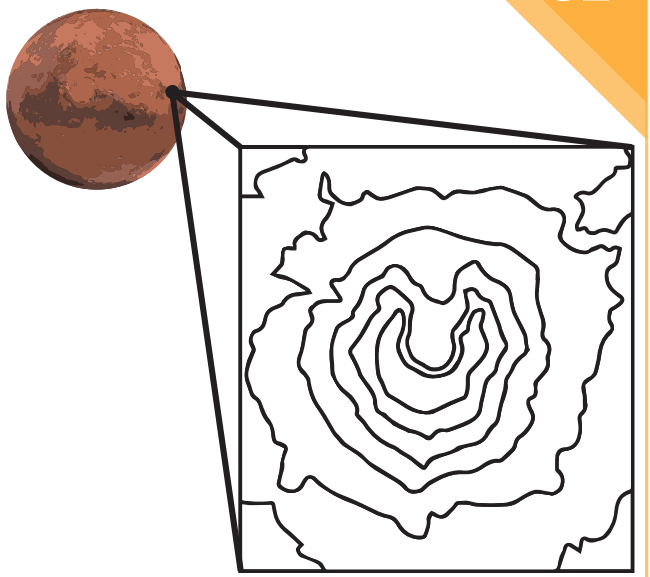
Communicate (in engineering): To share information, data, or ideas in order to improve designs or inspire new designs.

S1



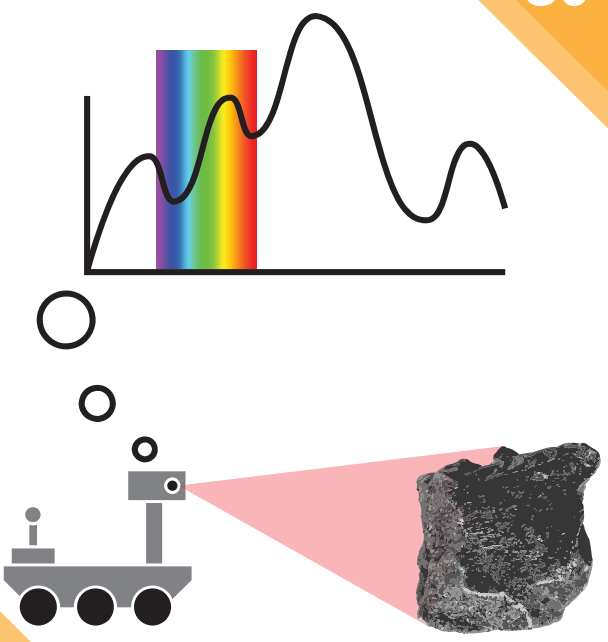
Remote Sensing & Mars
Exploring Visual Images

S2



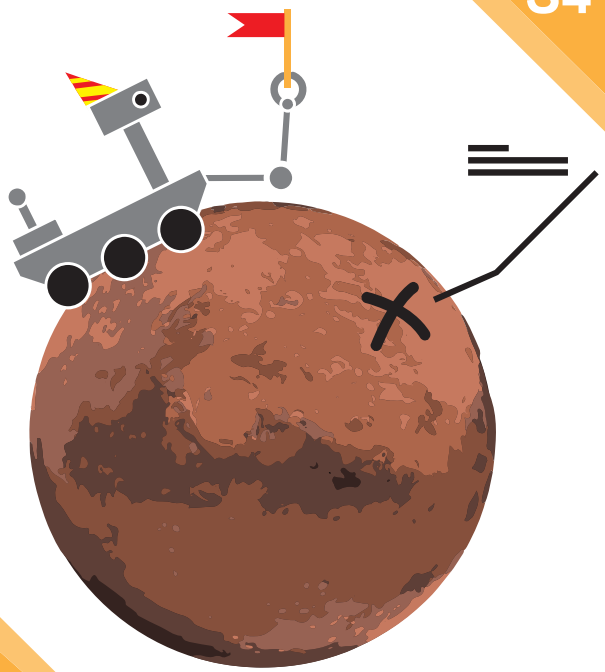
Landing Site Topography
Exploring Topographic Images

S3



Mineral Fingerprinting
Exploring Spectroscopic Graphs

S4



Choose a Landing Site
Evaluating Data

S1 Purpose

Introduces youth to the idea that NASA scientists are interested in finding evidence of past water on Mars that would indicate habitability. Challenges youth to select one of four landing sites for a rover by examining high resolution images of landforms on Mars.

Activity Timing

Introduction:	5 min
Questions:	10 min
Introduce Challenge:	15 min
Explore Data:	10 min
Evidence:	10 min
Reflect:	
Total	55 min

Quick Tips

* The Viking, HiRISE, and CTX images are at different scales. The ellipses are to be traced on the CTX (10 km scale bar) images only.
* If your Data packet prints out small, your landing ellipses will be too big. Have your students draw their own with pencil.

Prep Corner (1-2 hours total for S1, S2 ,S3, S4)

* Read through the entire PLANETS Science Series guide.
* Print or copy Science Notebooks, one for each youth.
* Print or copy, and staple Data Packets, Landforms Glossary, and Mineral Data Sheets, in the guide (color if possible), one for each group.
* Print or copy Landing Ellipses and cut out for each group.

Did you know?

Mars still has water, it is just mostly in the form of ice at the poles or trapped in minerals and underground.

Key Terms (More in the guide)

* Data: Information that is collected through scientific investigation
* Evidence: Information or data that supports an idea, claim, or belief

S2 Purpose

Provides opportunities for youth to compare topographic features of four potential landing sites.

Activity Timing

Introduction:	5 min
Interpreting Data:	10 min
Analyzing Site:	15 min
Reflect:	10 min
Total	40 min

Quick Tips

* Consider teaching about contour lines by tracing the layers of the moonscape from World's Apart Activity 4 and creating a topo map. Additionally, the pages of a thick paperback book can be manipulated to show a steep or shallow slope where every page edge is a contour line.

Prep Corner (5 to 15 min)

* If you have not already completed the prep for Science Series Activity 1, please refer to the S1 card for preparation.
* Revisit the PLANETS Science Series guide if its been a week or more since you completed Science Series Activity 1.
* For this activity you will need Science Notebooks for each youth, plus Data Packets and Landing Ellipses for each group.

Did you know?

Contour lines never cross, unless there is a overhanging cliff large enough to appear on a topo map.

Key Terms (More in the guide)

* Contour: A line on a map that represents a constant elevation.
* Topography: The arrangement, elevation, or height of the landforms in an area

S3 Purpose

Provides opportunities for youth to identify minerals that indicate past water or volcanism at each of four landing sites.

Activity Timing

Introduction:	10 min
Observing Spectra:	15 min
Explore Data:	10 min
Reflect:	5 min
Total	40 min

Quick Tips

* For more on why spectroscopy works check out our videos on the Electromagnetic Spectrum and how we use Spectroscopy to learn about other planets at www.planets-stem.org

* "Spectrum" is singular and "spectra" is the plural form of the same word.

Prep Corner (5 to 15 minutes)

* If you have not already completed the prep for Science Series Activity 1, please refer to the S1 card for preparation.
* Revisit the PLANETS Science Series guide if its been a week or more since you completed a Science Series activity.
* For this activity you will need Science Notebooks for each youth plus Data Packets and Mineral Data Sheets for each group.

Did you know?

Some animals can see more colors than us. Butterflies can see ultraviolet light and certain reptiles can detect infrared light.

Key Terms (More in the guide)

Spectroscopy: A remote sensing technology that measures the intensity of reflected light from a substance for the purpose of identifying the substance.

S4 Purpose

Youth combine all data to recommend the safest, most interesting landing site.

Activity Timing

Introduction:	5 min
Prepare Presentation:	15 min
Share Out:	30 min
Reflect:	5 min
Total	55 min

Quick Tips

* Youth can present and share in a variety of ways. Here are some options: a list of ranked landing sites, an annotated image or drawing, or an oral or written argument.

* Emphasize how scientists must use multiple sources of evidence when making claims.

Prep Corner (5 to 15 minutes)

* Revisit the PLANETS Science Series guide if its been a week or more since you completed a Science Series activity.
* For this activity you will need Science Notebooks for each youth plus Data Packets, Landforms Glossary, Landing Ellipses, and Mineral Data Sheets for each group.

Did you know?

Even with the right landing site, the Curiosity Rover had to be gently placed after crashing through the martian atmosphere. Learn more https://www.jpl.nasa.gov-/video/details.php?id=1090

Did you know?

The Curiosity Rover sings itself "Happy Birthday" every year on August 5th. The rest of the year, Curiosity is programmed to collect and send scientific data back to earth.