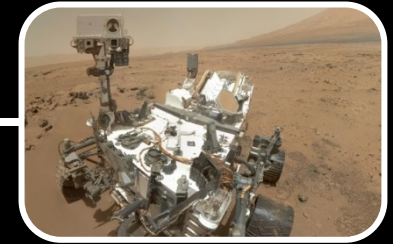
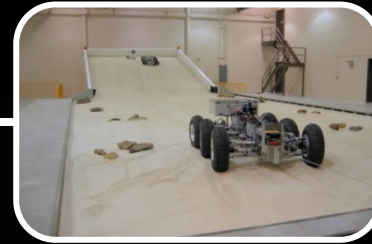


NASA Glenn Research Center Engineering Design Challenge

National Aeronautics and
Space Administration



EDC-01: Gaining Traction on Mars



Next Generation Science Standards Performance Expectations



MS-ETS1: Engineering Design

MS-ETS1-1: Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

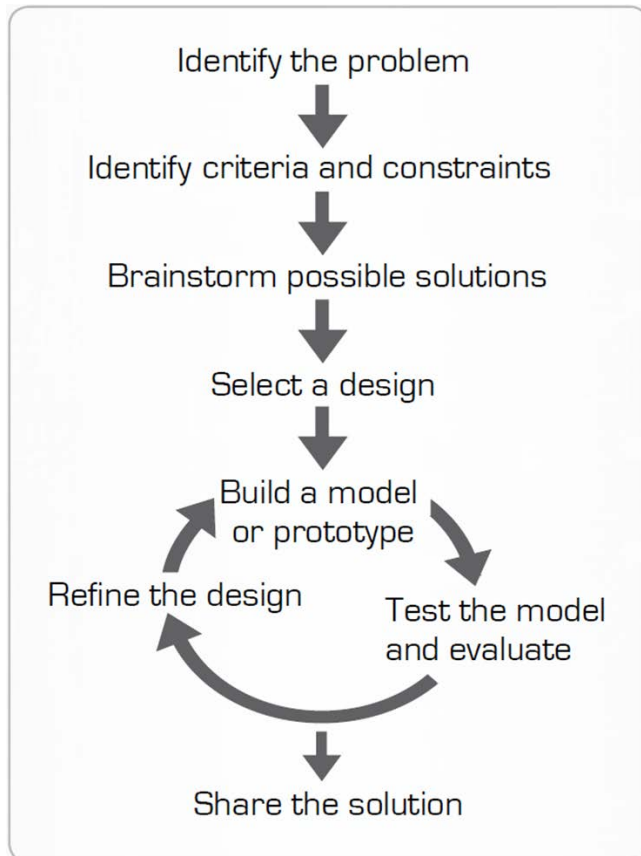
MS-ETS1-2: Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.



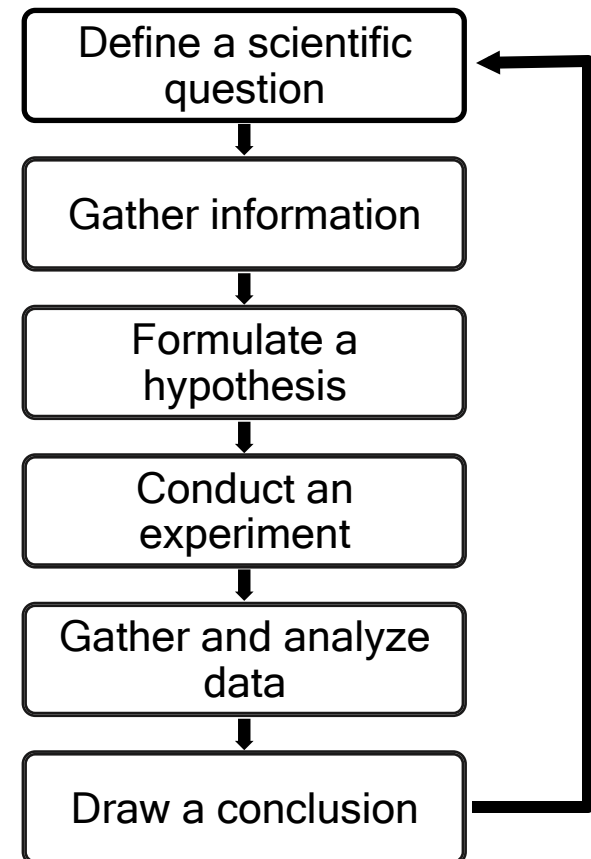
The Engineering Design Process vs. The Scientific Method



Engineering Design Process –
Helps to solve a problem in society
that humans face by creating or
inventing something new



Scientific Method – Asks and answers
scientific questions by making
observations and doing experiments





The Engineering Design Process



STEP 1: Identify the Problem - Students state the problem in their own words. How can I design a _____ that will _____?

STEP 2: Identify Criteria and Constraints - Students specify the requirements (criteria) and the limits (constraints) on the design due to resources and the environment.

STEP 3: Brainstorm Possible Solutions - Students sketch their ideas as they discuss ways to solve the problem with their team.

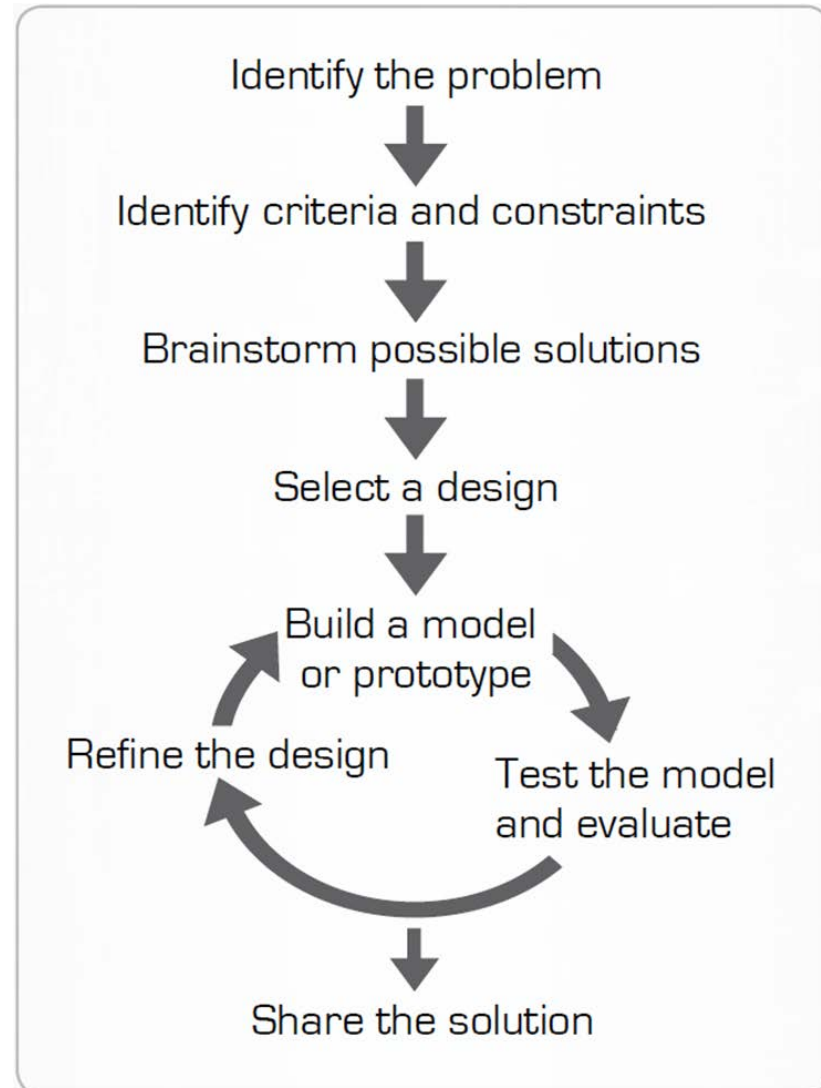
STEP 4: Select a Design - Students share their designs with their team and the team chooses a design.

STEP 5: Build a Model or Prototype - The team builds a model based on their selected design.

STEP 6: Test the Model and Evaluate - The team tests their solution in a controlled environment by taking measurements, making observations, considering modifications.

STEP 7: Refine the Design - The team examines and evaluates their prototype based on the criteria and constraints, and identifies changes that need to be made to improve the design.

STEP 8: Share the Solution - The team demonstrates their final solution and the knowledge they gained in a public forum.

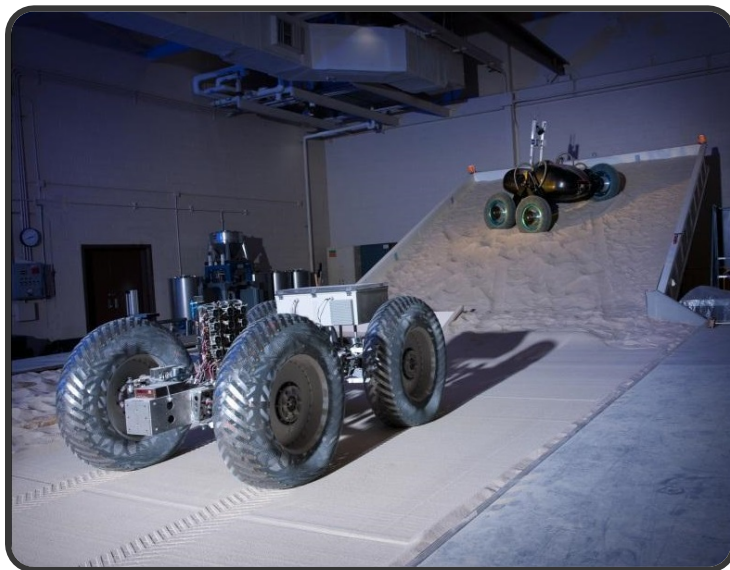




NASA Glenn Research Center Simulated Lunar Operations Lab



- NASA Glenn Research Center (GRC) in Cleveland is home to the Simulated Lunar Operations (SLOPE) laboratory and its Traction and Excavation Capabilities (TREC) Testbed.



- These test rigs are used to study how rover wheels operate in simulated extraterrestrial soils. For example, engineers are studying how damage on the wheels of the Curiosity rover affects its mobility as it explores Mars.



Gaining Traction on Mars Engineering Design Challenge



- This Engineering Design Challenge (EDC) serves as an authentic standards-based investigation that allows students to engage in the process of solving problems like today's scientists and engineers do.
- The Facilitation Guide includes a main challenge and four lead-up investigations to support Next Generation Science Standards.



Supports for Educators

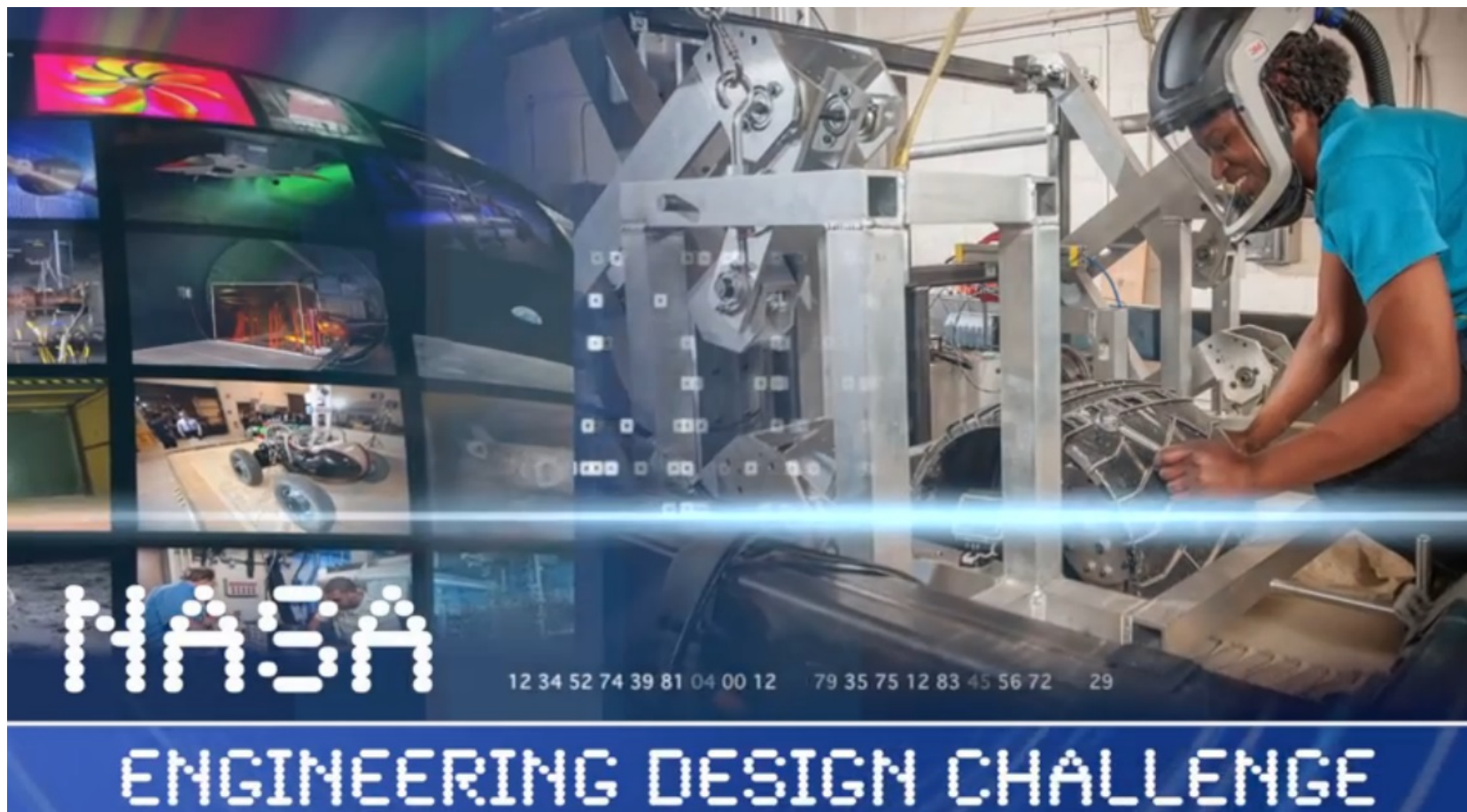


- Downloadable curriculum enhancement Facilitation Guide which includes
 - Differentiated instruction suggestions and pre and post assessments (see pages 9 to 16)
 - Materials list for the challenge and investigations (see pages 17 to 18)
 - Rubric for the EDC and investigations (see pages 35 to 36 and 42)
- Opportunities to connect LIVE with NASA subject matter experts (SMEs)
- A platform for students to submit their solutions to NASA, and share designs with participants across the country.





Introductory Video



<http://youtu.be/4ug-e4QIPEE>

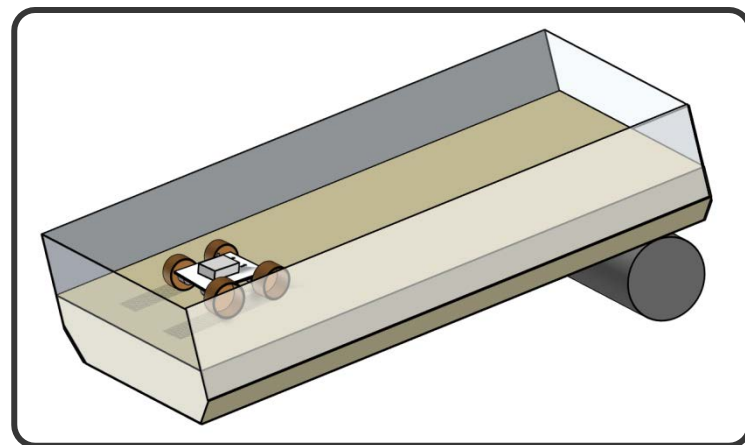
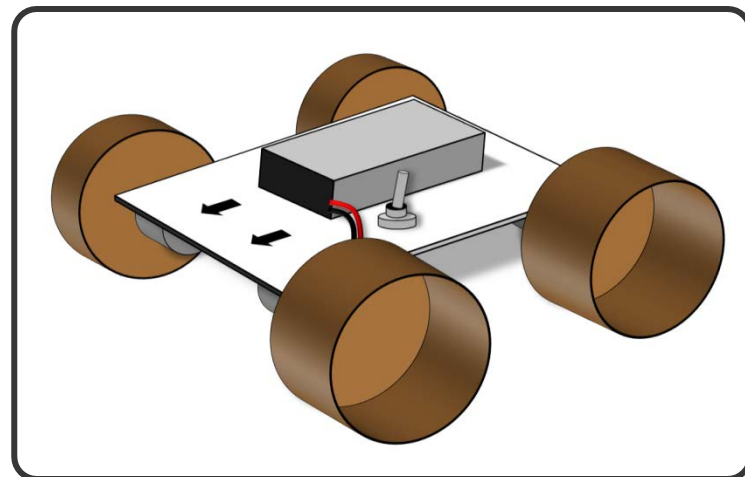


Gaining Traction on Mars Engineering Design Challenge



The Challenge:

- Student teams will design and build the most effective wheel configuration to use on a simulated Martian surface. It will be installed and tested as part of a battery-operated model rover.
- The best design will move from one end of the test bed to the other in the least amount of time and with the least amount of wheel damage.
- Bonus points will be awarded for designs that climb the test bed at an inclined angle to be determined by the team.





Choosing a Test Vehicle

- The test vehicle given in the Facilitation Guide is an inexpensive and effective model to help facilitators get to the wheel design challenge with students.
- The vehicle is an example of what test apparatus can be used but is not required. Facilitators can use whatever test vehicle works best for them and fits within their budget. Size and weight constraints should be modified to accommodate a different test vehicle.



Safely Testing in Sand

- Generally, play sand is
 - Washed to remove any dirt, dust, and fines
 - Screened to filter out smaller sized particles to reduce the risk of airborne silica particles
- Particles that are smaller than 10 micrometers (μm) are respirable. Play Sand (Quikrete®) particle sizes range from 297 to 1190 μm , and are too large to be breathed.
- **Use personal protective equipment (PPE)**, like safety glasses, to prevent sand from getting into eyes or mouths if vehicle wheels kick up sand in the test bed.
- Avoid standing directly behind the vehicle during testing.



Gaining Traction on Mars Facilitator Practice



- Work in groups of four to design and build wheels.
- Complete at least two wheel design iterations and test them in the sand.
- Assign each group member to one of the following roles and tasks
 - **Design engineer** - makes sketches, outlines, patterns, and plans based on the ideas the team generates
 - **Technical engineer** - assembles, maintains, repairs, or modifies the mechanical and electrical components of the system
 - **Operations engineer** - sets up and operates the system to complete a process or test
 - **Technical writer** - records and organizes information, data, and prepares documentation to be published



Directed Questioning for Students



Establish several time periods throughout the engineering design process for teams to share findings with the whole group.

Enhance discussion by asking questions like

- What do you need to consider when designing your wheels?
- What did you find out after your first design brainstorming session?
- What do you know about traction that may help you in this challenge?
- Can any other team contribute to the idea that was just discussed?

Acknowledge what each group reports and have teams try to incorporate those ideas into their new designs.



Next Generation Science Standards Performance Expectations for Lead-up Investigations



MS-PS2: Motion and Stability: Forces and Interactions

MS-PS2-2: Plan an investigation to provide evidence that the change in a object's motion depends on the sum of the forces on the object and the mass of the object.

MS-PS2-3: Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5: Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.



Lead-up Investigations



Investigation One - Racing Against Friction

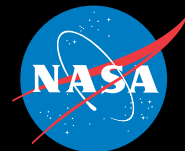
Investigation Two - Stacked for Power

Investigation Three - Charged Attraction

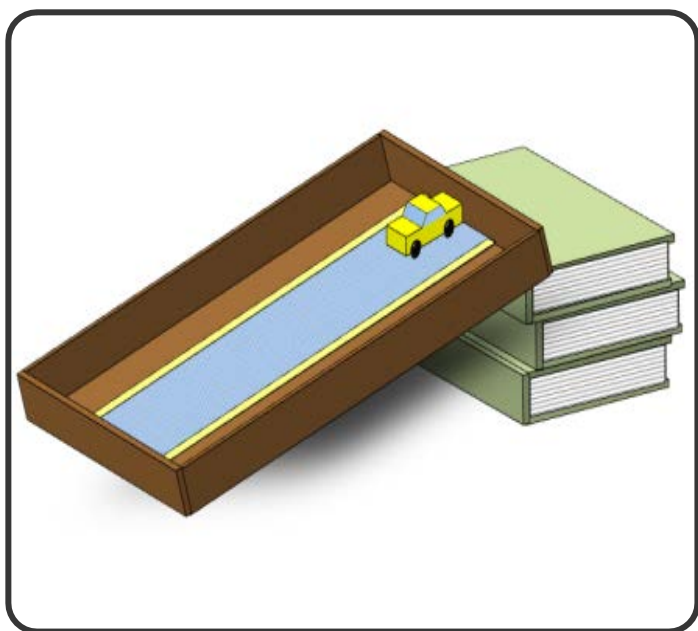
Investigation Four - Fine Motor Skills

Safety warnings:

Creating short circuits, even with relatively low-voltage and low-amperage circuits, can eventually create enough heat to burn skin or start fires. Instruct your students about the dangers of short circuits and how to avoid getting burned. **Wear goggles at all times.**



Racing Against Friction



Students will

- Demonstrate their understanding of force, gravity, friction, and speed
- Test how friction affects speed and motion
- Describe the ways multiple forces interact and the balance, or imbalance, of those forces

Connection to Gaining Traction on Mars

Students study the interaction between the car wheels and various ramp surfaces compare it to the friction between their wheel designs and the sand in the test bed.



Stacked for Power

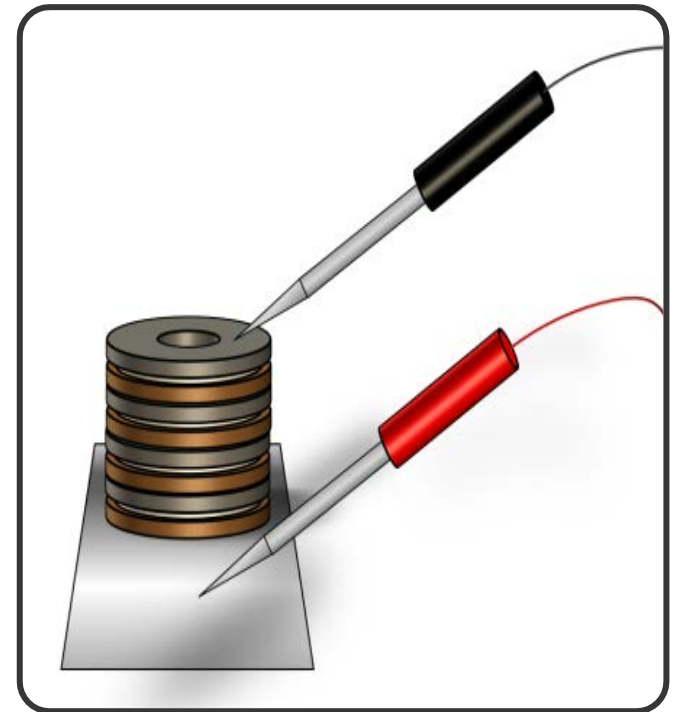


Students will

- Demonstrate their understanding of how a battery creates electric potential
- Create a circuit through which electricity moves
- Measure electric potential in volts

Connection to Gaining Traction on Mars

Students will build a simple battery and measure its electric potential and compare it to the batteries powering their test vehicles.





Charged Attraction

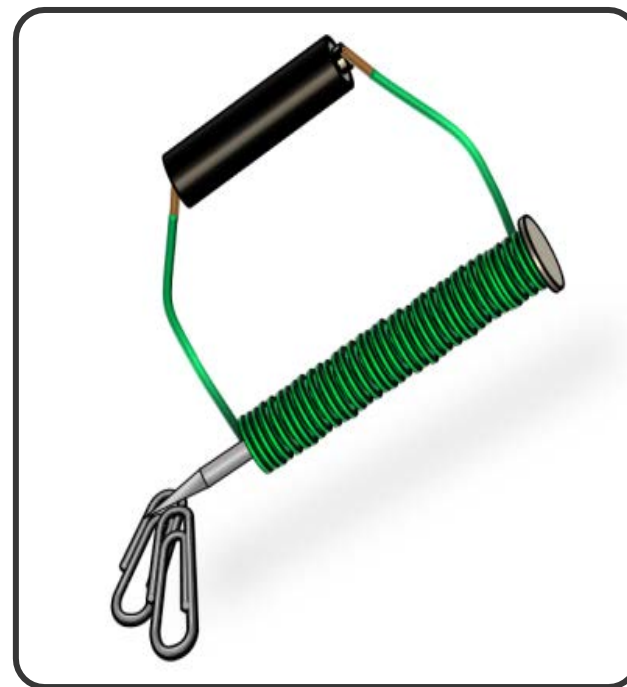


Students will

- Demonstrate how electromagnetic forces work
- Create an electronic circuit showing how forces interact with each other
- Use magnets to detect forces between objects that are not necessarily in contact

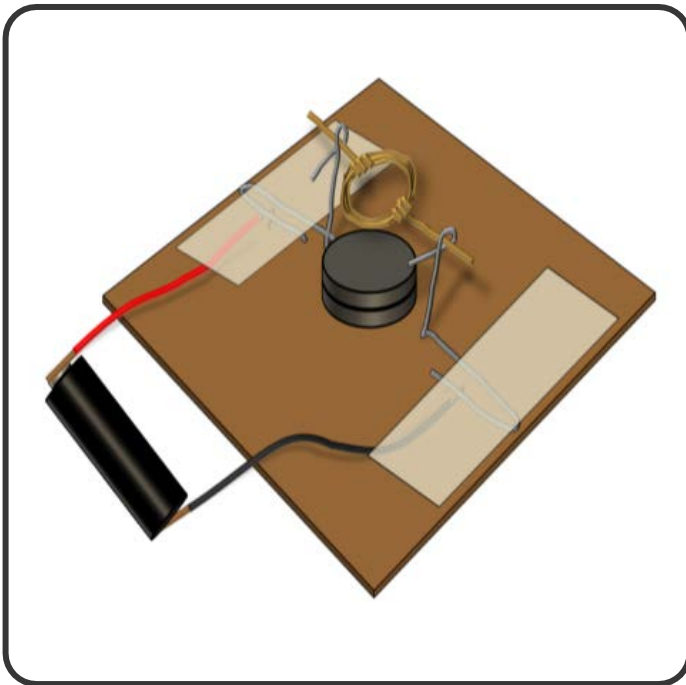
Connection to Gaining Traction on Mars

Students build a simple electromagnet and compare it to the electromagnets in the motors of their test vehicles.





Fine Motor Skills



Students will

- Create a model motor
- Increase their understanding of magnetic forces
- Explore how electrical force can change into magnetic force, which can change into mechanical force

Connection to Gaining Traction on Mars
Students build a working motor and compare it to how the motors on their test vehicles function.



Available Technical Supports from NASA



- Engineering Design Challenge Website
- EDC training and support videos
- Making a solution video
- Uploading to YouTube
- Submitting to NASA
- SME Connections



Engineering Design Challenge - Home Page



<http://www.nasa.gov/content/grc-engineering-design-challenges/>

The screenshot shows the NASA Engineering Design Challenges website. At the top, there are navigation tabs for NEWS, MISSIONS, MULTIMEDIA, CONNECT, and ABOUT NASA. Below these is a search bar and a navigation menu for 'For Public', 'For Educators', 'For Students', and 'For Media'. The main content area is titled 'Engineering Design Challenges' and includes a 'Purpose' section, a 'What a GRC EDC Entails' section, and a 'Current Design Challenges' section. The 'Current Design Challenges' section features a challenge titled '10/15/14 - Gaining Traction on Mars - Engineering Design Challenge' with a description: 'Design a set of wheels for a Martian rover that performs best on a simulated extraterrestrial soil bed.' There are also sections for 'Glenn Research Center', 'Related Multimedia', 'Glenn Education Contacts', and 'GRC EDC Participating Organizations'.

News and updates

Email subscription

NASA email contact
GRC-Ed-Opportunities@mail.nasa.gov

List of challenges



Engineering Design Challenge Gaining Traction on Mars - Overview



<http://www.nasa.gov/content/gaining-traction-on-mars-overview/>

The screenshot shows the NASA website interface for the 'Gaining Traction on Mars' challenge. At the top, there are navigation tabs for NEWS, MISSIONS, MULTIMEDIA, CONNECT, and ABOUT NASA. Below these is a search bar and a navigation menu with links for 'For Public', 'For Educators', 'For Students', and 'For Media'. The main content area is titled 'Engineering Design Challenges' and includes an 'Overview' section with a video player for an 'Introduction video'. A sidebar on the left provides 'Challenge navigation' with links to various challenge-related pages. On the right, there is an 'Email subscription' form and an 'EDC Contact' section with an email address.

Challenge navigation

Email subscription

NASA email contact
GRC-Ed-Opportunities@mail.nasa.gov

Introductory video



Engineering Design Challenge Gaining Traction on Mars – Content



<http://www.nasa.gov/content/gaining-traction-on-mars-challenge-content/>

The screenshot shows the NASA Glenn Research Center website for the Engineering Design Challenge 'Gaining Traction on Mars'. The page includes a navigation menu on the left, a main content area with challenge details, a 'Receive EDC Notifications' form, and a 'Plan the Challenge' section at the bottom. A callout box points to a 'Facilitation Guide' download link, and another callout box points to a 'Training and support videos' section.

Glenn Research Center

- Glenn Research Center
- About Glenn
- ▶ Glenn News
- Glenn Multimedia
- Space Station
- Technology
- Exploration
- Aeronautics
- Glenn Education
- Doing Business With Glenn
- Glenn Events

Glenn Engineering Design Challenges

- Main EDC Page
- Gaining Traction on Mars
 - Overview
 - Challenge Content
 - Submitting Student Videos
 - Event Schedule
 - Related NASA Content

Engineering Design Challenges
Glenn Research Center

Challenge Content

Gaining Traction on Mars

Challenge Content:

Students will work in engineering design teams to create and test various wheel designs and materials on a standard test vehicle to determine which are most effective on a simulated Martian surface. To understand how the test vehicle operates, students will explore the inner-workings that make-up the rover through four lead-up investigations:

1. "Racing Against Friction" – Students will test materials for the effects of friction.
2. "Stacked for Power" - Students will build a battery and measure its output.
3. "Charged Attraction" - Students will build an electromagnet and measure its attractive capabilities.
4. "Fine Motor Skills" - Students will build an electromagnetic motor and measure its efficacy in terms of rotations per minute (RPMs)

Below you will find links to PDF documents the facilitation guide and helpful videos for facilitating the challenge and engaging your students.

Engineering Design Challenge "Gaining Traction on Mars" Facilitation Guide Full Guide - Download - (PDF)

Plan the Challenge

Title	Video
Engineering Design Challenge Overview	Watch / Download

Receive EDC Notifications

To receive notifications of new EDC opportunities fill out the form below

Your email address:

Your name (optional):

EDC Contact:

For any questions regarding GRC Engineering Design Challenges, please send them to GRC-Ed-Opportunities@mail.nasa.gov

Link to download Facilitation Guide

Training and support videos



Engineering Design Challenge Gaining Traction on Mars – Student Videos



<http://www.nasa.gov/content/gaining-traction-on-mars-submitting-student-videos/>

The screenshot shows the NASA website interface for the 'Engineering Design Challenges' section. The top navigation bar includes links for NEWS, MISSIONS, MULTIMEDIA, CONNECT, and ABOUT NASA. Below this is a search bar and a navigation menu for 'For Public', 'For Educators', 'For Students', and 'For Media'. The main content area is titled 'Engineering Design Challenges' and features a sub-section for 'Submitting Student Videos'. This section includes a video player for 'NASA STEM Challenges: Telling Your Story With Video' and a list of 'Media Release Forms' for download. A sidebar on the left provides navigation for the Glenn Research Center, and a right sidebar offers a 'Receive EDC Notifications' form and 'EDC Contact' information.

Tips for creating student videos

Release forms for NASA media



Engineering Design Challenge Gaining Traction on Mars – Event Schedule



<http://www.nasa.gov/content/gaining-traction-on-mars-event-schedule/>

NEWS
News, features & press releases

MISSIONS
Current, future, past missions & launch dates

MULTIMEDIA
Images, videos, NASA TV & more

CONNECT
Social media channels & NASA apps

ABOUT NASA
Leadership, organization, budget, careers & more

For Public | For Educators | For Students | For Media

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- Aeronautics
- Glenn Education
- Doing Business With Glenn
- Glenn Events

Glenn Engineering Design Challenges

- Main EDC Page
- Gaining Traction on Mars
 - Overview
 - Challenge Content
 - Submitting Student Videos
 - **Event Schedule**
 - Related NASA Content

Engineering Design Challenges

Glenn Research Center

Receive EDC Notifications

To receive notifications of new EDC opportunities fill out the form below

Your email address:

Your name (optional):

EDC Contact:

For any questions regarding GRC Engineering Design Challenges, please send them to GRC-Ed-Opportunities@mail.nasa.gov

Event Schedule:

The following events, related to the Gaining Traction on Mars Engineering Design Challenge, are available for any groups interested in participating.

NOTE: All times shown are EASTERN times, and are subject to change.

Facilitator Training Opportunities

Date	Time	Activity
TBD	TBD	More learning opportunities to come

Student Opportunities and Subject Matter Expert Connections

Date	Time	Topic	NASA SME(s)
11/12/2014	10:00 am	Q & A about NASA and Challenge	TBD
11/12/2014	4:00 pm		
11/19/2014	10:00 am	Overcoming Roadblocks	TBD
11/19/2014	4:00 pm		
11/20/2014	2:00 pm		

Training session
schedules

Student opportunity
schedules

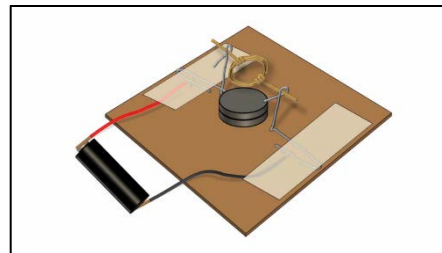
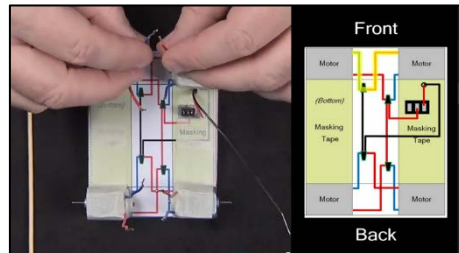
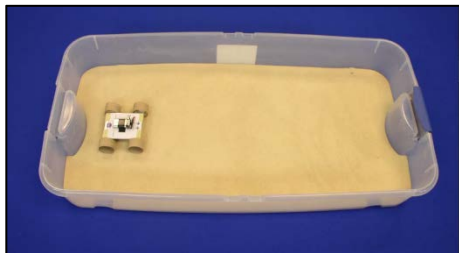


EDC Training Support Videos



Videos available for facilitators include

- Engineering Design Challenge Overview
- Building the Test Vehicle
- Investigation Four: Fine Motor Skills
- Creating and Submitting Solutions
- Connecting With Subject Matter Experts



<http://www.youtube.com/playlist?list=PLTUZypZ67cduoz4n5fu8j-K&v=zrnxP775>



Making a Student Solution Video



Tips for students on how to create quality video submissions



<http://youtu.be/TWHx95-8kBs>



Submitting Solution Videos to NASA



To submit a student solution video:

1. Upload your student video to a YouTube account. **Do not reveal any names of students, teachers, schools, or locations in the video.**
2. Use the “Share” button to locate your video’s URL.
3. Post your video’s URL in the comments section of the [Introduction to the Challenge](#) video.

Comments and video links are moderated and will appear on the feed once they are approved.

SMEs will review your submissions and provide feedback.



Subject Matter Expert Connections



- SME connections are posted on the Event Schedule page of the EDC website and announced by emails sent to the EDC distribution list.
- Registration instructions are included in the email.
- Currently, there is no limit to the number of SME connections a school or organization can join.

NASA Glenn Research Center
Engineering Design Challenge: *Gaining Traction on Mars*
E-BLAST October 28, 2014

What is the Challenge?

How can we make wheels that not only work but last while exploring other planets? Students will build a standard vehicle as a means to design and test wheels that achieve optimal traction in a simulated Martian environment. The Challenge simulates current research being done at NASA's Glenn Research Center's Simulated Lunar Operations (SLOPE) lab.
To view the intro video, visit <https://www.youtube.com/watch?v=4ug-e4QIPEE#t=10>.

What's New?

The Engineering Design Challenge: Gaining Traction on Mars website is up and running! Please visit <http://www.nasa.gov/content/gaining-traction-on-mars-overview> for all your content and support needs.

Upcoming Events

Live subject matter expert (SME) connections are coming up! Students will have an opportunity to videoconference with real NASA SMEs and hear firsthand what it is like to work at NASA and answer questions from students.

The first connection topic is: "Working at NASA and Introduction to the Challenge."
Connection Dates and Times (all times Eastern; registration is limited to one connection per site):

- Wednesday, November 12 @ 10:00AM
- Wednesday, November 12 @ 4:00PM
- Thursday, November 13 @ 2:00PM

Register at <http://tinyurl.com/EDC-SME-REG>.

Reminders

We are interested in showcasing everywhere the challenge is being implemented. To do that, we are working on generating a map to put on the EDC website, showing the locations of all the participating schools and organizations. If you are planning on starting this fall (November 2014-January 2015), please send an email with the name of your school or organization, address, and estimated number of student participants to GRC-Ed-Opportunities@mail.nasa.gov. Please use the subject, "We are go for rover wheel design!"





Gaining Traction on Mars Facilitator Debriefing



Guiding questions

- What will the challenge look like in your educational setting?
- What difficulties might you encounter facilitating the challenge?
- How will this fit into your assessment cycle?
- What suggestions for facilitating the challenge can you share with this group?



Questions?



- For any questions, email GRC-Education@mail.nasa.gov.