

Mission Briefing: Testing & Transport Module



Before a rocket or spacecraft gets anywhere near the launchpad every part, process and detail is tested to ensure that they will meet the requirements for a safe and successful spaceflight. Once everything is working as it should, the rocket and the mobile launcher must be transported to the launchpad. These jobs fall to the engineers and ground systems crew at NASA. In the second module students will learn about the engineers and ground systems crew that play a vital role in developing and testing the vehicles, equipment, and processes that are essential to the mission. The testing and transport module is a great way to illustrate how precise every aspect of the mission must be to achieve success, while exploring the important roles of the teams on the ground.

Mini-Mission

Time: 15 minutes

Objectives:

- Engage students in thinking about why testing an idea is important
- Ignite a discussion with students about testing

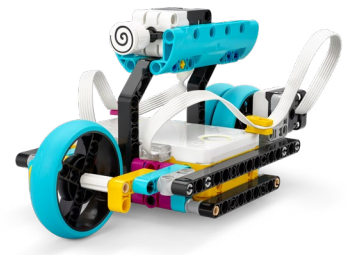
Consider asking questions like:

- Why is it important we test or try out our ideas?
- What can you do with the information you learn from testing?
- What are some ways that we can test ideas?
- What are some ideas that you have tested?

Challenge your students to explore the importance of testing an idea. Share the idea of creating the best paper airplane. Ask students to discuss how they can test their design ideas. Allow students to create and test their design. Tell students not to change their ideas, only to test their design several times.

Discuss as a group what the students want to do next. Students are likely to want to change their design to try new ideas that might be better. Ask students how they will use the information from the first tests to create a new design. Allow students to continue to try ideas as time allows. End the briefing with a discussion on how important testing is to provide useful information to help iterate on an idea and find the best possible solution.

Mission: Building a Bullseye



Time: 45–90 minutes

Objectives:

- Design and build a device to reach a target
- Examine the importance of testing and iterating

STEAM Practices:

- Ask questions and define problems
- Iteratively test and modify designs

Mission Briefing

Brief students on the mission by saying:

Ask them how they think the Orion or other spacecrafts move through space? Explain that there are precise mathematical calculations and thousands of steps that must be carried out to keep the spacecraft on the right trajectory. Talk about the sophisticated guidance systems NASA uses to balance and steer rockets so spacecrafts make it to their destinations. Remind students that prior to launching, NASA plans timing and tests their flight paths through simulations. Testing is vital to preparing for a space mission to ensure everything will go as planned. Through testing, NASA thinks about the challenges that could arise in space and makes sure their tools and resources will work as expected. Explain that if something doesn't work in testing, they're able to make any necessary changes before it impacts the mission.

Have students write one question they have about how a spacecraft stays on course in their Engineering Design Notebook.

Extend Student Curiosity about the Mission

Build curiosity with your students using these resources. Consider asking your students some prompting questions to discuss or to reflect on in their Engineering Design Notebook.

- What kind of things do you have to think about when you're trying to hit a target?
- What resources and tools do you think NASA uses to get the right timing, and ensure accurate movements through space?
- Why do you think testing is so important?

Read these articles with your students:

[Launching Orion into Space](#)

[NASA Engineers Analyze Navigation Needs of Artemis Moon Missions](#)

Career Connection

Connect the Mission to Careers at NASA

Connect students to an actual career at NASA to learn more about what people do each day. Share with students:

NASA engineers work to solve difficult problems every day. In this episode students will meet Avery, engineer for the LEGO® Space Team. Tell students that engineers make up more than half of all NASA employees. They are experts in everything from aerospace engineering to software and computers. Engineers are always thinking of ways to innovate and improve. And at NASA, that often means doing things that others might see as impossible.

Explain that engineers have all kinds of specialties, including the analysis and understanding of spacecraft hardware. Engineering teams spend months and even years designing, developing and testing hardware to ensure safety for all.

Let's meet another NASA Engineer

Andrew Johnson is a guidance, navigation, and control engineer. He's part of the team that developed the Mars Rover Lander Vision System which helped NASA's Perseverance Mars Rover "see" and avoid large hazards as it prepared to land on Mars.

For more about Andrew Johnson check out this inspiring video:

[Faces of Technology](#)



The Mission

Explain the mission to students by saying:

Now it's their turn to see how precise they can be with their aim. Have them design and build a free-moving wheeled vehicle or any contraption that they can use to aim a ball towards a target. Have them think about how they will need the model to move in order to reach the target. Does it need to move fast or slow? How will they keep it steady and straight? How will they make sure it can hit the target consistently?

Have them brainstorm and sketch out their ideas. Make sure they explain the task they're trying to complete with their tool. Remind them to build, test, and iterate on their models and to test it several times. Have them make changes as needed to make it to the target. Encourage them to try different ideas. If something doesn't work, they can try something new.

Be sure to leave enough time for all students to share their prototypes and explain why this is the best fit for the problem they were trying to solve.

Additional Inspiration Lessons

Consider completing these lessons from LEGO® Education prior to students completing their mission to scaffold their engineering skills.

- [LEGO® Education SPIKETM Prime Aim For It](#)
- [LEGO® Education BricQ Motion Prime Ski Slope](#)
- [LEGO® Education BricQ Motion Essential Free Throw](#)

Differentiation for All Learners

For younger or less experienced designers, consider providing a larger target that is a short distance away.

For older or more experienced designers, consider providing a smaller target that moves. Think of ways that the target could be changed after several successful tests in order to get students thinking about how they can use the same ideas to hit a new target.

Mission: The Path to the Pad



Time: 45–90 minutes

Objectives:

- Design and build a transport vehicle
- Investigate how to move large and heavy objects

STEAM Practices:

- Develop and use models
- Iteratively test and modify designs
- Understand structure and function

Mission Briefing

Brief students on the mission by saying:

Ask them to think about a time they had to move something really large. Was it easy to do? What did they need to help them move it? Then ask them to imagine having to move a rocket and a launchpad. You can recall the episode and talk about the Crawler NASA uses and some of the things they take into consideration.

Have students grab their Engineering Design Notebook and write down what they think are the top three problems to overcome when moving a rocket like the Space Launch System (SLS).

Extend Student Curiosity about the Mission

Build curiosity with your students using these resources. Consider asking your students some prompting questions to discuss or to reflect on in their Engineering Design Notebook.

- How can you move large and heavy objects?
- What factors should you consider when transporting large and heavy objects (such as speed, turning, etc.)?

Read this article with your students:

[The Crawlers](#)

Watch this video with your students:

[Artemis Path to the Pad: Crawler-Transporter 2](#)

Career Connection

Connect the Mission to Careers at NASA

Connect students to an actual career at NASA to learn more about what people do each day. Share with students:

Meet Zach, Ground Systems Technician for the LEGO® Space Team. Ground Systems Technicians represent the ground crew that develops, tests and operates the systems and facilities necessary to process and launch rockets and spacecraft during assembly, transport and launch. These diverse teams design and maintain the infrastructure to support a variety of missions.



Let's meet another member of the NASA Ground Crew

Jeff Adams is the Logistics, Engineering and Transportation Team Lead at NASA. His team works behind the scenes to move full-scale core stage test hardware from NASA's rocket factory, Michoud Assembly Facility near New Orleans, to test facilities at NASA'S Marshall Space Flight Center in Huntsville, Alabama.

The team spends months planning and developing detailed transportation procedures to ensure the test articles are delivered without a mishap. They also come up with contingency plans – just in case.

So far his team has safely transported the engine section, the intertank and the enormous liquid hydrogen tank, using three pieces of ground support equipment: the Engine Section Transporter, the Multipurpose Transportation System and NASA's Barge Pegasus.

Learn more about Jeff Adams:

[I Am Building SLS](#)

For more inspiration check out these resources:

[Exploration Ground Systems](#)

[Exploration Ground Systems Overview](#)

[In the Driver's Seat of Artemis I](#)

The Mission

Explain the mission to students by saying:

Tell your students it's their turn to create an easier way to move large equipment and objects just like NASA does. Have them design and create a device that can lift and move large objects like a rocket safely. Ask them to think about how they will control the movements of their device to ensure the objects they are transporting are not damaged. Ask leading questions like, how will your device hold the size and weight of the object? Or, how will you keep the object from moving or falling? Remind students that this is a prototype or model of a device that you would use to move large and heavy objects and it does not actually need to be at full scale!

Have them brainstorm and sketch out their ideas. Identify the heavy or large object they want to move. Then it's time for them to build, test, and rebuild their models. Remind them to try different ideas and that if it doesn't work, it's ok to try something new. Consider providing an actual object like a full water bottle to simulate a rocket. Students can use this to design around and test their prototype against.

Be sure to leave enough time for all students to share their prototypes and explain why this is the best fit for the problem they were trying to solve.

Additional Inspiration Lessons

Consider completing these lessons from LEGO® Education prior to students completing their mission to scaffold their engineering skills.

- [LEGO® Education SPIKE™ Prime Training Camp 2](#)
- [LEGO® Education SPIKE™ Prime Out of Order](#)
- [LEGO® Education BricQ_Motion Prime Gymnast](#)
- [LEGO® Education BricQ_Motion Essential Race Car](#)

Differentiation for All Learners

For younger or less experienced designers, consider providing scaffolding by giving students a specific object to try to move that is square. Providing a square object will reduce the amount of movement the object can have on the vehicle, allowing students to test their model with the object easier.

For older or more experienced designers, consider requiring students to use a larger object or multiple objects. Additionally, you could have older or more experienced students move the object over a longer, more difficult path.