SPACE HAZARDS

ENGINEERING SPACE GLOVES

Engineering Pathway

Materials Engineering Adventures for Out-of-School Time • Grades 3–5

Contents

Welcome to Space Hazards!

In This Unit

In this unit, learners think and work like scientists and engineers. They investigate and engineer solutions for the extreme environmental hazards that NASA astronauts face in space.

The unit is composed of a Science Pathway and an Engineering Pathway. In both pathways, learners have the opportunity to build their problem solving, teamwork, communication, and creative thinking skills. Specifically, the PLANETS units are designed to ensure that learners will

- engage in real-world activities that provide inclusive ways for all learners to connect to science and engineering.
- choose their path through open-ended challenges that have multiple solutions.
- engage in the habits of mind of engineers and inquiry practices of scientists.
- communicate and collaborate in innovative, active problem solving.

Getting to Know PLANETS

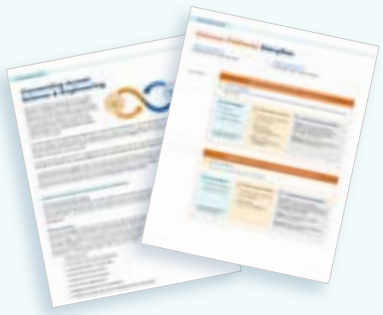
Planetary Learning that Advances the Nexus of Engineering, Technology, and Science (PLANETS) is an interdisciplinary and cross-institutional partnership that integrates planetary science, education, technology, and engineering.

The Center for Science Teaching and Learning at Northern Arizona University (NAU), the U.S. Geological Survey (USGS) Astrogeology Science Center, the Museum of Science, Boston, and WestEd have partnered to develop, pilot, and research the impact of three curriculum units and related professional development resources (http://planets-stem.org) for grades 3–8.

The purpose of PLANETS is to increase public awareness and use of NASA resources by highlighting the relationship between science, technology, engineering, and mathematics in the context of planetary science in out-of-school time settings.

Note

Much of the information at the start of this guide is the same for the Science and Engineering Pathways. If you have already read the Science Pathway, you can read just **Learners Working and Thinking Like Engineers** pg. v, and the **Engineering Pathway Storyline**, pgs. xxiii–xxvi, then skip to the **Engineering Pathway Vocabulary,** pg. 1, and read from there.



Space Hazards *Unit Overview*

This guide contains the **Engineering Pathway**.

Astronauts are exposed to some of the most extreme conditions while working in space. These include hazards such as cold temperatures, high levels of radiation, impact from space debris (trash), dangerous dust, and changes in pressure, oxygen, and gravity. In this unit, learners become familiar with these hazards and the mitigation strategies that NASA uses to keep astronauts safe. The unit contains an Engineering Pathway and a Science Pathway.

View the following video playlists:

- Background science and engineering content
- How to prepare and teach with the materials
- How to support learner differences

Engineering Pathway Overview: *Engineering Space Gloves*

Materials engineering is an interdisciplinary field that draws upon physics, chemistry, and engineering to understand how materials behave. Materials engineers may combine existing materials such as metals, ceramics, and textiles to see how they perform under different conditions or design entirely new materials to meet the growing technological needs of society. All materials have properties, such as strength, flexibility, and resistance to hot or cold temperatures, that determine how they can be used in specific technologies, from snowboards to spaceships. When astronauts go to space, they face several challenges that materials engineers must solve through special designs. Here are some examples:

- **Cold Temperatures:** To protect against cold temperatures, materials engineers use thermal insulators, materials that slow the transfer of heat from one place to another.
- **Impact:** Astronauts also need to avoid collisions with heavy, moving space debris (trash). NASA estimates there are over 500,000 pieces of space debris, such as non-functioning satellites and fragments of other spacecraft, currently orbiting Earth at up to 18,000 miles per hour. The growing volume of space debris increases the chances of impact and damage.
- **Dangerous Dust:** In space exploration, dust can be dangerous. On the Moon, it is abrasive to materials, gets stuck in the joints of spacesuits, and compromises sterile environments. Astronauts work hard to keep dust out of their equipment and spacecraft. Mars dust is not as abrasive or static-y as moon dust, but it is toxic to humans due to the presence of chlorine.

Learners in the Engineering Pathway engage in adventures as material engineers as they design space gloves that mitigate three space hazards: cold temperatures, impact, and dangerous dust.

The Engineering Pathway Storyline that more fully articulates the progression of activities can be found on pgs. xxiii–xxvi.

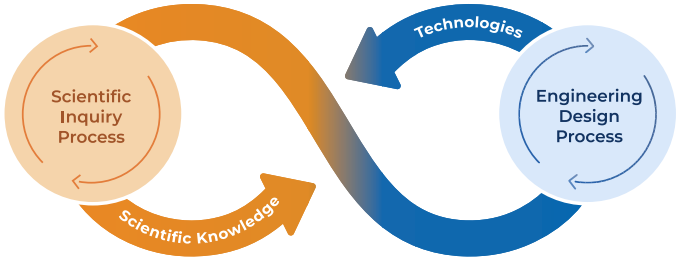
Science Pathway Overview: *Space Hazards*

Learners in the Science Pathway explore the field of planetary science. Planetary scientists often use the technologies developed by engineers to further their understanding of issues that astronauts, spacecrafts, and instruments face during their time in space, such as hazards. In this pathway, learners think like planetary scientists as they investigate hazards on Earth and in space and examine different strategies humans have developed to mitigate them. Learners also explore chance factors that either help (e.g., research, teamwork) or complicate (e.g., loss of power or communication) hazard mitigation. In the final adventures, learners put together all they have learned from their investigations to design and share hazard mitigation strategies for an upcoming NASA mission.

The Science Pathway Storyline that more fully articulates the progression of activities can be found on pgs. xxiii–xxv of the Science Educator Guide.

Connecting Across Science & Engineering

Science and engineering depend on one another. Engineers leverage their scientific knowledge to effectively and efficiently develop new technologies. Scientists rely on a wealth of technologies that have been developed by engineers to advance understanding of the natural world—and their understanding, in turn, helps engineers develop additional technologies.



Scientific inquiry and engineering design require similar skills and practices, such as utilizing critical thinking skills, bringing a lens of curiosity, taking a systems approach, and tapping into creativity to answer questions and solve problems. Neither process follows a set path but both typically rely on similar tools, such as developing models, using mathematics and statistics, and computers. However, scientists primarily focus on understanding natural phenomena through an inquiry-based process, while engineers apply their knowledge, including scientific knowledge, to design and build practical solutions to help solve real-world problems.

The PLANETS curriculum provides equitable opportunities to engage learners in the habits of mind of engineers and the thinking practices of scientists can increase engagement and catalyze STEM identity and confidence for *all* learners. Learning activities that engage learners in the habits of mind and thinking practices of engineers and scientists also fuel development in the 21st Century learning skills of critical thinking, creativity, collaboration, and communication. For more insight into how these skills develop as learners engage in an engineering design process, see the PLANETS educator resource on Developing 21st Century Skills.

Learners Working & Thinking Like Engineers

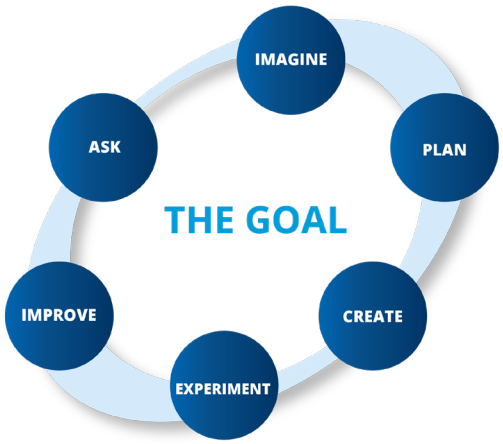
Engineering Design Process

Engineers use structured processes to design technologies to solve problems. Although the particular steps vary, these processes share many elements, including an investigation of criteria and constraints, the generation of various ideas, and the design, testing, and iterative improvement of a technology. These are Engineering Design Processes, or EDPs.

Many communities and cultures have similar structured processes, from Indigenous medicine wheels to community farming processes. For Grades 6–8, the Museum of Science uses an seven-phase EDP. This EDP and a similar six-step EDP process from NASA are shown below. Optional questions throughout the PLANETS learning activities promote discussion about EDP, and you have the option to have learners build their own EDP or share one from their community.

Examples of Engineering Design Processes

© Museum of Science



Adapted from NASA's BEST Engineering Design Process

Habits of Mind

Habits of mind describe practices engineers use, such as persisting through failure, constructing models, and communicating ideas. The Museum of Science has articulated 19 Habits of Mind, as shown in the table below, that give insight into the type of thinking learners should be engaging in during the hands-on activities.
As learners use these Habits of Mind, they draw on their scientific content knowledge of natural phenomena to inform their choices.

FEEL	THINK	DO
Collaborate effectively	Apply math knowledge to problem solving	Communicate effectively
Persist and learn from failure	Apply science knowledge to problem solving	Construct models and simulations
See themselves as problem solvers	Consider problems in context	Decompose problems
Weigh the implications of solutions	Consider tradeoffs between criteria and constraints	Innovate processes, methods, and designs
	Envision multiple solutions	Investigate features and uses of tools
	Make evidence-based decisions	Investigate properties and uses of materials
	Use abstraction to create efficient solutions	Use computers to solve problems
	Use systems thinking	

Navigating the Unit

For additional resources, please see the Space Hazards Unit Website

Considerations for Using the Space Hazards Unit

- The following pathways present suggested orders in which to teach the activities. However, you can adapt the order of activities as appropriate for your learners and setting. (For example, you can alternate between pathways.)
- If you have time, it is beneficial for learners to engage in the Science Pathway and then Engineering Pathway. Learners do not need to repeat the context-setting or Adventure 1.
- It is not necessary for learners to complete the Engineering Pathway activities to participate in the Science Pathway.

CONTEXT-SETTING ADVENTURE : *Ready, S.E.T., Go!*
Learners explore space trash. As scientists, they observe the energy of space trash impacts. As engineers, they design ways to protect against those impacts.

ADVENTURE 1: *Safety Stories: Sharing Experiences*
Learners share experiences with and stories about making hazards safer.

Science Pathway

ADVENTURE 2: *Everyday Hazards*
Learners act out everyday hazards and match them with safety tips.

ADVENTURE 3: *Hazards Where We Live*
Learners create their own hazard and mitigation cards and play a matching game with them.

ADVENTURE 4: *Earth Hazards*
Learners play a card game to learn about hazards on Earth and how people mitigate some of them.

ADVENTURE 5: *Hazards in Space*
Learners play a card game to learn about space hazards and their differences from hazards on Earth.

ADVENTURE 6: *Mitigating Hazards for Your Mission*
Learners think about hazards and mitigation strategies for NASA missions.

ADVENTURE 7: *Science Share-Out*
Learners share what they learned about hazards and mitigation strategies for NASA missions.

Engineering Pathway

ADVENTURE 2: *Everyday Gloves*
Learners try doing simple tasks wearing different kinds of gloves and compare results. Learners then find out about space hazards and spacesuit design.

ADVENTURE 3: *Chilling Out*
Learners test and compare materials to see which ones work best to protect against cold.

ADVENTURE 4: *Ready for Impact*
Learners test how well different materials protect against impact hazards.

ADVENTURE 5: *Dangerous Dust*
Learners test how dust resistant materials are.

ADVENTURE 6: *Creating a Space Glove*
Learners plan and create model space gloves and test how well they protect against space hazards.

ADVENTURE 7: *Improving a Space Glove*
Learners improve their space gloves and test them in a final test.

ADVENTURE 8: *Preparing for Engineering Share-Out*
Learners plan a presentation and present their space gloves to an audience.

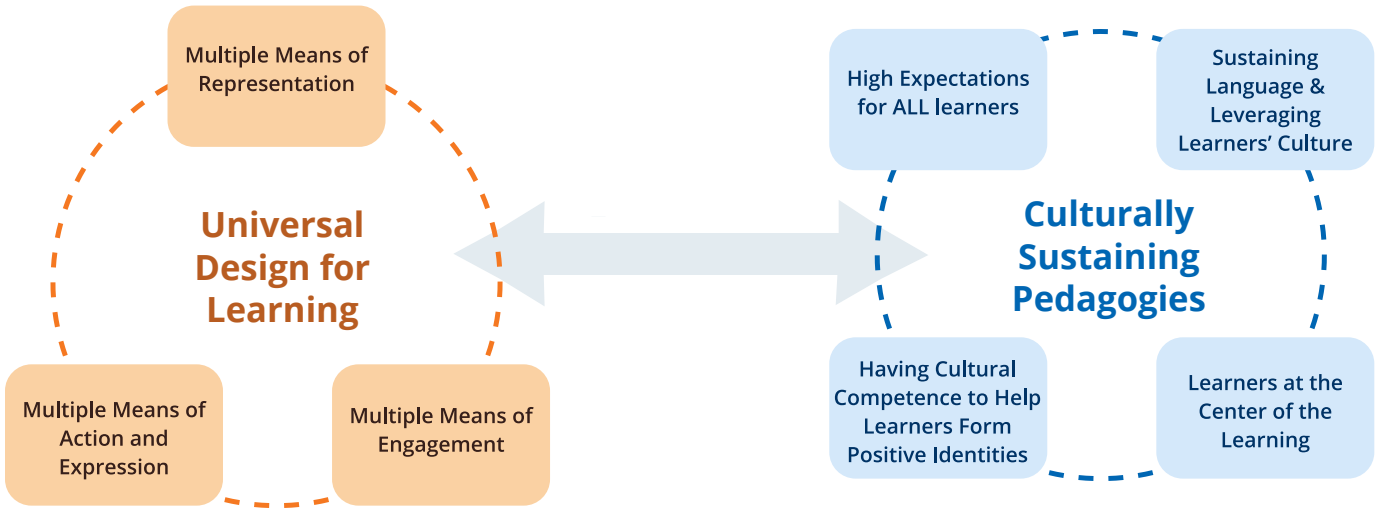
ADVENTURE 9: *Engineering Share-Out*
Learners plan a presentation and present their space gloves to an audience.

Educator Resources to Support Learning

An Inclusive and Equitable Approach for STEM Learning

The Space Hazards unit has been designed with an explicit focus on promoting STEM learning for all, and particularly Indigenous learners, emergent multilingual learners, and learners experiencing differing physical and/or sensory abilities. The Universal Design for Learning (UDL) and culturally sustaining pedagogies (CSP) conceptual frameworks informed the instructional design of this unit. This purposeful design supports all learners by reducing as many barriers as possible and incorporating planning for variability in learner strengths, needs, and interests.

These principles include the following:



Creating Inclusive & Collaborative Learning Environments

To create an inclusive learning environment, educators need to approach their learners with an asset-based mindset. Each learner possesses assets that contribute to the development and maintenance of that person's identity. Assets can be intellectual, physical, or social skills and personal strengths or qualities. A few ideas for cultivating inclusive and cooperative learning environments include the following:

Practices and Strategies for Inclusive Learning Environments

- Facilitate inclusive and cooperative learning environments.
- Build relationships with learners and their communities for learning partnerships.
- Build rapport to establish an emotional connection.
- Affirm the personhood of each learner by appreciating all aspects that they bring into a learning space and creating accessible and inclusive learning spaces.
- Design learning experiences that are authentic and relevant to the contexts of learners.
- Incorporate multisensory instruction.
- Provide options for multiple forms of expression to demonstrate understanding.
- Model and support self-advocacy.

Designing Instruction to Reach Diverse Learners

The strategies outlined below appear in this unit to support three groups of learners:

Multilingual learners: Youth who speak languages other than English at home and are in the process of becoming fluent speakers of English.

Indigenous learners: Youth who descend from the original, culturally distinct ethnic peoples of a land.

Learners with diverse abilities: Youth who experience differing physical abilities: (a) physical traits that affect mobility and/or dexterity; (b) sensory abilities that affect sight; and (c) sensory abilities that affect hearing.

DID YOU KNOW?

Some of these strategies, initially designed and highlighted below for specific learners, have shown potential benefits for all learners.

These strategies have been adapted from the *PLANETS Practical Guide for Inclusive and Engaging STEM Learning: Promoting Inclusion and Engagement in STEM Learning: A Practical Guide for Out-of-School-Time Professionals.*

The icons shown on the following pages appear throughout this guide in tips that are especially relevant for each group of learners.

Strategies for Multilingual Learners

Want to learn more about how PLANETS activities support Multilingual Learners? Please watch this educator support video.

Encourage translanguaging: learners using all the languages they know and making connections between those languages.

Why is this important?

Translanguaging signals to multilingual learners that their languages, culture, and experiences are valued and enrich learning.

It empowers learners to participate and can increase their comprehension and engagement.

Note that not all words have exact counterparts in English.

Strategy in Action

Encourage learners to share key vocabulary in their home or preferred languages. You can capture terms visually.

Note that some learners, including many Indigenous ones, communicate through gestures instead of speech.

Connections to the PLANETS Practical Guide

See Promising Instructional Practices, section 3: "Encourage Translanguaging and Storytelling" on pg. 20 of the Practical Guide.

Provide multiple means of accessing language.

Why is this important?

Providing learners enough support and tools (e.g., images, videos, diagrams with headings) to understand texts on their own empowers them to independently make sense of content without compromising the complexity of language.

Instead of simplifying language, amplify speech and text with supports and offer assistance to help learners grasp concepts effectively.

Strategy in Action

Actively listen and capture learners' ideas and use of vocabulary and language during partner, small-group, or whole-group discussions using written words, diagrams and pictures.
In PLANETS, this strategy is called the *Our Ideas Poster.*

Use icons and images to anchor language.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Welcoming Learning Environments" on pg. 13 of the Practical Guide.

Teach vocabulary in context.

Why is this important?

Exposing learners to vocabulary and concepts together and not separately helps learners make sense of key concepts and ideas.

Strategy in Action

Learners engage in activities and then use their experiences to make sense of vocabulary.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Features of Culturally and Linguistically Accessible and Welcoming Learning Environments" on pg. 13 of the Practical Guide.

Provide multiple means of expressing ideas.

Why is this important?

Multiple forms of expression, such as spoken, visual, and written, help learners share their understanding of science and engineering, make sense of concepts, and clarify their ideas.

Offering space to use different levels of formality (e.g., casual language from home vs. academic language from school) helps learners make sense of ideas.

Strategy in Action

Share-outs during group activities encourage multiple means of expression. Learners can share in diverse ways (e.g., posters, graphs, writing, drawings, audio, gestures, or videos).

Rather than "correcting" learners' speech, help them connect less-formal and more-formal words with similar meanings.

Connections to the PLANETS Practical Guide

See Promising Curriculum Design Elements, section 3, "Provide options for multiple forms of expression to demonstrate understanding" on pg. 28 of the **Practical Guide**.

Use strategic grouping.

Why is this important?

Conversations among peers who share languages (e.g., pairs, small groups, or whole-group share-out) provide a safe environment for learners to participate and gain comfort and confidence while testing out ideas. Educators can then build on the ideas expressed in whole-group discussions.

Strategy in Action

Activities engage learners in peer-to-peer conversations and sense-making discussions, including in pairs, small groups, and the whole group, depending on the needs of the learners.

Connections to the PLANETS Practical Guide

See Promising Instructional Practices, section 1, "Facilitate inclusive and cooperative learning environments" on pg. 16 of the **Practical Guide**.

Prioritize precise name pronunciation and understanding.

Why is this important?

Names are important in culture and personal identity. Pronouncing names correctly shows respect for individuals and their culture. (Because different languages use different sounds, it can take practice to pronounce names correctly.)

This approach is particularly beneficial for multilingual learners but creates an inclusive environment for all learners.

Strategy in Action

When meeting new learners, educators are encouraged to ask about, practice, and model pronouncing learners' names correctly.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Features of Culturally and Linguistically Accessible and Welcoming Learning Environments" on pg. 13 of the **Practical Guide**.

Strategies for Indigenous Learners

Want to learn more about how PLANETS activities support Indigenous Learners? Please watch this educator support video.

Encourage narratives.

Why is this important?

Indigenous communities have strong narrative traditions. These traditions serve as vital conduits of cultural heritage, transmitting knowledge, values, and history across generations. Through oral narratives, these communities forge a profound connection to their ancestral roots, fostering a sense of identity.

Relating narratives lets learners receive stories and tell their own. Narratives can be spoken, written, in song, or in pictures.

Strategy in Action

Make time for learner narratives that connect their learning to existing knowledge, stories, and culture. The "Building Community and Family Connections" section on p. xvi offers extension activities to engage community and family.

Take time to understand how stories are told in a particular community. Rhetorical style and the expected parts of a narrative vary between groups.

Connections to the PLANETS Practical Guide

See Promising Instructional Practices, section 3: "Encourage Translanguaging and Storytelling" on pg. 20 of the Practical Guide.

Use strategic grouping.

Why is this important?

Collaborative decision-making is more effective than individual spotlights in some Indigenous cultures. Small-group rather than large-group work enhances communication for Indigenous learners.

Thoughtful talk is often valued over spontaneous contributions, and delayed engagement may signify politeness rather than disinterest or shyness.

Strategy in Action

Group work is built into each activity. Grouping suggestions provide a comfortable group setting for Indigenous learners and others, such as grouping learners in even numbers to avoid a single designated leader.

Connections to the PLANETS Practical Guide

See Promising Instructional Practices, section 1, "Facilitate inclusive and cooperative learning environments" on pg. 16 of the Practical Guide.

Prioritize precise name pronunciation and understanding.

Why is this important?

Names are important in culture and personal identity. Pronouncing names correctly shows respect for individuals and their culture. (Because different languages use different sounds, it can take practice to pronounce names correctly.)

Note that Indigenous learners may want to share other information, such as their connections to tribes and locations.

Strategy in Action

When meeting new learners, educators are encouraged to ask about, practice, and model pronouncing learners' names correctly.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Features of Culturally and Linguistically Accessible and Welcoming Learning Environments" on pg. 13 of the Practical Guide.

Design authentic and relevant learning experiences.

Why is this important?

Learners are most engaged when what they are learning is connected to their lives and communities. Providing a relevant cultural context helps to drive this engagement.

Strategy in Action

Spend time in learners' community and make connections with local knowledge keepers.

Learn about the cultural approaches of the community regarding competition and collaboration, communication styles, and systems of observation.

Connections to the PLANETS Practical Guide

See Promising Curriculum Design Elements, section 1, "Design learning experiences that are authentic and relevant to the contexts of learners" on pg. 23 of the **Practical Guide**.

Strategies for Learners with Diverse Abilities

Want to learn more about how PLANETS activities support Learners with Diverse Abilities? Please watch this educator support video.

Ask learners what they need.

Why is this important?

The needs of learners with diverse sensory and physical abilities vary. Learners and caregivers, being the most knowledgeable about their capabilities, provide valuable insights. Educators should emphasize learners' strengths and rely on them to guide facilitation of activities.

Strategy in Action

Ask learners directly about their needs prior to beginning an activity. This guide gives some ideas to consider when offering learners options.

Learn about etiquette for working with **blind learners**, etiquette for working with **D/deaf learners**, or etiquette for working with **wheelchair users**.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Create safe, accessible, and welcoming learning environments" on pg. 11 of the **Practical Guide**.

Incorporate multisensory activities.

Why is this important?

Visual representations can be particularly beneficial for learners who are deaf or hard-of-hearing. Visual science and engineering models are powerful tools to illustrate observations, processes, and connections.

Auditory modalities of instruction can facilitate access to learners who are blind or have low vision.

Tactile models and physical objects are beneficial for all learners but are particularly important for blind and low vision learners.

Strategy in Action

Learners are given diverse means to participate in activities. For instance, spectrographic information is presented both visually and aurally so that all learners can access it.

Allow blind and low-vision learners to explore pre-made models ahead of time and to join the educator during demonstrations to follow the educator's movements.

Connections to the PLANETS Practical Guide

See Promising Curriculum Design Elements, section 2, "Incorporate multisensory instruction" on pg. 26 of the **Practical Guide**.

Use strategic grouping.

Why is this important?

For blind and low vision learners, although a note-taking role may be a preferred option, provide learners with the flexibility and opportunity to choose from a variety of roles, fostering exploration and skill development.

For deaf and hard-of-hearing learners, group work can be challenging due to elevated noise levels. Engage learners in smaller groups, move groups to quieter spaces, and encourage learners to speak clearly so everyone can follow the conversation.

Strategy in Action

Educators are provided with guidance on **surfacing learners' diverse abilities** through activities.

It's essential to ask individual learners about their preferences and needs, as learners with diverse abilities have widely varying preferences.

Connections to the PLANETS Practical Guide

See Promising Practices for Program Design, section 1, "Create safe, accessible, and welcoming learning environments" on p. 11 of the **Practical Guide**.

Building Community and Family Connections

Strong relationships are key to learner success. Building community and family connections with learners encompasses having ongoing and meaningful two-way interactions between educators and families and/or other communities of supportive adults. It also involves creating a learning environment within OST (Out-of-School Time) programs that is familial, supportive, and empowering. OST programs with strong learning environments and communities recognize the assets that learners bring and allow learners to express themselves, making them feel comfortable engaging in STEM content. Family connections set the stage for social-emotional learning in the unit via:

- **Relevance—**Family connections allow learners to draw connections between NASA science and engineering and the science and engineering in their daily lives and communities. This type of connection allows learners to bring their own funds of knowledge to the activities.
- **Belonging—**When learners see how their cultures and families use science and engineering principles, they feel that they belong in STEM.
- **Cultural responsiveness—**Family connections allow for relevant aspects of learners' cultures to enter or ground the learning in ways that the educator may not have been aware of. Learners' cultural knowledge can play an important scaffolding role in learning science and engineering while simultaneously sustaining that cultural knowledge for the next generation.

What does building community and connections look like in action?

A few examples of how to purposefully develop these relationships with learners and their families include the following:

- **Use a variety of communication methods.**
- **Acknowledge challenges to family and community engagement.**
- **Invite families to engage in and design STEM learning activities.**

Consider using some of the following ways to build family connections during this unit based on your capacity and/or your learners' ability to include family members:

- Add an activity in which you invite families to be guest speakers. (Families can also work with you to find guest speakers from the community.)
- A Level Up! tip at the end of each activity invites learners to discuss a particular question with their families. (You can also suggest family activities to spark conversation around a particular topic.) Learners can share what they discussed at the start of the next activity.
- Invite families to the Engineering and Science Share-Outs at the end of each pathway to not only share in celebration of their learners' accomplishments but also to provide their knowledge (cultural or otherwise) about the engineering or science discussed and used in the pathway.

Instructional Support Tips for Learning

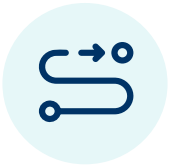
Within each activity across the Space Hazards unit, several strategic tips are provided as opportunities for additional instructional support. These tips are guided by the following PLANETS core design principles:

- Support Thinking
- Teaching Tips
- Connecting Across Activities
- Support Learner Differences
- Level Up

The table below provides guidance on the purpose and use of each of the tips found within the activities.

Instructional Support Tip: Support Thinking 	**Purpose:** Provides ideas for educators to productively support learners' thinking, such as • suggestions of targeted language to use with learners to increase social emotional supports. • things to emphasize during student collaboration. • language that explicitly helps students to realize they are working, thinking, and looking like engineers or scientists (metacognitive and representation/identity/ confidence in STEM). • additional resources that may enhance student engagement/thinking about the current instructions of the activity (e.g., videos, audio).
Instructional Support Tip: Teaching Tip 	**Purpose:** Provides additional recommendations for educators with regards to the mechanics of the activity, such as • modifying materials. • grouping and/or roles of learners during parts of the activity based on materials, timing, and engagement. • additional procedural tips to increase effectiveness of investigations and designs. • modifying timing of activities with different procedures.

Instructional Support Tip: Connecting Across Activities



Purpose:
Highlights ways that the activities connect within the pathways and across the disciplines of engineering and science.

Instructional Support Tip: Support Learner Differences

Purpose:
Provides just-in-time supports during the activity that help educators ensure they are meeting the needs of all STEM learners—especially Indigenous learners, emergent multilingual learners, and learners experiencing differing physical and/or sensory abilities—such as

- ways to support multiple pathways for ensuring all learners can equitably engage in the activity.
- strategic peer grouping(s) to enhance engagement equity.
- additional challenges or ways to increase the learning rigor for learners who are ready.
- additional resources that increase equity to ensure that all learners can engage effectively in the activity (e.g., videos, audio).

Unique icons are used in PLANETS activities to help educators quickly identify specific tips that may apply to their learners:

 **Multilingual learners**

 **Indigenous learners**

 **Learners with diverse abilities**

 **Engaging all learners**

Instructional Support Tip: Level Up

Purpose:
Provides supplemental guidance to educators facilitating activities, such as

- ways to make the activities more inclusive to all STEM learners.
- extensions to broaden both content and options provided within each activity. Note that time estimates for Level Up activities are provided separately from the main activity timing.

References

Elsayed, R., Clark, J. G., Daehler, K. R., & Bloom, N. E. (2022). *A practical guide for out-of-school-time professionals to promote inclusion and engagement in STEM learning*. PLANETS, Northern Arizona University and WestEd.

Inclusion Activities

At the beginning of each activity, you can lead an inclusion activity that is appropriate for your group. Below are some possible activities:

Story of Your Name

In pairs or small groups, have learners share their names and stories behind them. For example, what do they mean? Why were they given? Have learners share other important information about their identities, such as locations they are from and tribes or other groups they belong to.

Handshakes and High Fives

Play three rounds of this inclusion activity. Each round, have learners pair up and introduce themselves in some way (e.g., handshake, high five, elbow bump, dance, nod, codeword). Then ask a question and have them discuss it for one minute. Once learners have completed all three rounds, have them re-find their three partners in order and repeat the introduction for each.

Paper Toss

Give each learner a piece of paper and a writing utensil. Ask a question and have them write an answer on the paper (for example, What is your name? What do you do for fun?) Have learners crumple the papers and throw them around. Then have them uncrumple the papers and share the answers with the group.

Choose an Object

Lay out a set of objects, such as small figurines, playing cards, or craft supplies. Ask a question (for example, How is your day going? What is a strength you bring to the group?) and have each learner choose an object that represents their answer (for example, *I chose the owl because I am good at watching what is happening*). Have learners share their objects and answers in pairs or small groups.

Interviews

Have learners pair up and spend three minutes each interviewing each other, then have them share about their partners in a large group. Possible interview questions include the following:

- What is your favorite place to hang out that is not school or home?
- What are some things you are good at?
- What tools or machines do you know how to use?
- What languages do you speak at home?
- What is something you did this week with someone else?
- How do you like to express yourself?

Accessibility Check

Have learners go around a circle and share their names and access needs. Access needs are things they might need to fully participate and feel comfortable in an activity or space. They can be anything that helps people learn, communicate, move around, or feel safe and included. As needed, share first yourself and give some examples, such as "I need short breaks during long activities to stay focused," "I need to refill my cup of water," "I feel more comfortable lying on the floor," or "I need pictures to help me understand what we are learning." Learners can also say "I'm still thinking about my access needs" or "All my access needs are met, check." Note that learners may not be comfortable sharing their needs until after several days of participation.

Design a NASA Mission Patch

NASA mission patches are special symbols that tell the story of each space mission. They use pictures, colors, and symbols to show the mission's goals, who the astronauts are, and important parts of the crew's lives. Have learners form groups of three, choose a mission name, choose a patch shape, and draw or write three things to include on their patch. Patches can include meaningful images, symbols, and colors. As needed, show examples from **NASA's Human Spaceflight Mission Patches.**

Transition

Say:

Let's talk about why we did this. Inclusion isn't just a nice idea–it's crucial for success, both here and in the real world. At NASA, every astronaut needs to know their team well. Why? Because in space, your crew is your lifeline. Similarly, in our group, everyone matters. We learn better when we understand each other. Knowing our teammates helps us work together and solve problems. By sharing parts of ourselves, we build trust and respect. This makes our "mission"–learning together–more fun and more effective. Remember, great teams are built on understanding and appreciating each person's unique strengths.

Conclude by connecting the inclusion activity to what learners are doing next. For example, say:

You just made different partners. Now you are going to work with one of those partners to...

Intentional Grouping Strategies

Intentional Grouping can support learners in a variety of ways.

Group roles can play to learners' **diverse abilities and strengths**. For instance, a blind or low vision learner might be much more skilled at tactile or auditory tasks, and having a role that plays to this strength will elevate that learner and strengthen the group. Never assume which tasks learners will prefer, because they can feel othered and misunderstood. Give them the first choice of group roles.

Grouping learners with **similar spoken or signed languages** can help multilingual learners bounce ideas off each other in their native language before translating them for the whole group. This will also help learners decide what words to share in their native languages.

Grouping learners by **culture** can allow them to work through things in ways that are familiar and valued at home before sharing with the larger group. For instance, Indigenous learners might benefit from being grouped together and working by consensus rather than by having a leader. Or they may decide to communicate their final challenge on posters during a gallery walk, rather than by presenting publicly.

Similarly, if learners are grouped by **shared interests or hobbies**, they may start to interpret the learning in the context of what they know, which is fantastic! For example, "We mitigate hazards when biking all the time by slowing down, wearing helmets, and not biking when it's dark outside."

The number of learners in a group

Groups of 2: If students are sharing personal information or stories, working in pairs first gives learners an opportunity to hear other ideas and rehearse their own ideas before sharing with the whole group. Pairing up is especially helpful for multilingual learners.

Groups of 4: Use groups of four when learners would benefit from lots of perspectives or ideas.

Please note, *these activities are not designed for groups of five or more. A group of five would likely have an outlier with not enough to contribute.*

Engineering Pathway Storyline

Engineering Adventures 2–5
Learners have experiences with materials so they are successful in the final design challenge.

Engineering Adventures 6–9
Learners apply what they have learned in the prior activities about space hazards as they design, test, and improve their own space gloves.

CONTEXT

CONTEXT SETTING ADVENTURE – *Ready, S.E.T., Go!*

ADVENTURE SNAPSHOT
Learners scientifically investigate the energy from space trash impacts, and they engineer a device to protect against those impacts.

Prep Snapshot

Prep Time: 70 min

- Read unit
- Print Notebooks
- Prepare materials
- Make an *Our Ideas* poster

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection
- Critical Thinking

Habits of Mind
- Use a structured problem-solving process

Science Practices
- Construct explanations

Connecting Across Activities

Today, learners explore space trash. As scientists, they measure the energy of space trash impacts. As engineers, they design ways to protect against those impacts.

Next time, learners share experiences with and stories about making hazards safer.

1

ENGINEERING ADVENTURE 1 – *Safety Stories: Sharing Experiences*

ADVENTURE SNAPSHOT
Learners share experiences with, and stories about, making hazards safer.

Prep Snapshot

Prep Time: 30 min

- Set up Materials Table

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection
- Communication

Habits of Mind
- Communicate effectively

Connecting Across Activities

Last time, learners explored space trash. As scientists, they measured the energy of space trash impacts. As engineers, they designed ways to protect against those impacts.

Today, learners share experiences with and stories about making hazards safer.

Next time, learners do simple tasks wearing different gloves and compare results. Then they learn how spacesuit gloves protect astronauts from space hazards.

2

ENGINEERING ADVENTURE 2 – *Everyday Gloves: Exploring Glove Uses*

ADVENTURE SNAPSHOT

Learners try doing simple tasks wearing different kinds of gloves and compare results. Learners then find out about space hazards and spacesuit design.

Prep Snapshot

Prep Time: 55 min

- Set up materials stations
- Print handouts
- Prepare ice and sponges for upcoming adventures

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Collaboration

Habits of Mind

- Collaborate effectively
- Construct models and simulations

Connecting Across Activities

Last time, learners shared experiences with and stories about making hazards safer.

Today, learners do simple tasks wearing different gloves and compare results. Then they learn how spacesuit gloves protect astronauts from space hazards.

Next time, learners will test different materials to see how well they protect against cold temperatures. Later, they'll use that info to design space gloves.

3

ENGINEERING ADVENTURE 3 – *Chilling Out: Protecting Against Cold*

ADVENTURE SNAPSHOT

Learners test and compare materials to see which ones work best to protect against cold.

Prep Snapshot

Prep Time: 50 min

- Set up materials stations
- Prepare chart
- Print handouts

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving
- Investigate properties and uses of materials

Connecting Across Activities

Last time, learners did simple tasks wearing different gloves and compared results. Then they learned how spacesuit gloves protect astronauts from space hazards.

Today, learners test how well different materials protect against cold. Later, they'll use collected data to design space gloves.

Next time, learners will test how well different materials protect against impact.

4

ENGINEERING ADVENTURE 4 – *Ready for Impact: Protecting Against Impact*

ADVENTURE SNAPSHOT

Learners test how well different materials protect against impact.

Prep Snapshot

Prep Time: 40 min

- Set up materials stations
- Print handouts

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving
- Investigate properties and uses of materials

Connecting Across Activities

Last time, learners tested how well different materials protect against cold.

Today, learners test how well different materials protect against impact. Later, they'll use collected data to design space gloves.

Next time, learners will test how well different materials resist dust.

5

ENGINEERING ADVENTURE 5 – *Dangerous Dust: Protecting Against Dust*

ADVENTURE SNAPSHOT

Learners test how dust resistant materials are.

Prep Snapshot

Prep Time: 40 min

- Set up materials stations
- Print handouts
- Prepare ice for Adventure 6

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving
- Investigate properties and uses of materials

Connecting Across Activities

Last time, learners tested how well different materials protect against impact.

Today, learners test how well different materials resist dust. Later, they'll use collected data to design space gloves.

Next time, learners will plan, create, and test gloves to protect against space hazards.

6

ENGINEERING ADVENTURE 6 – *Put it Together: Creating a Space Glove*

ADVENTURE SNAPSHOT

Learners plan and create model space gloves and test them to see how well they protect against space hazards.

Prep Snapshot

Prep time: 45 min

- Set up materials stations
- Print handouts
- Prepare ice for Adventure 7

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Creativity

Habits of Mind

- Consider problems in context
- Consider tradeoffs between criteria and constraints

Connecting Across Activities

Last time, learners tested how well different materials resist dust.

Today, learners plan, create, and test gloves to protect against space hazards.

Next time, learners will improve their gloves and test them again.

7

ENGINEERING ADVENTURE 7 – *The Final Test: Improving a Space Glove*

ADVENTURE SNAPSHOT

Learners improve their space gloves and test them in a final test.

Prep Snapshot

Prep time: 30 min

- Set up materials stations
- Invite people to Share-Out

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Critical Thinking

Habits of Mind

- Make evidence-based decisions
- Persist and learn from failure

Connecting Across Activities

Last time, learners planned, created, and tested gloves to protect against space hazards.

Today, learners improve their space gloves and test them again.

Next time, learners will prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.

8

ENGINEERING ADVENTURE 8 – *Spread the Word: Preparing for the Engineering Share-Out*

ADVENTURE SNAPSHOT

Learners prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.

Prep Snapshot

Prep Time: 20 min

- Invite people to Share-Out
- Find videos about sharing information

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Collaboration
- Communication

Habits of Mind

- Make evidence-based decisions

Connecting Across Activities

Last time, learners learners improved their space gloves and tested them again.

Today, learners prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.

Next time, learners will ommunicate their ideas about designing space gloves in the Engineering Share-Out.

9

ENGINEERING ADVENTURE 9 – *Sum It Up: Engineering Share-Out*

ADVENTURE SNAPSHOT

Learners share their designs and how they used the Engineering Design Process.

Prep Snapshot

Prep Time: 20 min

- Set up Materials Table
- Invite people to Share-Out

* See *Materials & Preparation* for more information

Skills, Habits, Practices

21st Century Skills Connection

- Communication

Habits of Mind

- Weigh the implications of solutions
- Communicate effectively

Connecting Across Activities

Last time, learners prepared to communicate their ideas about designing space gloves in the Engineering Share-Out.

Today, learners communicate their ideas about designing space gloves in the Engineering Share-Out.

Next time, learners will experience the science of this topic in the PLANETS Space Hazards Science Pathway (optional).

Engineering Pathway Vocabulary

This list is included to provide an overview of the content of this pathway. Note that you should not pre-teach it to learners before the activities–terms are introduced after learners have direct experience with the materials and processes to which those terms are connected.

Inclusion Activities

- **Mission Patch**: A special design worn by astronauts to represent the mission, crew, and goals of their space journey.

Ready, S.E.T., Go!

- **Space Junk**: Broken pieces of old satellites, rockets, or other objects left in space.
- **Spacecraft**: A vehicle designed to travel in space, like a spaceship or space shuttle.

Engineering Adventure 2

- **Hazard**: A danger or something that can cause harm.
- **Space Glove**: A protective glove worn by astronauts to keep their hands safe in space.
- **Spacesuit**: A special suit astronauts wear to protect their body, provide air, and keep them safe in space.

Engineering Adventure 4

- **Impact Test**: A test to see how something reacts when it gets hit or crashes into something

Engineering Materials List

The quantities below are for one group of 24 learners. Follow this weblink to calculate the amount of materials you'll need for your number of learners.

Non-Consumable Items

Quantity	Material
1	clock/timepiece for scheduling
1	measuring cup, 2 cups
1	permanent marker
1	tablespoon measure
2	black lights, handheld
2	buckets, 5 liters
2	calculators
2 pairs	dish gloves
2 pairs	garden gloves
2	hand lenses
2 pairs	oven mitts
2	plastic bags, resealable, gallon-size
2	skewers
2	thermometers, digital
2 pairs	winter gloves
4	cups, plastic, 16 oz
4	jars, plastic, with twist lids, 12 oz
6	aluminum trays, 12" × 10" × 2.5"
8	timers (stopwatches, device apps with timers, etc.)
12	rulers
12 pairs	scissors
60	beads
160	paper clips
210	metal washers, 1.25" diameter
	tongs, plastic bags, socks (as needed)

Consumable Items

Quantity	Material
1 roll	aluminum foil
1 pad	chart paper
1 bottle	dish soap
1 box	food-safe gloves, adult, 100 count
1 small container	Salt, rice, or sand
1 bottle	UV glow powder, white, 4 oz
1 box	vinyl gloves, adult, 100 count Note: Vinyl gloves should be at least 3 mil thickness to prevent tearing.
2 sheets	cardboard, thin, 8.5" × 11"
2	craft sticks, jumbo
2	deli containers, round, with lids, 16 oz
2 cups	gravel
2 rolls	paper towels
2 boxes	spaghetti Note: The spaghetti used in Adventure 4 should be standard, No. 5 size. Thin spaghetti or angel hair pasta will be too fragile for this activity.
6	markers
6 cups	sand
8	pens or pencils
12 rolls	tape, masking
24	Engineering Notebooks (PDF)
24	plastic bags, resealable, quart size
30 sheets	transparency, 8.5" × 11"
36 sheets	craft foam, green, 8.5" × 11"
36 sheets	felt, 8.5" × 11"
36 cups	ice cubes Note: You will need 36 cups of ice cubes for 3 adventures. Please ensure that you have access to a freezer.
36	sponges
50 square ft	cheesecloth
125	fuzzy sticks
260	straws, regular
300	cotton balls
700	index cards
	copy paper for printing
	presentation materials, to make and display signs, posters, pictures, etc.
	water

Engineering Advance Preparation

You can complete much of the preparation for the Engineering Adventures ahead of time. Follow the steps below.

Educator Background

1. Read through the entire PLANETS Engineering Pathway Educator Guide Introduction (pgs. iii–xxvi) to learn more about the engineering content in this unit.
2. Read the Educator Science Background (weblink) for context about the science and engineering in the unit.
3. Print and laminate any pages you want available for easy reference. (The Inclusion Activities, pgs. xx-xxi, Intentional Grouping Strategies, pg. xxii, and Pathway Storyline, pgs. xxiii–xxvi, are especially useful.)
4. Print your own copy of the Engineering Notebook (PDF) for reference.
5. Reflect on the learners who will engage in the pathway and identify ways to create an inclusive and collaborative learning environment (see pgs. viii–xviii).
6. Consider whether to split any adventures. If you have learners who would benefit from repetition and extra time, you can split the adventures at the points indicated throughout this guide.
7. View the following video playlists:
   - How to prepare and teach with the materials
   - Background science and engineering content
   - How to support learner differences

For the Whole Group

8. Invite staff, family, and community members to attend the Engineering Share-Out in Adventure 9. Make copies of the Engineering Adventure 7 Share-Out Invitatiion, pg. 97, to distribute to family and friends.
9. Prepare an *Our Ideas* poster by following the Prep & Setup Guide (PDF).
10. Print 1 copy of the directions and results sheets for Stations 1–3, pgs. 36-41.
11. Take sponges out of packages to give them time to dry out.

Teaching Tip

If internet access may be a problem, consider downloading videos ahead of time. If it would benefit your learners, you can adjust the video playback speed. Note that video links may change over time; if a link does not work, try searching the title of the video.

Support Learner Differences

All videos in this unit include captions. As needed, these captions can be translated by online video platforms.

For Each Group of Four

12. Print 1 copy of Engineering Ready, S.E.T., Go! Visual Instructions Handout, pg. 19, for each group of four learners.

For Each Pair of Learners

13. Print 1 copy of each of the following handouts for each pair of learners:
    - Engineering Adventure 2 Glove Testing Directions Handout, pg. 42
    - Engineering Adventure 3 Cold Test Procedure Handout, pg.53
    - Engineering Adventure 4 Impact Test Procedure Handout, pg. 62
    - Engineering Adventure 5 Dust Test Procedure Handout, pg. 72
    - Engineering Adventure 6 Mission Profiles Handout, pg. 84

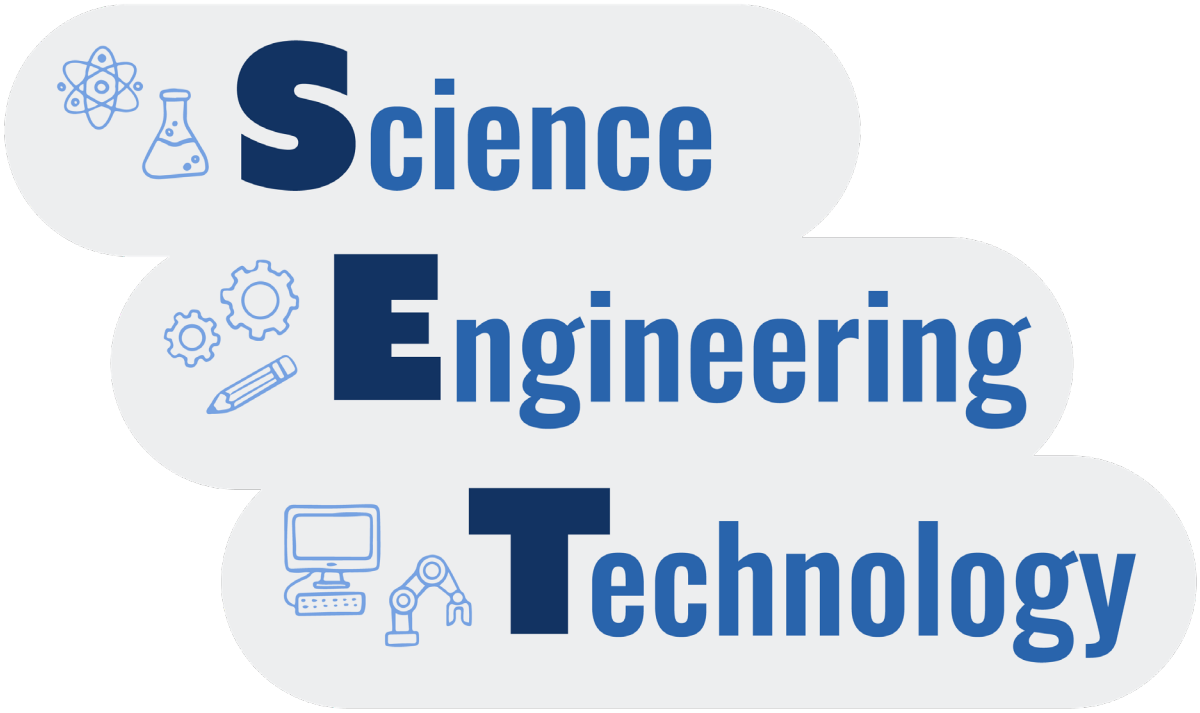
Teaching Tip

If you think learners will benefit from having more space in the Notebook, print one-sided or add sheets of blank paper as you make the Notebooks.

For Each Learner

14. Print and staple one Engineering Notebook for each learner, in color if possible.

Ready, S.E.T. (Science, Engineering, Technology), Go!



Educator Preview

Adventure Snapshot

Learners scientifically investigate the energy from space trash impacts, and they engineer a device to protect against those impacts.

Timing | 60 minutes

Get Ready & Team Up	5 min.
Plan & Create (S.E.T.)	50 min.
Reflect (Go!)	5 min.
Total	**60 min.**

Level Up Activities 5–30 min. each

Prep Snapshot*

Prep Time 70 min.

- Read unit.
- Print Notebooks.
- Prepare materials.
- Make an poster.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Use a structured problem-solving process.

Science Practices

- Constructing Explanations

Guiding Question

How does space trash damage spacecraft and can we design ways to protect against it?

Learners Will Do

As scientists, measure the energy of space trash as it impacts spacecraft. As engineers, design technology to protect against space trash impacts.

Learners Will Know

Scientists and engineers work together to solve problems.

Connecting Across Adventures

Ready, S.E.T., Go!	Adventure 1: Sharing Experiences
Today, learners explore space trash. As scientists, they measure the energy of space trash impacts. As engineers, they design ways to protect against those impacts.	**Next time**, learners share experiences with and stories about making hazards safer.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/07c21986

Materials and Preparation

Materials

For the whole group

- blank poster or sheet of chart paper
- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
  - index cards
  - markers
  - scissors
  - tape

For each learner

- Engineering Notebook (PDF)

For each group of 4

- Engineering Ready, S.E.T., Go! Visual Instructions Handout, p. 19
- salt or rice, 1/8 tsp per trial
- 1 piece of aluminum foil, 6" × 6"
- 1 aluminum tray, 12" × 10" × 2.5"
- 1 piece of cheesecloth, 6" × 6"
- 1 piece of craft foam, 4.25" × 5.5"
- 1 piece of felt, 4.25" × 5.5"
- 1 pack of index cards (about 100 cards)
- 1 piece of masking tape, at least 12"
- 2 rulers
- 4 washers
- 1 piece of dark-colored paper (optional)

Ready, S.E.T., Go! Materials Preparation (70 min.)

Ahead of Time

1. Read through the PLANETS Engineering Pathway Educator Guide Introduction (pgs. iii–xxvi) to learn more about the engineering content in this unit.
2. Print and staple one Engineering Notebook for each learner, in color if possible. As needed, prepare to share the Notebook digitally.

Teaching Tip

- This adventure is the same in both the Science and Engineering Pathways. If you have already taught it in one pathway, you do not need to fully teach it again. The only exception is the introduction of an Engineering Design Process and a fun Level Up tip at the end. See the reflect section of pg. 16 to determine if you would like to add this option for your learners to benefit the remainder of the pathway.
- This adventure can stand alone as a brief single-session program.

3. Print a copy of the Notebook for your own reference throughout the pathway.
4. Prepare an *Our Ideas* poster by following the online Prep & Setup Guide (PDF). Add the Guiding Question "How does space trash damage spacecraft and can we design ways to protect against it?" so learners can refer to it throughout the adventure.
5. For each group, cut a 6" × 6" piece of aluminum foil, a 6" × 6" piece of cheesecloth, a 4.25" × 5.5" piece of craft foam, and a 4.25" × 5.5" piece of felt. All sizes are approximate.
6. Print one Engineering Ready, S.E.T., Go! Visual Instructions Handout, p. 19 for each group of 4 learners.

In Your Space

7. Place the *Our Ideas* poster in a location all learners can access. Make a plan to store it between activities.

Teaching Tip

You can begin the *Our Ideas* poster with several standard 23" × 32" pieces of chart paper. You may fill them up before the end of the pathway, in which case you can add additional pieces as needed. See the weblink for an Our Ideas poster example (PDF).

The *Our Ideas* posters capture students' authentic language and ideas as they emerge in real-time discussions.The posters are not meant to simply display and front-load vocabulary. The posters develop over time as the educator listens for and adds the language that learners use in the moment, thus validating their ideas, providing feedback and supporting sensemaking and language development.

Support Learner Differences

Different learners have different needs. Choose from the following tips to best support your learners:

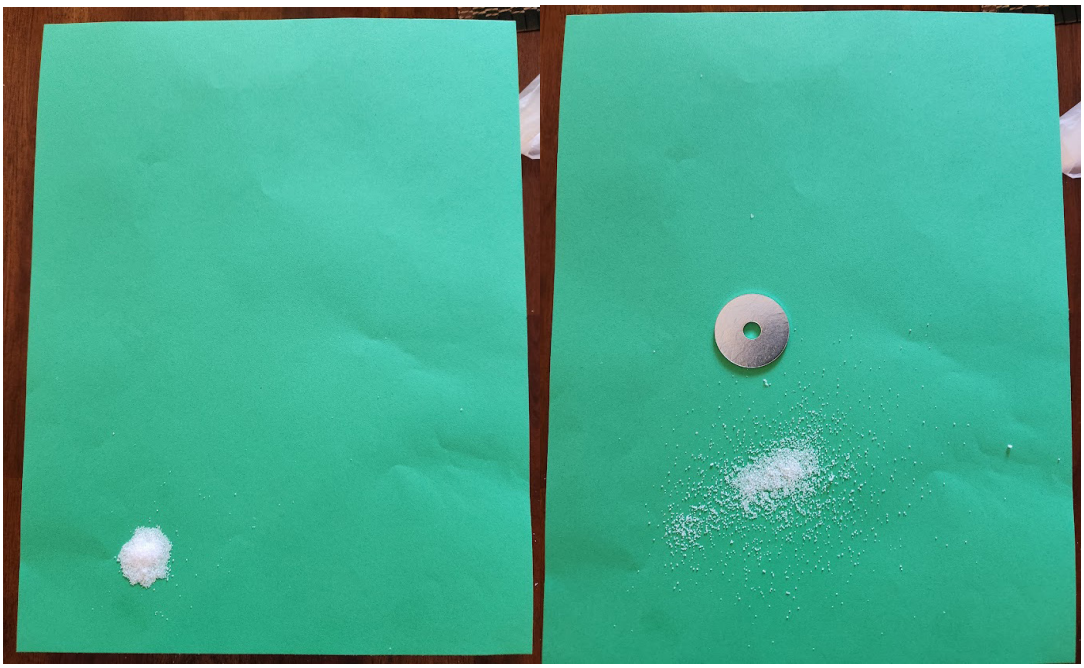
- View the Translanguaging Video to support learners who speak multiple languages.
- For those with low vision: add tactile elements, such as three-dimensional representations and Braille. Prepare a shared digital document all learners can access, ensuring that it supports text-to-speech for your learners.
- Add learner questions to the *Our Ideas* poster to foster an interest-led approach.

Teaching Tip

If you think learners will benefit from having more space in the Notebook, print one-sided or add sheets of blank paper as you make the Notebooks.

Support Learner Differences

The Engineering Notebook can be printed in large font and you can share a digital version that will work with screen readers. The Notebook is written in English, but you can translate the instructions into other languages; see translation guidance in our Translatable Glossary (DOCX).



Learners follow the directions on Investigate It!, pg. 7 in their Engineering Notebooks to measure the amount of damage to their "spacecraft" based on how much salt is disturbed. Then, they attempt to reduce the damage using the materials provided.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Give each learner an Engineering Notebook. Say: **This Notebook is a place to record your observations and ideas.**
2. Have learners read the *Ready, S.E.T., Go! Comic*, pgs. 2-6 in their Notebooks, to set the context for the adventure. Say: **Today you are going to investigate and solve the problem of space trash**. Share the Guiding Question with learners aloud and in writing (using multiple languages as needed): **How does space trash damage spacecraft and can we design ways to protect against it?**

Plan & Create (S.E.T.) (50 min.)

3. Ask: **What kinds of trash might be in space?** *(Pieces of old rockets and satellites.)* **Why could space trash be a problem for people?** *(Space trash can hit astronauts and hurt them.)*

Support Learner Differences

If learners are new to you or each other, have them share their names, name pronunciations, and other important parts of their identities. These introductions are important for all learners and can be especially relevant for Indigenous learners, multilingual learners, and learners with different physical abilities. You can also distribute index cards and have learners write anything they want you to know but do not want to share with the whole group, such as resources that will help them learn. If everyone knows each other's names, ask if anyone has a middle name or nickname you could learn to pronounce. Invite them to share about it.

For more strategies to engage learners, refer to Designing Instruction to Reach Diverse Learners, pg. x.

You can project a digital version of the comic or share it so learners using text-to-speech technology can access the comics.

- iOS or macOS users should enable text-to-speech or voice-over.
- Windows users should use JAWS or NVDA at NV Access.

Be sure to read carefully and leave a visual shortcut to exit the program, or have your learner restore settings when they are done.

Have learners talk about places in outer space they know about and if any of those places are important to them. *(Possible responses include planets, moons, comets, and the Sun. Learners may have seen particular objects with family or community members, or they may know stories about those objects.)* If you have learners who speak multiple languages, encourage them to share in their preferred languages.

Teaching Tip

Throughout this guide, information for you to say to students appears in **bold**. You can say the bold sentences exactly as they are written or paraphrase them.

4. Say: **Even if space trash is tiny, it can cause a lot of damage to spacecraft because it is traveling so fast. Today, we're going to investigate what happens when space trash hits a spacecraft.**
5. Organize learners into groups of 4. Give a copy of Engineering Ready, S.E.T., Go! Visual Instructions Handout, p. 19, to each group.
6. Give each group materials: an aluminum tray, four washers, a piece of tape, and two rulers. Say: **The washers represent a piece of space trash, and the aluminum tray represents the outside of the spacecraft. You will drop the washers onto the upside-down tray, making changes and observing what happens each time.**

Level Up!

- If you can, show the video clip NASA has big 'guns' to study micrometeorite & space debris impacts - See test fires (2:33–2:53). Preview audio before playing; it compares the speed of the test trash to the speed of a gun. (5 min.)
- Introduce this activity with a children's book about trash like Team Trash by Kate Wheeler and Trent Huntington (weblink), or one that is relevant to your community to get your learners invested in the character's problem. (30 min.)

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials. Give learners time to examine the materials before beginning the tests.

Check out the Intentional Grouping Strategies, pg. xxii.

7. Have learners turn to *Investigate It!*, pg. 7 in their Notebooks. Say: **You will be testing two kinds of changes.**
   a. **You will drop one, two, three, or four washers to represent space trash of different sizes. When you are dropping more than one washer, you will tape them together. It is important that you only *drop* the washers and do not throw them, in order to keep the test results consistent and avoid damaging the tray.**
   b. **You will drop the washers from one or two feet above the tray to represent space trash traveling at different speeds. You will measure how much the energy of the space trash damaged the spacecraft. You can measure this damage in three ways:**
      - **A louder sound means more damage.**
      - **More vibrations in the tray mean more damage.**
      - **A small pile of salt or rice will be on the edge of the tray. More movement of the salt or rice means more damage.**

Support Thinking

Play the translatable video Space Hazards Instructional Read Aloud, which describes the testing procedure.

8. Have groups discuss and record their predictions about damage in the "prediction" columns on the top part of *Investigate It!* in the Engineering Notebook, pg. 7.

9. When groups have made their predictions, put 1/8 tsp of salt or rice on the edge of each group's tray. Have learners begin testing. Have them record the results in the "actual" columns on the top part of *Investigate It!* in the Engineering Notebook, pg. 7.

10. When groups are finished testing, revisit the first part of the Guiding Question: **How does space trash damage spacecraft?** *(When space trash hits a spacecraft, its energy can break the spacecraft. We can observe this energy when the tray moves, vibrates, and makes noise.)* Ask: **What patterns do you notice about space trash damaging the spacecraft?** (*Space trash that is larger or moving faster does more damage.*) Give groups five minutes to discuss and record their ideas on the *Our Ideas* poster. Say: **We will keep recording ideas on this poster.**

Support Learner Differences

Covering the tray with a piece of dark-colored paper makes the salt or rice easier to see and has a minimal effect on sound and vibration. Vibrations can be felt by lightly touching the side of the pan during testing.

If necessary, increase the drop height so it is easier to time the fall.

Level Up!

If you have decibel meters or a decibel meter smartphone app available, learners can use them to measure the loudness of each impact. They can graph the results to observe how the loudness changes as other things change. (10 min.)

Have groups time how long it takes the washers to fall two feet, then calculate the average fall speed by dividing two feet by the amount of time. (Note that the average fall speed is not the same as the speed on impact, because the washers get faster as they fall.) (10 min.)

Support Learner Differences

Recording learners' ideas using words, diagrams, and pictures on the *Our Ideas* poster or shared digital document throughout the adventures allows them to refer to the poster to remember words and build on past ideas. You can refer to an "In-Use Example" in the Prep & Setup Guide (PDF).

If you have learners who speak multiple languages, encourage them to share in their preferred languages.

As needed, allow learners to choose other methods of sharing their ideas, such as audio recordings. Have them write the filename of each record on an index card and put the index cards on the *Our Ideas* poster. They will serve as placeholders. When necessary, you can ask, "Who has the idea named X?" and have the learner in question share the record.

11. Say: **You have been acting as scientists. Scientists often ask questions and gather evidence to answer the questions. Besides space trash, what other things do you know about that scientists study?** *(Responses will vary. Possible responses include living things, the Earth, and what objects are made of.)* Write the word *scientist* on the *Our Ideas* poster. Have learners come up with a description of scientists together and record it on the poster. (For example: Scientists ask questions, test things out, make observations and measurements, and gather evidence to answer the questions.) You can have learners add translations, drawings, or related images to the poster as well.

12. Say: **Now that you have identified a problem, you will design something to solve the problem of protecting spacecraft when they are hit by space trash. You need to design a shield to absorb as much energy as possible when space trash hits it. You can use a variety of flat materials: cheesecloth, felt, foam, foil, and an index card. You will compare the damage done to the tray without any material with the damage done to the tray that is protected by each material.** Give each group one piece of each material.

13. Have groups discuss how well they think each material will absorb the energy of the space trash. Have them record their predictions about damage in the first column on the bottom part of *Investigate It!* in the Engineering Notebook, pg. 7.

14. When groups have made their predictions, have them test the shielding materials one at a time (dropping four washers from two feet each time). Have them record the results in the second column on the bottom part of *Investigate It!* in the Engineering Notebook, pg. 7.

15. Ask: **Which materials absorbed the most energy? Why do you think so?** *(The foam and felt absorbed a lot of energy because the space trash was quiet when it hit them and didn't make a lot of vibrations that were felt or transferred to the salt or rice.)*

16. Explain that learners can now combine these materials to make the most effective shield. Have groups begin and work for about 15 minutes.

17. Revisit the second part of the Guiding Question: **How can we design ways to protect against space trash?** *(Responses will vary. Possible responses include we can stack layers of materials, and we can fold materials like index cards to make them more absorbent. When these materials absorb energy from the space trash, the spacecraft is protected.)*

Level Up!

- Tell learners that when washers are dropped from 2 feet, they are moving at 11.2 feet per second when they hit the tray. Actual space trash can move at up to 18,000 miles per hour. Have them figure out how much faster the actual space trash is moving than the washers. (10 min.)
- For an additional challenge, have groups construct a shield using only 10 index cards, 12 inches of tape, and no other materials. (10 min.)
- Introduce the terms ***criteria*** (requirements for evaluating a design), ***constraints*** (limitations on a design), and ***tradeoff*** (a compromise engineers make to balance competing design requirements). Have learners consider how each term applies to the shields they are engineering. (10 min.)

18. Say: **You have been acting as engineers. Engineers design things to solve problems.** Write the word *engineer* on the *Our Ideas* poster. Have learners come up with a description of engineers together and record it on the poster. (For example: Engineers design things to solve problems.) You can have learners add translations, drawings, or related images to the poster as well.

19. Say: **Your designs to protect against space trash are *technologies.* Technology is anything designed by people to solve problems. Scientists often ask questions, and engineers help them by designing technologies to answer those questions. They depend on each other.** Write the word *technology* on the *Our Ideas* poster. You can have learners add translations, drawings, or related images to the poster as well.

Level Up!

Learners may believe that *technology* refers only to devices powered by electricity. Explain that anything designed by people to solve a problem is technology. Have learners identify non-electrical technologies around them. (5 min.)

Have learners explore actual shielding for NASA spacecraft in the video How Can We Protect Our Astronauts in Space? (1:31 min.)

Reflect (Go!) (5 min.)

20. Say: **You will be acting as engineers to help solve more problems in space. These problems will involve learning about and protecting against other *hazards*, or dangers.**

21. Say: **Space trash is one kind of hazard. What other hazards can you think of?** *(Accept all responses.)*

22. Say: **You will be acting as engineers to help solve more problems in space. These problems will involve protecting against other *hazards*, or dangers. You will think about the phases you used to solve the problem of space trash so you can use those phases again later with other hazards.**

Level Up!

Instead of using the premade *Engineering Design Process*, you can have learners make their own.

1. Give each group index cards, markers, and one set of cards cut from Engineering Ready, S.E.T., Go! Phase Cards Handout, (PDF). Explain that they should choose the phases they used to solve the trash problem. They can choose some or all of the phase cards, and they can write or draw their own cards (one phase per card). They should put the phases in the order they used them. (Note that the options shown on the phase cards are intentionally different from the phases of the *Engineering Design Process* (EDP) in the *Engineering Notebook*, to avoid implying that the EDP in the Notebook is the "correct" answer.)

2. When writing their own phases, learners may describe specific actions, such as "We folded the index cards." Through discussion, encourage learners to come up with terms to describe each phase of the process more generally, such as "We talked about it" and "We tested the materials." If learners speak multiple languages, encourage them to discuss in their preferred languages.

3. Give groups copies of the Engineering Ready, S.E.T., Go! Engineering Design Process Example Handout, (PDF) for inspiration.

4. Gather the group and compare processes. Organize all the cards in groups on a poster to create a whole-group engineering design process of between three and ten phases. (For example: ask, imagine, plan, create, test, improve.) Save this Engineering Design Process poster (PDF) for use in future adventures.

5. Say: **You have just designed a set of phases like the ones engineers use to solve problems: an engineering design process**. Ask: **How can you use your engineering design process to solve the problem of trash or litter here or in your neighborhood?** (*We can use our process to make tools for picking up the trash.)*

Note: If you've used this Level Up, skip step #23 that follows.

23. Have learners turn to *Our Engineering Design Process,* pg. 8, in their Notebooks. Say: **There are many different processes that engineers use to design things to solve problems. You will be using these five phases as your Engineering Design Process: Ask, Imagine, Plan, Create, and Test, with an Improve cycle.** Ask: **How did you use this Engineering Design Process when engineering protection against space trash?** *(We asked what materials we had, imagined possible designs, planned and created one design, and tested it. If necessary, we improved our design to absorb more energy.)*

24. Say: **Next time, we will think about what we already know about protecting against other types of dangers.**

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 1.
   - Throw away the salt, rice, and any materials that are too damaged to reuse. Check to ensure the foil trays have not developed holes.
   - Collect the washers and other shielding materials.
2. Have learners invite people from the community, including their families and friends, to the Engineering Share-Out in Adventure 9.
3. Plan ahead for Adventure 1. See Adventure 1 Preparation on pg. 22.
4. Take time to reflect on the following educator prompt. **How did you create connections between the science and engineering portions of the adventure?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Engineering Ready, S.E.T., Go! Visual Instructions Handout

Part 1

1

Gather materials

salt and colored paper

+

ruler

+

various sizes of metal washers

+

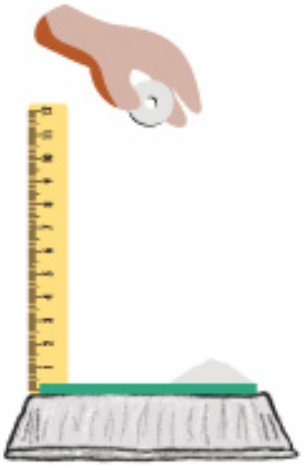
foil tray

2

Impact testing

tray with paper then salt in the corner

How to test:



3

Record your results

On the *Investigate It!* page:

1. Write your predictions.

2. Test.

3. Record what happened.

Part 2

4

??? What other materials can you use?

Reset

1. Clean up the salt.
2. Put all materials back where they belong.

Educator Guide

Engineering Adventure 1: Safety Stories: Sharing Experiences

Educator Preview

Adventure Snapshot

Learners share experiences with, and stories about, making hazards safer.

Timing | 45 minutes

Get Ready & Team Up	10 min.
Storytelling	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 5–60 min. each

Prep Snapshot*

Prep Time 30 min.

- Set up Materials Table.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Communication

Habits of Mind

- Communicate effectively.

Guiding Question

Why is it important to make hazards safer?

Learners Will Do

Share a story or experience about a time they made a hazard safer in their home, town, or school.

Learners Will Know

Humans can make choices to make hazards safer.

Connecting Across Adventures

Ready, S.E.T., Go!	Adventure 1: Sharing Experiences	Adventure 2: Exploring Glove Uses
Last time, learners explored space trash. As scientists, they measured the energy of space trash impacts. As engineers, they designed ways to protect against those impacts.	**Today**, learners share experiences with and stories about making hazards safer.	**Next time**, learners do simple tasks wearing different gloves and compare results. Then they learn how spacesuit gloves protect astronauts from space hazards.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/9e7c4815

Materials and Preparation

Materials

For the educator

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
  - index cards
  - markers
  - scissors
  - tape

For the Materials Table

- drawing supplies (such as pencils, crayons, markers)
- building supplies (such as clay, Legos, beads, natural materials)

For each learner

- Engineering Notebook (PDF)

Adventure 1 Materials Preparation (30 min.)

Ahead of Time

1. If you did not do so before the Ready, S.E.T., Go Adventure, prepare an *Our Ideas* poster by following the Prep & Setup Guide (PDF). Add the Guiding Question "Why is it important to make hazards safer?" so learners can refer to it throughout the adventure.
2. Learn about local hazards, reasons why hazards are important in local communities and cultures, and ways they are made safer. This information will help you understand learners' stories, and you can use it to provide examples and prompt learners' thinking.
3. Learn about or reflect on the storytelling styles of learners' communities. Think about the kinds of stories learners might tell and how you can structure the adventure to support them.

Teaching Tip

This adventure is the same in both the Science and Engineering Pathways. If you have already taught it in one pathway, you do not need to teach it again.

In Your Space

4. Place the *Our Ideas* poster in a location all learners can access. Make a plan to store it between activities.
5. Set up a Materials Table with the items listed in the Materials section.
6. Optional: Set the mood for the adventure by playing music.

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(As scientists, we figured out what affected energy from impacts. As engineers, we designed ways to protect spacecraft from impacts.)*
2. Say: **Our ultimate goal is to design gloves to protect astronauts against hazards in space. To start figuring this out, we're going to share what we know about hazards and how to make them safer.** Share the Guiding Question with learners aloud and in writing (using multiple languages as needed): **Why is it important to make hazards safer?**
3. Organize learners into groups of four and distribute Engineering Notebooks.

Support Learner Differences

- If learners are new to you or each other, have them share their names, name pronunciations, and other important parts of their identities. These introductions are important for all learners and can be especially relevant for Indigenous learners, multilingual learners, and learners with different physical abilities. You can also distribute index cards and have learners write anything they want you to know but do not want to share with the whole group, such as resources that will help them learn. Lead an inclusion activity that is appropriate for your group (a list of possible activities is available on pgs. xx–xxi). This tip is repeated because you may have new learners joining you in this and future sessions. Whenever you have new learners, repeat this strategy.

  For more strategies to engage learners, refer to Designing Instruction to Reach Diverse Learners, pg. x

- If you have learners who speak multiple languages, consider pairing learners with the same preferred language so they can share with each other in that language. Check out the Intentional Grouping Strategies, pg. xxii.

- If you have learners who speak multiple languages, have them discuss words for "hazards" and "safety" in their preferred languages and notice similarities between languages. If you can, provide an example from a language you know. Take time to learn learners' words and use them throughout the activities.

Storytelling (25 min.)

4. Say: **We all have stories. They can be stories we've heard from other people, stories we've watched or read about, or stories about things we have experienced ourselves. We experience stories every day in conversations, art, traditional craft, and online videos. Today, we're going to share stories about times we made a hazard safer in our homes, towns, or schools.**

5. Have learners turn to *My Safety Story*, pg. 10 in the Engineering Notebook. Say: **To start, everyone will have 15 minutes to think about a story to tell about making a hazard safer. Create some art that tells your story. You can write it down or write a poem that tells it, draw it, record it on a device, create a performance about it, or build something to demonstrate it.** Note that there are drawing and building materials on the Materials Table. During this time, check in with each group. If learners are struggling, consider sharing your own short story about hazards to spark ideas.

6. After 15 minutes, say: **Now, everyone in your group will take a few minutes to share their stories. If your story is long, you can choose one or two minutes of it to share so there is time for everyone.**

7. Allow learners to share their stories for 10 minutes. Remind them to switch so that everyone has time to share. Visit each group and listen to learners' perspectives on hazards and safety.

Reflect (10 min.)

8. Say: **Thank you for sharing your stories. They gave us great reasons why it is important to make hazards safer.** Point out common themes you noticed among stories. Emphasize how addressing hazards protects people and communities. Ask: **Is there anything else you want to share to answer the Guiding Question?** Revisit the Guiding Question: **Why is it important to make hazards safer?**

Support Thinking

Learners may want to make up their own stories. Bear in mind that the goal of the activity is to identify why making hazards safer is important to learners and communities they belong to, which made-up stories may or may not do.

Support Learner Differences

It is possible that stories about hazards may bring up trauma. If you notice this, ask the learner privately what they might need at that moment. If they do not know, you can offer some ideas from the Arizona Adverse Childhood Experiences Consortium Resource Library.

In this activity, you will need to strike a balance between allowing learners to share complete stories and ensuring there is enough time for everyone to share. Different cultures have different conventions for storytelling, which may involve very long stories with many parts, the significance of which is not immediately apparent. Consider the best way to approach time management, which may involve dedicating multiple sessions to this adventure.

You can use storytelling as an opportunity for learners to practice social skills such as taking turns and showing respect for other people's experiences.

9. Have learners record answers to the Guiding Question near it on the *Our Ideas* poster. You can
   - have each group designate a member to record responses on the *Our Ideas* poster.
   - have each learner write or draw something on a (physical or digital) index card and add it to the *Our Ideas* poster.

10. Say: **Next time, we will begin exploring how to protect astronauts' hands from hazards in space.**

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 2.
   - If learners created objects related to their stories, save those objects for reference in future activities.
2. Plan for Engineering Adventure 2. See the Adventure 2 Preparation on pg. 28. Note that you will need to prepare three glove testing stations. This setup will likely take at least 40 minutes.
3. Take time to reflect on the following educator prompt. **What strategies helped learners feel comfortable sharing stories?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Support Thinking

Learners may bring up ideas that will be relevant in future activities, such as clothing that protects against hazards. As appropriate, note that the group will return to these ideas.

Support Learner Differences

As needed, allow learners to choose other methods of sharing their ideas, such as audio recordings. Have them write the filename of each record on an index card and put the index cards on the *Our Ideas* poster. They will serve as placeholders. When necessary, you can ask, "Who has the idea named X?" and have the learner in question share the record.

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The ASK phase. We asked why it is important to make hazards safer.)* (5 min.)
- Check out some great examples of the more than 2,000 NASA spin-off technologies that enrich our lives–and keep us safe–thanks to space exploration. (5 min.)
- Tell learners, if anyone asks them what they did today, they can tell them "We shared stories about why it is important to make hazards safer." (5 min.)

Engineering Adventure 2: Everyday Gloves: Exploring Glove Uses

Educator Preview

Adventure Snapshot

Learners try doing simple tasks wearing different kinds of gloves and compare results. Learners then find out about space hazards and spacesuit design.

Timing | 75 minutes

Get Ready & Team Up	10 min.
Which Glove Works Best?	50 min.
Reflect & Wrap Up	15 min.
Total	**75 min.**

Level Up Activities 5–45 min. each

Prep Snapshot*

Prep Time 55 min.

- Set up materials stations.
- Print handouts.
- Prepare ice and sponges for upcoming adventures, as noted in Materials & Preparation.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Collaboration

Habits of Mind

- Collaborate effectively.
- Construct models and simulations.

Guiding Question

Which gloves work best for everyday tasks?

Learners Will Do

Connect test results for different gloves with the performance of spacesuits that protect astronauts from space hazards.

Learners Will Know

Engineers design technologies that protect people from different hazards.

Connecting Across Adventures

Adventure 1: Sharing Experiences	Adventure 2: Exploring Glove Uses	Adventure 3: Protecting Against Cold
Last time, learners shared experiences with and stories about making hazards safer.	**Today**, learners do simple tasks wearing different gloves and compare results. Then they learn how spacesuit gloves protect astronauts from space hazards.	**Next time**, learners will test different materials to see how well they protect against cold temperatures. Later, they'll use that info to design space gloves.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/4179271c

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
  - index cards
  - markers
  - scissors
  - tape
- 1 box of food-safe gloves
- 1 box of vinyl gloves
- 1 permanent marker
- 1 tablespoon measure

For the Glove Test Stations

- access to water
- directions and results sheets for Stations 1–3, pgs. 36-41.
- 1 bottle of dish soap
- 1 roll of masking tape
- 2 rolls of paper towels
- 4 jars with twist lids
- 4 fuzzy sticks
- 4 plastic cups, 16 oz.
- 6 aluminum trays, 12" × 10"
- 8 timers
- 28 washers, 1.25"
- 60 beads
- 160 paper clips

For each pair of learners

- 1 pair of gloves: dish, food-safe, garden, oven mitt, vinyl, or winter
- tongs, plastic bags, socks (as needed)
- Engineering Adventure 2 Glove Testing Directions Handout, pg. 42

For each learner

- Engineering Notebook (PDF)

Adventure 2 Materials Preparation (55 min.)

Ahead of Time

1. Check to ensure the foil trays did not develop holes in the previous adventure. If they did, find other containers to hold liquids during this adventure.
2. Make 1 copy of each of the directions and results sheets for Stations 1–3, pgs. 36-41.

Teaching Tip

This is a very messy adventure. Ensure you have enough time to clean up afterward, and consider using page protectors that will make it easier to clean materials.

3. Make 1 copy of Engineering Adventure 2 Glove Testing Directions Handout, pg. 42, for each pair of learners.
4. If you did not do so before the Ready, S.E.T., Go Adventure, prepare an *Our Ideas* poster by following the Prep & Setup Guide (PDF). Add the Guiding Question "Which gloves work best for everyday tasks?" so learners can refer to it throughout the adventure.

In Your Space

5. Place the *Our Ideas* poster in a location all learners can access. Make a plan to store it between activities.
6. See Glove Test Setup Instructions, pg. 33.

Ice and Sponge Preparation for Other Adventures

7. Be aware that you will need 12 cups of ice **each** for Adventures 3, 6, and 7.
8. Take sponges out of packages to give them time to dry out. Sponges need to be dry so tape will stick to them. Dry sponges are for Adventures 3–7.

Support Learner Differences

Group learners with different abilities and strengths in a way they can all contribute. Check out the Intentional Grouping Strategies, pg. xxii.

Get ready to adjust the activity or materials for any learner whose physical abilities mean they have different needs for using gloves. Ask learners in advance what they need to complete the activity. They are the experts knowing their physical capabilities. You can have alternative tools like tongs, oven mitts, plastic bags, or socks to test how wearing protective coverings affects their ability to handle objects in their usual way, but don't assume they cannot do the activity as written.

Adventure Guide

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We told stories about hazards and how we have made them safer.)* Draw learners' attention to their work on the *Our Ideas* poster about the hazards they addressed.
2. Ask: **What are hazards?** Have learners decide on a definition of *hazard* as a whole group. Add *hazard* and the definition that you agree on to the *Our Ideas* poster, along with translations into learners' preferred languages and relevant images. (You may want to add a danger icon next to the term.)
3. Have learners read the *Engineering Comic*, pgs. 11-14 in their Notebooks, to set the context.
4. Say: **As engineers, we are going to try to answer the big question in the comic: How can we design space gloves that protect astronauts from space hazards on the Moon, Mars, or asteroids?** Write the question in a prominent spot at the top of the *Our Ideas* poster. **To start figuring this out, we're going to explore how easy–or hard–it is to do things while wearing gloves.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **Which gloves work best for everyday tasks?**
5. Organize learners into pairs.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Support Learner Differences

You can project a digital version of the comic or share it so learners using text-to-speech technology can access the comics.

- iOS or macOS users should enable text-to-speech or voice-over.
- Windows users should use JAWS or NVDA at NV Access.

Be sure to read carefully and leave a visual shortcut to exit the program, or have your learner restore settings when they are done.

Support Learner Differences

Pair learners in a way that lets each learner use their self-identified strengths. If you have learners who speak multiple languages, consider pairing learners with the same preferred language so they can share with each other in that language.

Depending on your learners, it may be useful to have two pairs work together in a group of four in order to allow more discussion and specialization. For example, at the "Find the Message" station, a learner who is good with their hands can turn over the washers, and a learner who is good at reading can read the message.

Which Glove Works Best? (50 min.)

6. Give one type of glove to each pair and allow them time to examine it. Have pairs discuss if they think it will be easier or harder to do things wearing these gloves.
7. Show learners the sheet at each station. Point out the directions and results chart. Give each pair a copy of Engineering Adventure 2 Glove Testing Directions Handout, pg. 42. Say:
   a. **First, you will read directions on how to test gloves.**
   b. **Next, you will complete the test with your gloves on.**
   c. **Then, you will record your results in the chart.**
   d. **Finally, you will reset the station.**
   e. **You must visit all three stations. When you finish one station, you can move to any available station.**
   f. **You and your partner need to decide how to take turns testing, recording, and resetting.**
8. Ask: **Do you have all the tools you need to do this activity? What other tools would help you?** (Have tongs, socks, or bags on hand.)
9. Have learners go to their first station and begin. Give learners a 3-minute limit warning and a 1-minute warning, then tell them when to switch.

Teaching Tips

- This activity uses six types of gloves. Each pair of learners tests one type. If you have more than six pairs, assign food-safe or vinyl gloves to more than one pair.
- Let learners know they can replace food-safe and vinyl gloves between stations, if they need to.

Reflect & Wrap Up (15 min.)

10. Gather learners and review the results. **Ask: What surprised you? Which tasks did your gloves do best and worst in? Why?** Have learners discuss in pairs and record their ideas on the *Our Ideas* poster. Guide learners to think about how the **materials** that the gloves are made from affected results. Add *materials* and a definition learners agree on to the *Our Ideas* poster, along with translations into learners' preferred languages and relevant images.
11. Revisit the Guiding Question on the *Our Ideas* poster: **Which gloves work best for everyday tasks?** Help learners make the connection that, just as different gloves work better for different tasks, different spacesuit materials are designed to work for the different goals of a mission. As needed, remind learners of the term *hazard*.
12. Say: **Next time, you will test materials to see how well they protect against cold. Later, you will use what you learn to design space gloves.**

Support Thinking

Hand out Engineering Adventure 2 Gloves in Action Handout (PDF) to review the function, materials, and features of each glove.

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Ask phase. We asked which gloves are best for which uses.)* (5 min.)
- If you can, show the NASA video #AskNASA | What Are the Next Generation Spacesuits? (3:32) to help learners understand how NASA engineers design spacesuits to meet the needs of astronauts. The video mentions the testing of five spacesuit materials on Mars, happening now on the Perseverance rover. Learners will be testing materials in Adventures 3, 4, and 5. (5 min.)
- Ask this story prompt: **Can you tell me a story about another time when using the right tool or clothing made something way easier for you?** Tell learners, if anyone asks what they did today, they can say "we tried to do things wearing different types of gloves in the same way that NASA tests spacesuits for astronauts," and then ask them the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)
- Get families or a community member involved to share relevant stories of engineering. Download customizable flyers and get ideas on the Space Hazards Family and Community Connections (weblink). (45 min.)

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 3.
   - Throw away disposable gloves and any materials that cannot be reused.
   - Dispose of water and rinse soapy materials and dry them.
   - Save reusable gloves, washers, and other materials.
2. Plan for Engineering Adventure 3. See the Adventure 3 Preparation on pg. 45. Note that you will need to prepare two Cold Testing Stations, requiring a total of 12 cups of ice. Set up will likely take at least 45 minutes.
3. Take time to reflect on the following educator prompt. **What strengths did your diverse learners bring to the adventure?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Glove Test Setup Instructions

Arrange the glove test stations on separate tables by following the instructions below. Each station will have 4 setups so that 4 pairs of learners can test at a time. Arrange the setups per station as needed to meet your group's needs.

Station 1: Slippery Jar Setup

Materials

- Engineering Adventure 2 Station 1: Slippery Jar Directions Handout, pg. 36
- Engineering Adventure 2 Station 1 Results Handout, pg. 37
- access to water
- writing utensil
- 1 bottle of dish soap
- 1 roll of paper towels
- 1 tablespoon measure
- 2 aluminum trays, 12" × 10"
- 4 pipe cleaners / fuzzy sticks
- 4 plastic jars with twist lids
- 4 timers
- 60 beads

Instructions

1. Place the Engineering Adventure 2 Station 1: Slippery Jar Directions Handout, pg. 36 and Engineering Adventure 2 Station 1 Results Handout, pg. 37 at the station where learners can see them, along with a writing utensil.
2. Place 15 beads in each jar and tighten the lids.
3. Pour 1 cup of water into each aluminum tray and add 2 tablespoons of dish soap.
4. Roll the jars in the soapy water and leave them in the tray.
5. Place 2 fuzzy sticks, 2 timers, and a roll of paper towels near each tray.

Station 1: Slippery Jar

Station 2: Paper Clip Pickup Setup

Materials

- Engineering Adventure 2 Station 2: Paper Clip Pickup Directions Handout, pg. 38
- Engineering Adventure 2 Station 2 Results Handout, pg. 39
- writing utensil
- 4 plastic cups, 10 oz or larger
- 4 timers
- 160 paper clips

Instructions

1. Place the Engineering Adventure 2 Station 2: Paper Clip Pickup Directions Handout, pg. 38 and Engineering Adventure 2 Station 2 Results Handout, pg. 39 at the station where learners can see them, along with a writing utensil.
2. Spread the paper clips on the table in a single layer.
3. Place the plastic cups and timers around the paper clips.

Station 2: Paper Clip Pickup

Station 3: Find the Message Setup

Materials

- Engineering Adventure 2 Station 3: Find the Message Directions Handout, pg. 40
- Engineering Adventure 2 Station 3 Results Handout, pg. 41
- access to water
- writing utensil
- 1 permanent marker (to write the message. It is not part of the station.)
- 1 roll of paper towels
- 4 aluminum trays, 12" × 10"
- 28 washers

Instructions

1. Place the Engineering Adventure 2 Station 3: Find the Message Directions Handout, pg. 40 and Engineering Adventure 2 Station 3 Results Handout, pg. 41 at the station where learners can see them, along with a writing utensil.
2. Fill each tray halfway with water.
3. Choose a word with 5 letters (e.g., "hello")—this will be the message learners need to find.
4. Use a permanent marker to write 1 letter of the message on each washer. Do this again so you have 4 sets of washers with the same 5 letters written on them.
5. Place 1 message in each tray. Add 2 additional washers to each tray and turn all the washers over to hide the letters.
6. Place a roll of paper towels at this station in case of spills.
7. Optional: Write the message on *Engineering Adventure 2 Station 3: Find the Message Directions Handout* so learners know what to look for as they complete the task.

Station 3: Find the Message

Station 1: Slippery Jar Directions

Note: These directions are also read aloud in a translatable online video.

1

2 hands and gloves

timer (max time = 3 min.)

jar and lid

fuzzy stick

stringing beads

2

Test directions

1. Start the timer.
2. Open the jar and take out 3 beads.
3. String each bead onto the fuzzy stick.
4. Twist the lid back on the jar.
5. Stop the timer.

3

Record your results

How long did it take to do the task?

Reset

1. Put the beads back in the jar and close the lid.
2. Roll the jar in the soapy water.
3. Use the paper towels to dry your gloves.
4. Move to the next station.

wash station

Station 1 Results

Glove Type	Time to Complete (seconds)
dish 	
food safe 	
garden 	
oven 	
vinyl 	
winter 	

Station 2: Paper Clip Pickup Directions

Note: These directions are also read aloud in a translatable online video.

1

1 hand and glove

+

timer (20 sec.)

+

empty cup

+

paper clips

2

Test directions

1. Set the timer for 20 seconds.
2. Pick up paper clips one at a time and drop them in the cup.
3. Stop the timer after 20 seconds.

3

Record your results

How many paper clips are in the cup?

Reset

1. Take the paper clips out of the cup.
2. Spread the paper clips on the table in a single layer.
3. Move to the next station.

Station 2 Results

Glove Type	Number of Paper Clips
dish 	
food safe 	
garden 	
oven 	
vinyl 	
winter 	

Station 3: Find the Message Directions

Note: These directions are also read aloud in a translatable online video.

1

2 hands and gloves

+

tub with water and washers

2

Test directions

no time limit

1. Turn over the washers in the water.
2. Arrange the washers to reveal the message.
3. Take the gloves off.

3

Record your results

Are your hands wet or dry?

Reset

1. Turn the washers over so the message is hidden.
2. Mix up the washers so the message is hard to find.
3. Use paper towels to dry your gloves.
4. Move to the next station.

Station 3 Results

Glove Type	Wet or Dry Hands?
dish 	
food safe 	
garden 	
oven 	
vinyl 	
winter 	

Glove Testing Directions

At each station...

1. Read directions on how to test gloves.
2. Complete the test with the gloves on.
3. Record your results in the chart.
4. Reset the station.

You must visit all three stations. When you finish one station, you can move to any available station.

You and your partner need to decide how to take turns testing, recording, and resetting.

Engineering Adventure 3: Chilling Out: Protecting Against Cold

Educator Preview

Adventure Snapshot

Learners test and compare materials to see which ones work best to protect against cold.

Timing | 70 minutes

Get Ready & Team Up	5 min.
Which Material Is Best?	55 min.
Reflect & Wrap Up	10 min.
Total	**70 min.**

Level Up Activities 5–10 min. each

Prep Snapshot*

Prep Time 50 min.

- Set up materials stations.
- Prepare Testing Results chart.
- Print handouts.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving.
- Investigate properties and uses of materials.

Guiding Question

Which materials are good at protecting against cold?

Learners Will Do

Test how materials insulate against cold and consider which to use in a space glove.

Learners Will Know

Engineers must learn how different materials work for different uses.

Connecting Across Adventures

Adventure 2: Exploring Glove Uses	Adventure 3: Protecting Against Cold	Adventure 4: Protecting Against Impact
Last time, learners did simple tasks wearing different gloves and compared results. Then they learned how spacesuit gloves protect astronauts from space hazards.	**Today**, learners test how well different materials protect against cold. Later, they'll use collected data to design space gloves.	**Next time**, learners will test how well different materials protect against impact.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/63471629

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
  - chart paper and markers
  - 1 roll of masking tape
  - 1 roll of paper towels
  - 1 measuring cup
  - 2 buckets, 5-liter
  - 2 digital thermometers
  - 2 rulers
  - 2 sheets of thin cardboard
  - 2 timers
  - 12 cups of ice cubes
  - 20 cups of water (1-1/4 gallons total)

For each pair of learners

- 1 pair of scissors
- 2 resealable plastic bags, quart size
- Engineering Adventure 3 Cold Test Procedure Handout, pg.53

For the Materials Table

- 1 piece of cheesecloth, approx. 8.5" × 11"
- 1 sheet of craft foam
- 1 sheet of felt
- 1 sheet of foil, approx. 8.5" × 11"
- 1 sheet of transparency
- 5 sponges, dry
- 40 cotton balls
- 50 straws

For each learner

- Engineering Notebook (PDF)

Teaching Tip

The thermometer may take a little time to adjust to the ice water.

Support Learner Differences

To provide learners with audio data, you can purchase talking thermometers online.

Adventure 3 Materials Preparation (50 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.
2. Place one resealable bag inside another to make an empty mitt for demonstrating.
3. Make 1 copy of Engineering Adventure 3 Cold Test Procedure Handout, pg. 53, for each pair of learners.

In Your Space

4. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally. Copy the *Testing Results* chart onto the *Our Ideas* poster so that learners can refer to it throughout the adventure. Consider including a sample or image of each material in the "Material" column for learners to reference.
5. See Cold Test Setup Instructions, pg.50.
6. Set up a Materials Table. See list above.

Support Learner Differences

You can leave space on the poster for learners to write names of materials in their preferred languages.

Teaching Tip

If time is limited, you can split this adventure into two sessions, having learners prepare the gloves in the first session and test them in the second. If you have a limited number of sessions, consider preparing the gloves yourself and having learners move directly to testing them.

Chart for Adventure 3

Testing Results

Material	[Leave blank]	[Leave blank]	[Leave blank]
none cheesecloth cotton balls craft foam felt foil sponges straws transparency	[Results will go here.]	[Leave blank.]	[Leave blank.]

Note: You will leave the last two columns blank until Adventures 4 and 5.

Teaching Tips

- Be sure sponges are dry before using them.
- Save the Testing Stations, including the model hands and thermometers, for Adventures 6 and 7.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We tested different types of gloves by doing simple tasks and comparing results. Astronauts use gloves when they're wearing spacesuits.)* Draw learners' attention to their work on the *Our Ideas* poster about how different gloves work well for different tasks.
2. Say: **Today you will continue the Ask phase of our engineering design process. You will explore how well glove materials protect against cold.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **Which materials are good at protecting against cold?**
3. Organize learners into pairs.

Which Material Is Best? (55 min.)

4. Say: **You will use model hands in model mitts to test which materials are better at protecting against the cold.**
5. Gather learners at the testing area. Give each pair a copy of Engineering Adventure 3 Cold Test Procedure Handout, pg.53 and demonstrate the steps with the empty demonstration mitt. Record how many degrees colder the thermometer got in the "None" row of the *Our Ideas* poster. As needed, allow learners to feel the test setup.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Support Thinking

- To give learners more context about this hazard, show the video Extreme Temperatures in Space (1:17 min. video length). Read the Educator Science Background (weblink) for more information.
- This adventure assumes learners are familiar with the word *temperature*. If they have not encountered this word before, you can introduce it later in the adventure after they have used thermometers. It may be useful to use the word in context and have learners define it and use it in a sentence.

Support Learner Differences

Encourage learners to identify their own strengths and the roles they would like to play during testing, and form pairs that can play a variety of roles. For example, one learner can specialize in assembling the mitt for testing, and another learner can read the temperature.

Level Up!

The Artemis III astronauts are the first humans to return to the Moon since the Apollo era and NASA chose the South Polar region of the Moon for their landing site. This area is known for having some of the coldest temperatures in the entire Solar System, even colder than Pluto! Check out this article to learn more about the Mission Objectives of the Artemis III mission: "Moon's South Pole is Full of Mystery, Science, Intrigue - NASA" (10 min.)

6. Have learners turn to *Temperature Changes*, pg. 15 in their Engineering Notebooks. Say: **You will record each material's temperature twice: once at the start, and again after 30 seconds. You will rank the materials by how much the temperature drops in 30 seconds.**

7. Assign each pair one or two materials to test. Make sure all materials are tested.

8. Let pairs visit the Materials Table and assemble their mitts.

9. As pairs are ready, have them move to Testing Stations.

Support Thinking

- If learners would benefit from an additional visual of the testing procedure, play the video How to Design and Test Space Gloves (0:26–1:00).
- To ensure learners understand the test procedure, have pairs summarize it together.

Level Up!

Explain that "cold" describes something that has a lot less heat energy than the things around it. Heat energy always moves from warmer places to colder places. So, "protects against cold" means "slows the transfer of heat energy." Materials that slow the transfer of heat energy are called ***insulators***. For example, when you're outside on a hot day and you put your hand on the metal bar of a playground, it feels really hot because metal is a poor insulator. Put your hand on something at the playground made of wood, and it doesn't feel nearly as hot because wood is a pretty good insulator. Show a NASA video about Artemis insulation, NASA Crews Spray Foam Insulation on Artemis III Rocket Hardware (1:26), and discuss why insulation is important for rockets. (5 min.)

Support Learner Differences

- If you have learners who speak multiple languages, have them discuss words for "temperature," "heat," "warm," and "cold," and things that protect against the cold in their preferred languages and notice similarities between languages.
- Give learners time to feel and become familiar with the materials before testing them.

Teaching Tip

If time is short, pause the adventure here and finish it in another session.

10. As learners finish, have them find out how much colder each material got. Have pairs record results on *Temperature Changes*, pg. 15 in their Engineering Notebooks and in the "Cold" column on the *Our Ideas* poster by writing whether the material was "not good," "good," or "great" at protecting against the cold.

Reflect & Wrap Up (10 min.)

11. Gather learners and review the *Our Ideas* poster. Revisit the Guiding Question: **Which materials are good at protecting against cold?** *(Thick materials like cheesecloth, foam, and cotton balls are good against cold.)* Ask: **Why do you think they worked well?** *(Accept all responses.)* **Which materials were not good? Why not?** *(Thin materials like foil and transparency did not work well.)* **Which would be good to use in a space glove? Why?** *(Ask learners to support answers with results from their tests.)*

Teaching Tips

- Wave the paper hand in the air between tests to bring the temperature back up to 20–22°C. That way all tests start at about the same place.
- As needed, make copies of Engineering Adventure 3 Celsius and Fahrenheit Table Handout (PDF) for learners to refer to. Note that the boiling point listed is for sea level; water boils at colder temperatures as its elevation increases.

Support Thinking

To help learners visualize which materials are better at protecting against cold, have them post a sample of each material on a wall in a spectrum from "not good" at one end to "great" at the other. Consider photographing this spectrum and printing copies for learners to reference later.

Support Learner Differences

Have learners write names or descriptions of materials in their preferred languages on the *Our Ideas* poster. Note that some languages may have several terms for a given material.

Encourage open communication within each pair. Assign one member to describe the temperature reading while another records it verbally. This way, everyone can actively participate and contribute to the experiment.

Support Learner Differences

Give learners options to express materials they think would be good, such as giving a thumbs up or thumbs down.

Support Thinking

Help learners make connections between their results and everyday objects that protect against the cold, like a Styrofoam coffee cup or the lining of a winter coat.

12. Say: **Next time, you will test materials that protect against damage from hazards like space trash.**

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Ask phase. We asked which materials are best at protecting against cold.)* (5 min.)
- Ask this story prompt: **Can you tell me a story about something creative you did to keep warm when it got really cold?** Tell learners, if anyone asks what they did today, they can tell them "we tested materials to protect from cold in a bucket of ice," and then ask them the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 4.
   - Pour out water and ice, and dispose of materials that cannot be reused.
   - Save Testing Stations, model hands, and thermometers for Adventures 6 and 7.
   - If the sponges are wet, set them out to dry so that tape will stick to them in Adventure 4.
2. Plan for Engineering Adventure 4. See Engineering Adventure 4 Preparation on pg. 58. Note that you will need to prepare two Impact Testing Stations. Setup will likely take at least 25 minutes.
3. Take time to reflect on the following educator prompts. **How did learners help each other understand temperature and temperature changes?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

webllink: https://hov.to/940428f7

Cold Test Setup Instructions

Set up two testing stations for learners to test how well their gloves insulate against cold.

Materials for each setup:

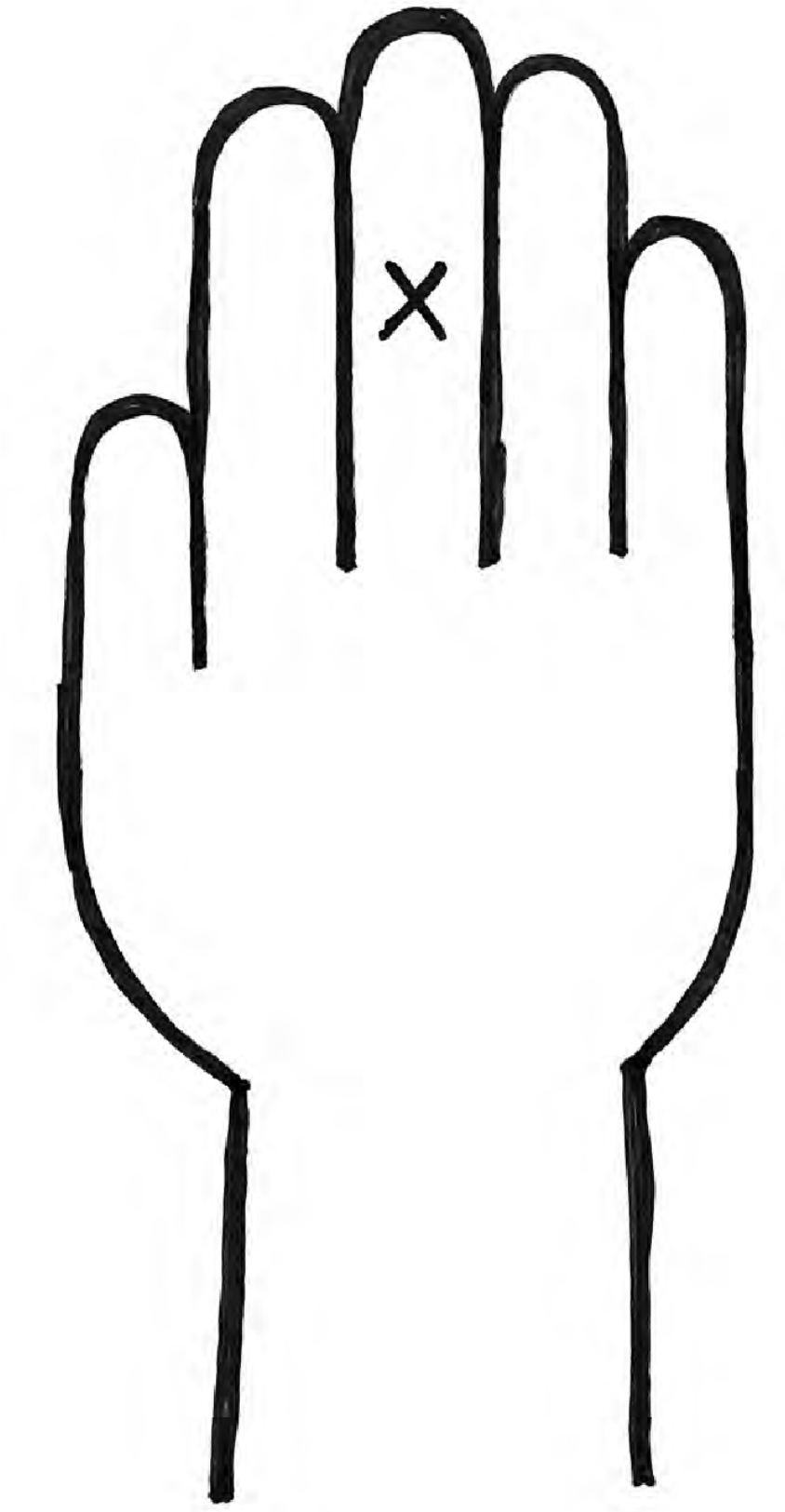
- 1 roll of masking tape
- 1 roll of paper towels
- 1 bucket, 5-liter
- 1 digital (or talking) thermometer
- 1 ruler
- 1 sheet of thin cardboard
- 1 timer
- 6 cups of ice cubes
- 10 cups of water

Prepare Testing Stations

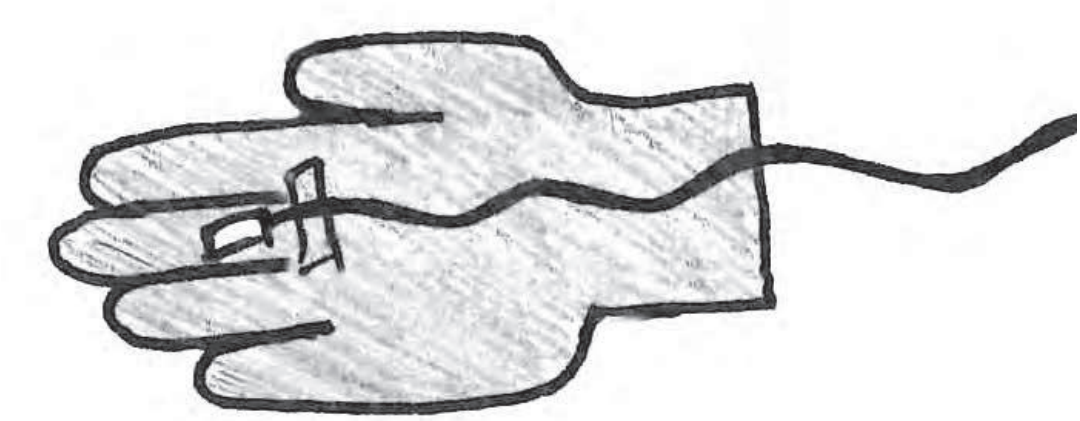
1. Fill each bucket with 6 cups of ice and 10 cups of water.
2. Arrange the buckets on a table with digital thermometers, rulers, timers, and 1 roll of paper towels.

Prepare Model Hands

3. Place the hand illustration (on the next page) onto a sheet of thin cardboard to cut out a cardboard hand.



4. Attach the thermometers with masking tape. Make sure the metal probes are positioned over the X. Be careful not to tape over the probe itself.



5. Place one model hand with the digital thermometer attached at each Testing Station.

Cold Test Procedure

1

Tape one layer of the material being tested around both sides of the outside of the bag.

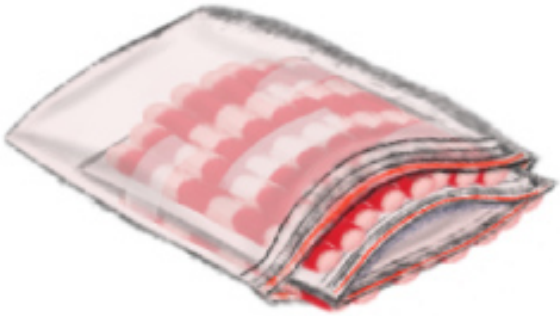
Possible materials are cheesecloth, cotton balls, craft foam, felt, foil, sponges, straws, and transparency.

Every part of the *outer surface* of the bag should be covered in one layer of the material being tested.

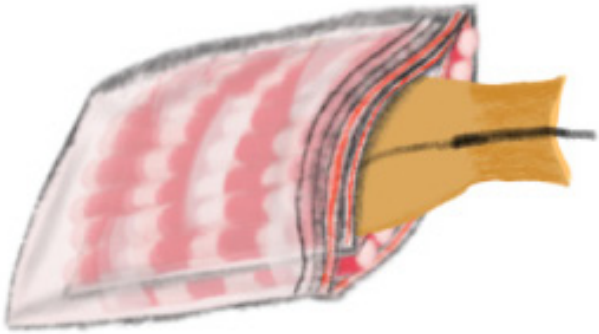
Example 1: Foil.
Cut the foil in half. Tape each half to the *outside* of the bag, on both sides.

Example 2: Straws.
Tape straws next to each other to cover the *outside* of the bag on both sides.

2 Place the plastic bag with the materials inside the other plastic bag. The materials should now be sandwiched between the 2 plastic bags. This is your mitt.

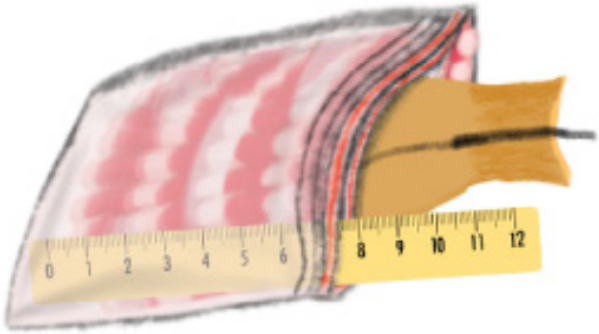


3 Put the model hand with attached thermometer into the inner bag of the mitt.



4 Place the ruler into the corner of the mitt.

5 Record the starting temperature.



6 Place the mitt straight down into the ice water and start the timer. Use the ruler to keep the mitt under the water.

7 Record the temperature after 30 seconds.

8 Subtract to find the difference in temperature.

9 Record your results on *Temperature Changes* in the Engineering Notebook.

Educator Guide

Engineering Adventure 4: Ready for Impact: Protecting Against Impact

Educator Preview

Adventure Snapshot

Learners test how well different materials protect against impact hazards.

Timing | 50 minutes

Get Ready & Team Up	5 min.
Which Material Is Best?	35 min.
Reflect & Wrap Up	10 min.
Total	**50 min.**

Level Up Activities 5 min. each

Prep Snapshot*

Prep Time 40 min.

- Set up materials stations.
- Print handouts.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving.
- Investigate properties and uses of materials.

Guiding Question

Which materials are good at protecting against damage from heavy moving objects?

Learners Will Do

Test how materials protect against impacts and consider which to use in a space glove.

Learners Will Know

Engineers must learn how different materials work for different uses.

Connecting Across Adventures

Adventure 3: Protecting Against Cold	Adventure 4: Protecting Against Impact	Adventure 5: Protecting Against Dust
Last time, learners tested how well different materials protect against cold.	**Today**, learners test how well different materials protect against impact. Later, they'll use collected data to design space gloves.	**Next time**, learners will test how well different materials resist dust.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/7e4eaf79

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
- 1 glove, vinyl, large
- 2 aluminum trays
- 2 deli containers, round, with lids, 16 oz.
- 2 rulers
- 2 skewers, wooden
- 2 boxes of spaghetti
- 200 metal washers, 1.25"

For the Materials Table

- 1 piece of cheesecloth, 8.5" × 11"
- 1 sheet of craft foam, 8.5" × 11"
- 1 sheet of felt, 8.5" × 11"
- 1 sheet of foil, 8.5" × 11"
- 1 sheet of transparency
- 2 sponges
- 4 rolls of masking tape
- 20 straws
- 30 cotton balls

For each pair of learners

- 1 pair of scissors
- 1 vinyl glove
- Engineering Adventure 4 Impact Test Procedure Handout, pg. 62

For each learner

- Engineering Notebook (PDF)

Adventure 4 Materials Preparation (40 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.
2. Make 1 copy of Engineering Adventure 4 Impact Test Procedure Handout, pg. 62, for each pair of learners.

In Your Space

3. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
4. See Impact Test Setup Instructions, pg. 61.
5. Set up a Materials Table. See list above.
6. Place 1 piece of pasta in each finger of a vinyl glove for demonstrating.

Teaching Tip

In this adventure, learners attach materials to a vinyl glove to develop construction skills and think about wearable designs. Be sure sponges are dry so tape will stick to them.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We measured how well different materials protected against cold.)* Draw learners' attention to their work on the *Our Ideas* poster about protection against cold.
2. Say: **Today you will continue the Ask phase of our engineering design process. You will explore how well glove materials protect against damage from heavy moving objects.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **Which materials are good at protecting against damage from heavy moving objects?**
3. Organize learners into pairs and distribute Engineering Notebooks.

Support Learner Differences

- If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).
- If you have learners who speak multiple languages, encourage them to share the words for something hitting something else in their preferred languages. If you can, provide an example from a language you know. Take time to learn learners' words and use them throughout the adventures.
- Encourage learners to identify their own strengths and the roles they would like to play during testing, and form pairs that can play a variety of roles. For example, one learner can specialize in attaching materials to the glove and another learner can pick up and count the pieces of pasta.

Support Thinking

To give learners more context about this hazard, show the video Micro-Impacts and Low Gravity. Read the Educator Science Background (weblink) for more information.

Which Material Is Best? (35 min.)

4. Gather learners at a Testing Station. Show the demonstration glove. Say: **The weight represents a heavy moving object, the pasta pieces represent the bones in a hand, and the skewer represents a tool the hand is holding.**
5. Give each pair a copy of Engineering Adventure 4 Impact Test Procedure Handout, pg. 62. Demonstrate the test procedure and record the result in the "None" row on the *Our Ideas* poster. As needed, allow learners to feel the test setup.
6. Point out the Materials Table. Tell learners they will test one material three times and record results on *Impact Protection*, pg. 16 in their Engineering Notebooks. They will write the highest result in the "Final" column.

Support Thinking

If learners would benefit from an additional visual of the testing procedure, play How to Design and Test Space Gloves (1:00–1:33).

7. Assign each pair a different material than the one they tested in Adventure 3. Let pairs get materials and start working.
8. Say: ***Impact* is a word that means damage from heavy moving objects.** Write *impact* on the *Our Ideas* poster, along with translations into learners' preferred languages and relevant images. Have pairs record results on *Impact Protection* and in the "Impact" column on the *Our Ideas* poster. They should write whether the material was "not good," "good," or "great" at protecting against impact.

Reflect & Wrap Up (10 min.)

9. Revisit the Guiding Question on the *Our Ideas* poster: Ask: **Which materials are good at protecting against damage from heavy moving objects (impact)?** *(Thick, cushiony materials like cheesecloth, cotton balls, sponges, and foam are good.)* **Why?** Ask: **Which materials were not good? Why?** *(Thin, flexible materials like foil did not protect against impact.)*
10. Tell learners that next time, they'll explore dust as a hazard.

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for use in Adventure 5.
   - Dispose of broken pasta and other materials that cannot be reused.
   - Save the Impact Testing Stations and materials for Adventures 6 and 7.
2. Plan for Engineering Adventure 5. See Engineering Adventure 5 Preparation on pg. 67. Note that you will need to prepare two Dust Testing Stations. Setup will likely take at least 30 minutes.
3. Take time to reflect on the following educator prompt. **What strategies did you use to help learners understand what the model hand represented?**

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials. Give learners time to examine the materials before they begin testing.

Support Thinking

To help learners visualize which materials are better at protecting against impact, have them post a sample of each material on a wall in a spectrum from "not good" at one end to "great" at the other. Consider photographing this spectrum and printing copies for learners to reference later.

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Ask phase. We asked which materials are best at protecting against impact.)* (5 min.)
- If you can, show the video clip NASA has big 'guns' to study micrometeorite & space debris impacts - See test fires (2:33–2:53) to help learners understand how NASA tests materials to protect against impacts. (5 min.)
- Ask this story prompt: **Can you tell me a story about something creative you did to protect yourself from getting hurt?** Tell learners, if anyone asks what they did today, they can say "We tested which materials protected model bones made of spaghetti from falling weights" and ask the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Impact Test Setup Instructions

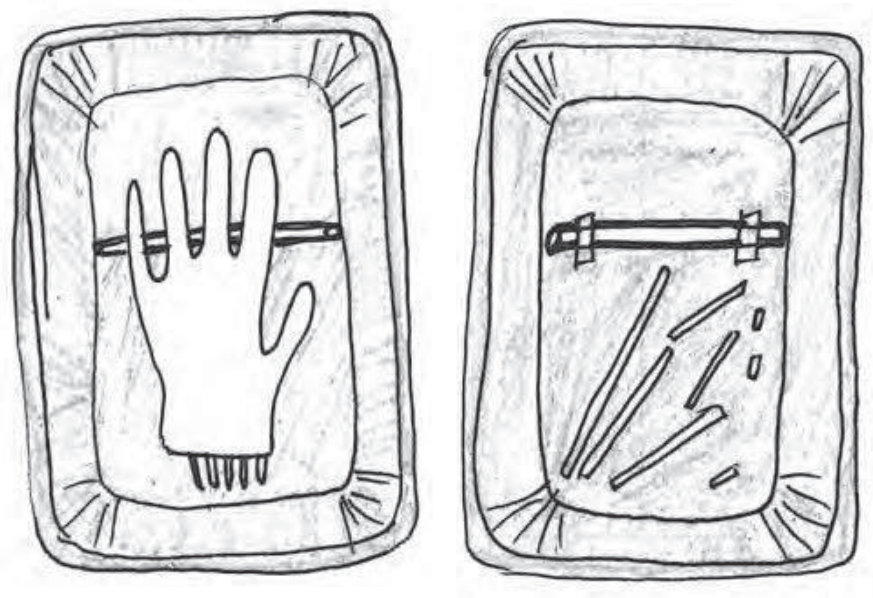
Set up two testing stations for learners to test how well their gloves protect against impact.

Materials for each setup:

- 1 box of spaghetti
- 1 aluminum tray
- 1 deli container, round, with lid, 16 oz.
- 1 ruler
- 1 skewer, wooden
- 100 metal washers, 1 1/4"

Prepare Testing Stations

1. Fill each deli container with 100 washers.
2. Seal the lids of the containers with masking tape.
3. Tape a skewer to the bottom of each tray.



4. Place a box of spaghetti and a ruler at each Testing Station.

Impact Test Procedure

1. Cut your material in half.
   Tape 1 half to 1 side of your glove.
   Do not tape material to the other side.

2. Flip the glove over.
   Put 1 piece of pasta in each glove finger.
   Snap off extra pasta that is sticking out.

3 Place your glove in the tray. Make sure the fingers are on the wooden skewer.

4 Lift the weight 1 foot above the center of your glove.

5 Drop the weight.

6 Carefully empty the pasta out of the glove and count the number of pieces.

7 Record results.

8 Repeat 2 more times for a total of 3 tests.

9 Record the highest number in the "Final" column.
How well did your glove protect against the impact?

Educator Guide

Engineering Adventure 5: Dangerous Dust: Protecting Against Dust

Educator Preview

Adventure Snapshot

Learners test how dust resistant materials are.

Timing | 60 minutes

Get Ready & Team Up	5 min.
Which Material Is Best?	45 min.
Reflect & Wrap Up	10 min.
Total	**60 min.**

Level Up Activities 5–45 min. each

Prep Snapshot*

Prep Time 40 min.

- Set up materials stations.
- Print handouts.
- Prepare ice for Adventure 6, as noted in Materials & Preparation.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving.
- Investigate properties and uses of materials.

Guiding Question

Which materials are good at protecting against dust?

Learners Will Do

Test how materials protect against dust and consider which to use in a space glove.

Learners Will Know

Engineers must learn how different materials work for different uses.

Connecting Across Adventures

Adventure 4: Protecting Against Impact	Adventure 5: Protecting Against Dust	Adventure 6: Creating a Space Glove
Last time, learners tested how well different materials protect against impact.	**Today**, learners test how well different materials resist dust. Later, they'll use collected data to design space gloves.	**Next time**, learners will plan, create, and test gloves to protect against space hazards.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/71ed50aa

Materials and Preparation

Materials

For the whole group

- 1 container of UV glow powder
- 1 roll of paper towels
- 1 tablespoon measure
- 2 aluminum trays, 12" × 10"
- 2 black lights, handheld
- 2 craft sticks
- 2 cups of gravel
- 2 hand lenses
- 6 cups of sand
- 8 resealable plastic bags, quart size
- 10 washers, 1.25"

For each pair of learners

- 1 pair of scissors
- 1 vinyl glove
- Engineering Adventure 5 Dust Test Procedure Handout, pg. 72

For each learner

- Engineering Notebook (PDF)

Support Learner Differences

Glow powder makes dust that gets on the gloves visible, so learners can collect data visually. To provide data that is not visual, use an indicator detectable by smell, such as a powdered spice, alongside or instead of glow powder. After testing, learners can measure the amount of dust on the glove by the intensity of the scent. Demonstrate wafting the scent to avoid inhaling powder.

For the Materials Table

- 2 pieces of cheesecloth, 8.5" × 11"
- 2 sheets of craft foam, 8.5" × 11"
- 2 sheets of felt, 8.5" × 11"
- 2 sheets of foil, 8.5" × 11"
- 2 sheets of transparency, 8.5" × 11"
- 4 rolls of masking tape
- 4 sponges
- 40 straws
- 60 cotton balls

Adventure 5 Materials Preparation (40 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.
2. Make 1 copy of Engineering Adventure 5 Dust Test Procedure Handout, pg. 72, for each pair of learners.

In Your Space

3. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally. Title the last column for test results "Dust."
4. See Dust Test Setup Instructions, pg. 71.
5. Set up a Materials Table. See list above.

Support Learner Differences

Get ready to adjust the activity or materials for any learner whose physical abilities make it difficult to use gloves. Ask learners in advance what they need to complete the activity. They are the experts at knowing their physical capabilities. You can have alternative tools like tongs or scoops available, but don't assume they cannot do the activity as written.

Teaching Tips

- In this adventure, learners attach materials to a vinyl glove to develop construction skills and think about wearable designs. Be sure sponges are dry so tape will stick to them.
- Save the materials and Testing Stations for Adventures 6 and 7.

Ice Preparation for Other Adventures

6. Be aware that you will need 12 cups of ice for Adventures 6 and 7.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We measured how well glove materials protected spaghetti against a falling weight.)* Draw learners' attention to their work on the *Our Ideas* poster about impact.
2. Say: **Today you will explore how different glove materials do or do not pick up dust.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **Which materials are good at protecting against dust?** Say: **This is the last hazard you will explore before you start designing your space gloves.**
3. Ask: **Which phase of our engineering design process do you think we are in right now?** *(The Ask phase.)* Say: **Once you are finished testing materials, you will move to the Imagine, Plan, and Create phases as you design space gloves.**
4. Organize learners into pairs and distribute Engineering Notebooks.

Which Material Is Best? (45 min.)

5. Gather learners at the Testing Station. Turn on the black light and pass it over the trays. Say: **The glowing powder represents dangerous dust.**

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Support Thinking

To give learners more context about this hazard, show the video Dangerous Dust (1:08). Read the Educator Science Background (weblink) for more information.

Support Learner Differences

- If you have learners who speak multiple languages, encourage them to share the word for *dust* in their preferred language. If you can, provide an example from a language you know. Note that different languages and cultures may have different concepts of dust. Take time to learn learners' words and use them throughout the adventures.
- Encourage learners to identify their own strengths and the roles they would like to play during testing, and form pairs that can play a variety of roles. For example, one learner can specialize in attaching materials to the glove, and another learner can count the areas with dust.

Teaching Tip

Make sure learners do not look directly into the black light at any time.

6. Give each pair a copy of Engineering Adventure 5 Dust Test Procedure Handout, pg. 72. Demonstrate the test procedure with a plain, uncovered glove and record the result in the "None" row on the *Our Ideas* poster. As needed, allow learners to carefully feel the test setup.
7. Explain that each pair will use one material to design both sides of the glove. They will record their results on *Dust Protection*, pg. 17 in their Engineering Notebooks, and in the "Dust" column on the *Our Ideas* poster.
8. Give each pair a glove and a material. (If necessary, assign some pairs two types of materials so all materials are tested.) Let learners collect materials and start working. Remind them that their fingers must be able to move in the glove.
9. Have each pair record results on *Dust Protection* and on the *Our Ideas* poster by writing "not good," "good," or "great."

Support Learner Differences

If learners cannot see the powder under the black light, turn off overhead lights. Add 1/2 tablespoon of glow powder between tests.

To support learners who would benefit from smelling the powder, replace with scented spices as necessary, but be careful of very strong or aggravating scents. If using this option, demonstrate wafting the scent to avoid anyone inhaling powder. Score using scent as follows:

- **Not Good**: Intense smell in any zone, smell in 4 areas
- **Good**: Moderate smell in any zone, smell in 2–3 areas
- **Great**: Faint or no smell in any zone, smell in 0–1 areas

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials. Give learners time to examine the materials before they begin testing.

Support Thinking

- If learners would benefit from an additional visual of the testing procedure, play How to Design and Test Space Gloves (1:33–2:11).
- To help learners visualize which materials are better at protecting against dust, have them post a sample of each material on a wall in a spectrum from "not good" at one end to "great" at the other. Consider photographing this spectrum and printing copies for learners to reference later.

Reflect & Wrap Up (10 min.)

10. Gather at the *Our Ideas* poster. Ask: **Which materials picked up a lot of dust? Why?** *(Porous or fuzzy materials caught a lot of dust in their creases and fibers.)* Revisit the Guiding Question: **Which materials are good at protecting against dust? Why?** *(Smooth materials let dust shake off easily.)*

11. Say: **Next time, you will design a space glove to protect astronauts on a mission.**

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 6.
   - Save any leftover materials and Testing Stations for use in Adventures 6 and 7.
2. Plan for Engineering Adventure 6. See Engineering Adventure 6 Preparation on pg. 77. Note that you will need to prepare two Final Testing Stations, in addition to the Cold, Impact, and Dust Testing Stations you have prepared already. You will need another 12 cups of ice for the Cold Testing Stations. Setup is likely to take at least 30 minutes.
3. Take time to reflect on the following educator prompt. **How did you support learners to make connections between this adventure and their lives?**

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Ask phase. We asked which materials are best at protecting against dust.)* **What other technologies protect objects from dust?** *(Instrument cases, laptop/tablet cases, dust jackets, vacuums.)* (5 min.)
- If you can, show the video clip Lunar Dust Is Difficult (1:00) to help learners understand the hazards of dust on the surface of the Moon. (5 min.)
- Dust is a very big problem for astronauts and rovers exploring other planets. Here's an article from NASA about some of the hazards and mitigation strategies that astronauts are considering for exploration of the Moon: "Dust: An Out-of-This World Problem." (5 min.)
- Invite a family or community member to come in as a special guest and share their knowledge about hazard-related topics. (45 min.)
- Ask this story prompt: **Can you tell me a story about something creative you did to keep yourself or your clothes from getting dirty?** Tell learners, if anyone asks what they did today, they can tell them "We tested how well materials protect against dust," and then ask them the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Dust Test Setup Instructions

Set up two testing stations for learners to test how well their gloves protect against dust.

Materials for each setup:

- 1 container of UV glow powder
- 1 roll of paper towels
- 1 tablespoon measure
- 1 aluminum tray, 12" × 10"
- 1 black light, handheld
- 1 craft stick
- 1 cup of gravel
- 1 hand lens
- 3 cups of sand
- 4 resealable plastic bags, quart size
- 5 washers, 1 1/4"

Prepare Testing Stations

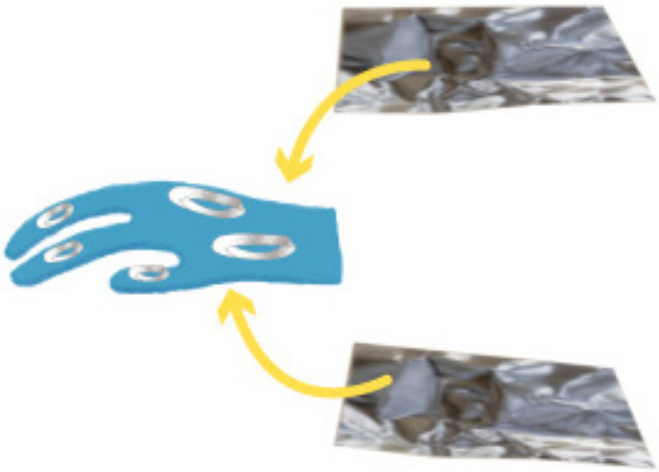
1. For each Testing Station, combine 1 cup of gravel, 3 cups of sand, and 1 tbsp. of glow powder in a 12" × 10" tray.
2. Mix thoroughly using a craft stick.
3. Bury 5 washers in each tray.
4. Place a black light, craft stick, 4 resealable plastic bags, and paper towels by each tray.

Dust Test setup

Dust Test Procedure

1. Cut your material.

2. Use loops of masking tape to attach 1 layer of the material to *both* sides of the glove.



3 Open the plastic bag.

4 Use your gloves to dig in the dust and find the 5 metal washers.

5 Use your glove to place the 5 metal washers in the plastic bag.

6 Use a paper towel to wipe extra dust off your glove.

7 Look at the palm of your glove with the hand lens and black light to find places that glow.

8 Record the number of areas with glowing dust in your Engineering Notebook.

Reset

1. Bury the 5 metal washers back in the sand.
2. Mix the sand using the craft stick.

Engineering Adventure 6: Put It Together: Creating a Space Glove

Educator Preview

Adventure Snapshot

Learners plan and create model space gloves and test them to see how well they protect against space hazards.

Timing | 55 minutes

Get Ready & Team Up	5 min.
Plan & Create	45 min.
Reflect & Wrap Up	5 min.
Total	**55 min.**

Level Up Activities 5–15 min. each

Prep Snapshot*

Prep Time 45 min.

- Set up materials stations.
- Print handouts.
- Prepare ice for Adventure 7, as noted in Materials & Preparation.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Creativity

Habits of Mind

- Consider problems in context.
- Consider tradeoffs between criteria and constraints.

Guiding Question

How can we design space gloves that protect astronauts from space hazards on the Moon, Mars, or asteroids?

Learners Will Do

Plan, create, and test space gloves that meet mission criteria.

Learners Will Know

Engineers choose materials for designs based on what they need the design to do.

Connecting Across Adventures

Adventure 5: Protecting Against Dust	Adventure 6: Creating a Space Glove	Adventure 7: Improving a Space Glove
Last time, learners tested how well different materials resist dust.	**Today**, learners plan, create, and test gloves to protect against space hazards.	**Next time**, learners will improve their gloves and test them again.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/f9ad3ecc

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
- 2 calculators
- 2 Cold Testing Stations from Adventure 3
- 2 Impact Testing Stations from Adventure 4
- 2 Dust Testing Stations from Adventure 5
- 2 jars with lids
- 2 pieces of paper, 2" × 3"
- 2 resealable plastic bags, gallon size
- 1 box food-safe gloves (optional)

For each group of 4

- 2 pairs of scissors
- 2 vinyl gloves
- Engineering Adventure 6 Mission Profiles Handout, pg. 84

For each learner

- Engineering Notebook (PDF)

Support Learner Differences

Mechanical calculators are used to test the ability of the gloves to push buttons. However, your learners may benefit from using adaptive calculators instead.

Teaching Tip

If time is short or learners would benefit from a starting point, you can create simple prototype gloves for learners to modify.

For the Materials Table

- 4 rolls of masking tape
- 20 sheets of craft foam
- 20 sheets of felt
- 20 sheets of foil, 8.5" × 11"
- 20 sheets of transparency
- 20 sponges
- 40 pieces of cheesecloth, 8.5" × 11"
- 150 cotton balls
- 150 straws

Adventure 6 Materials Preparation (45 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.
2. Watch the video How to Design and Test Space Gloves (3:00).
3. Make 1 copy of Engineering Adventure 6 Mission Profiles Handout, pg. 84, for each group of 4.
4. Make a plan to store gloves-in-progress between adventures. For example, you may want to have sturdy boxes to store the gloves so they are not damaged.

In Your Space

5. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
6. See Mission Test Setup Instructions, pg. 81.
7. Set up a Materials Table. See list above.

Ice Preparation for Other Adventures

8. Be aware that you will need 12 cups of ice for Adventure 7.

Teaching Tips

- If you have space, you can leave the Testing Stations set up exactly as they are at the end of this adventure. They will be reused in Adventure 7.
- Be sure sponges are dry so tape will stick to them. Save the Testing Stations and model space gloves for Adventure 7.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last three activities, what did you do and why?** *(We measured how well different materials protected a glove from cold, impact, and dust.)*
2. Revisit the *Engineering Comic* with learners, focusing on how space gloves need to protect against multiple hazards.
3. Say: **Today you will work on the Imagine, Plan, Create, and Test phases of our engineering design process. You will use everything you learned to design a space glove for a mission.** Point out the Guiding Question at the top of the *Our Ideas* poster and share it aloud: **How can we design space gloves that protect astronauts from space hazards on the Moon, Mars, or asteroids?**
4. Organize learners into groups of 4 and distribute Engineering Notebooks.

Plan and Create (45 min.)

5. Review the Testing Results chart on the *Our Ideas* poster. Ask: **What do you notice?** *(Accept all answers. For example, some materials protect against impact but not dust.)* Say: **You can refer to this chart as you work.**
6. Give each group a copy of Engineering Adventure 6 Mission Profiles Handout, pg. 84. Have them read each description and choose a mission.
7. Say: **Each group will be designing two gloves. For each glove, you can use up to 3 materials, scissors, and up to 3 feet of tape.**
8. Show learners the Testing Stations: cold, impact, dust, and a final test. Review each test. As needed, allow learners to feel the test setups.
9. Give learners a few minutes to discuss and fill out *Plan*, pg. 18 in their Engineering Notebooks.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Teaching Tip

It's important to keep the same groups for Engineering Adventures 6, 7, and 8. That way, the same learners are working together on the same gloves each time.

Support Learner Differences

Encourage learners to identify their own strengths and the roles they would like to play during testing, and form groups that can play a variety of roles. For example, at the Final Test Station, a learner who is good at reading can read the equation, and a learner who is good with their hands can enter it into the calculator.

10. Give groups 25 minutes to collect materials and create designs.

Teaching Tip

If time is running short, you can pause the adventure here and test the gloves in another session. You can also have learners perform one test rather than two for each glove.

Support Thinking

- Allow learners to try modifying materials before adding them to the gloves. For example, they may get a sponge wet before attaching it.
- If learners would benefit from an additional visual of the testing procedure, play *How to Design and Test Space Gloves* (from 2:12).
- Learners may say that they have failed. Emphasize that engineers think about designs failing, not about people failing. To help learners persist and learn from failure, treat ineffective designs as an opportunity to gather data and make improvements. Ask: **What did you find out from that test? How will you use it to plan the next design of your gloves?**
- Have learners think about local traditions of making gloves and other clothing items to protect against hazards. Ask: **What materials do you know of that people use to make gloves? Why are these materials useful?**

11. As groups finish, have them test their gloves and record the results on *Test Results*, pg. 20 in their Engineering Notebooks.

Reflect & Wrap Up (5 min.)

12. Revisit the Guiding Question: **How can we design space gloves that protect astronauts from space hazards on the Moon, Mars, or asteroids?** Ask: **Which materials did you use? Why? What happened when you tested? How can you improve your glove?** Allow learners to record ideas on the *Our Ideas* poster.
13. Say: **Next time, you will improve your gloves and retest them.**

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 7.
   - Save the gloves and Testing Stations for Adventure 7.
2. Plan for Engineering Adventure 7. See Engineering Adventure 7 Preparation on pg. 94. Note that you will need another 12 cups of ice for the Cold Testing Station. This setup will likely take at least 30 minutes.
3. Take time to reflect on the following educator prompt. **How did you help learners embrace and learn from failure during this adventure?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(Responses will vary. Possible responses include the Imagine, Plan, and Create phases.)* (5 min.)
- If you can, show the NASA video clip Spacesuits for the Next Explorers (Full feature) (12:03) to help learners understand that different space missions require different spacesuits. (15 min.)
- NASA often tests components and technology before deciding to use it in a full mission. This is called a "technology demonstration," often shortened to "tech demonstration," and helps NASA learn about what can and can't work in different types of environments. The Mars 2020 helicopter named "Ingenuity" was one such Tech Demonstration, testing whether it was possible to fly a helicopter in the thin atmosphere of Mars. Turns out it's possible; learn more in the article "Ingenuity Passes the Test - NASA" (10 min.)
- Ask one of these story prompts: (1) **Can you tell me a story about building something to solve several problems at the same time?** (2) **Can you tell me a story you know about something in the night sky?** (If you are working with Indigenous learners, be aware that it may not be an appropriate time of year to tell star stories. If you are unsure, use the first story prompt.) Tell learners, if anyone asks what they did today, they can tell them "We designed an astronaut glove!", and then ask them the above story prompts. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

Mission Test Setup Instructions

Set up testing stations for learners to test how well their gloves protect against cold, impact, and dust, as well as how easy they are to use and how durable they are.

Mission Profile Images

1. Make color copies of Engineering Adventure 6 Mission Profiles Handout, pg. 84, for each group.

Cold Test Stations

2. Trim the model hands so they fit inside the palm area of a vinyl glove.
3. Use Cold Test Setup Instructions, pg.50, to set up two Cold Testing Stations.
4. Place Engineering Adventure 3 Cold Test Procedure Handout, pg.53, on the table.

Impact Test Stations

5. Use Impact Test Setup Instructions, pg. 61, to set up two Impact Testing Stations.
6. Place Engineering Adventure 4 Impact Test Procedure Handout, pg. 62 on the table.

Dust Test Stations

7. Use Dust Test Setup Instructions, pg. 71 to set up two Dust Testing Stations.
8. Place Engineering Adventure 5 Dust Test Procedure Handout, pg. 72, on the table.

Final Test Stations

Materials for each setup:

- 1 calculator
- 1 piece of paper, 2" × 3"
- 1 plastic jar with lid

Prepare Test Stations

9. Prepare two Test Stations for groups to share.
   - Write simple equations on 2 slips of paper and put them in 2 jars. Tighten the lids.
   - Set out 2 calculators.
10. Place Final Test Procedure Handout, pg. 83, on the table.

Final Test Procedure

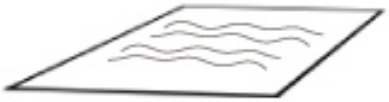
1

Part 1

How Easy Is It to Use Your Glove?

1. Put on your glove.
2. Unscrew the jar and remove the paper.
3. Use your glove to type the equation on the paper into the calculator.
4. Put the equation back in the jar and tighten the lid.
5. Were you able to get the answer?

Record your results in your Engineering Notebook.



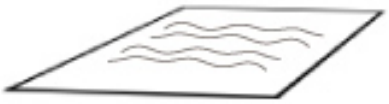
2

Part 2

How Strong is Your Glove?

1. Take your glove off.
2. Take a close look at your glove. Did it stay together? Did it get damaged in any way?

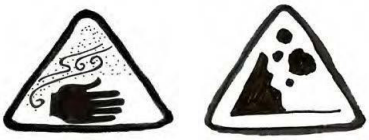
Record your results in your Engineering Notebook.

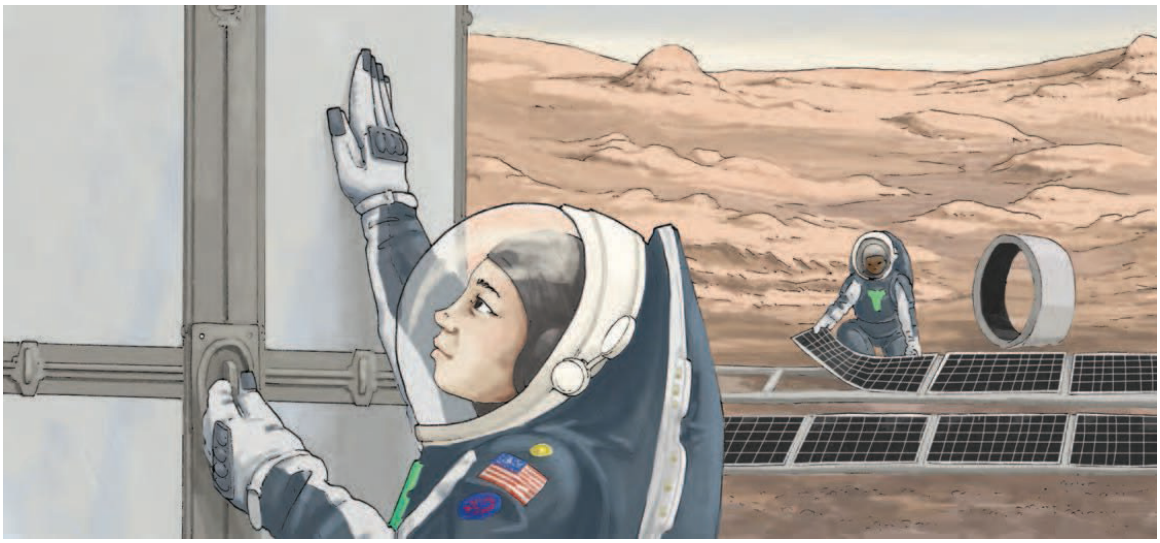


Mission Profiles

Mars

Build a habitat on the planet Mars.





Your model space glove should

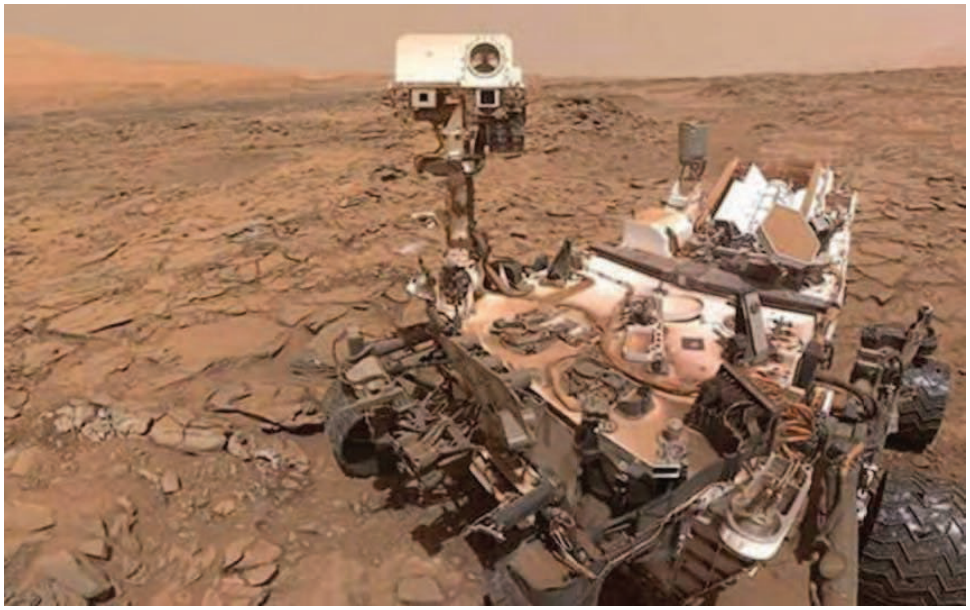
- protect from both **dust** and **impact** hazards.
- allow you to open a jar and type on a calculator.
- be removable.

Your model space glove cannot

- use more than 3 materials.
- use more than 3 feet of tape.
- have any materials or parts fall off after testing.

Did You Know?

Mars is the fourth planet from the Sun. There is so much rust in the rocks that Mars is nicknamed the "Red Planet." No humans have visited Mars.



Curiosity rover exploring Mars.

Photo courtesy of NASA.

The rocky surface of Mars, from the Mars Pathfinder lander.

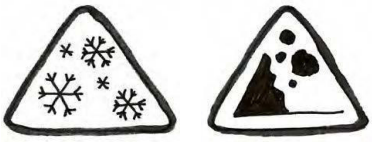
Photo courtesy of NASA.

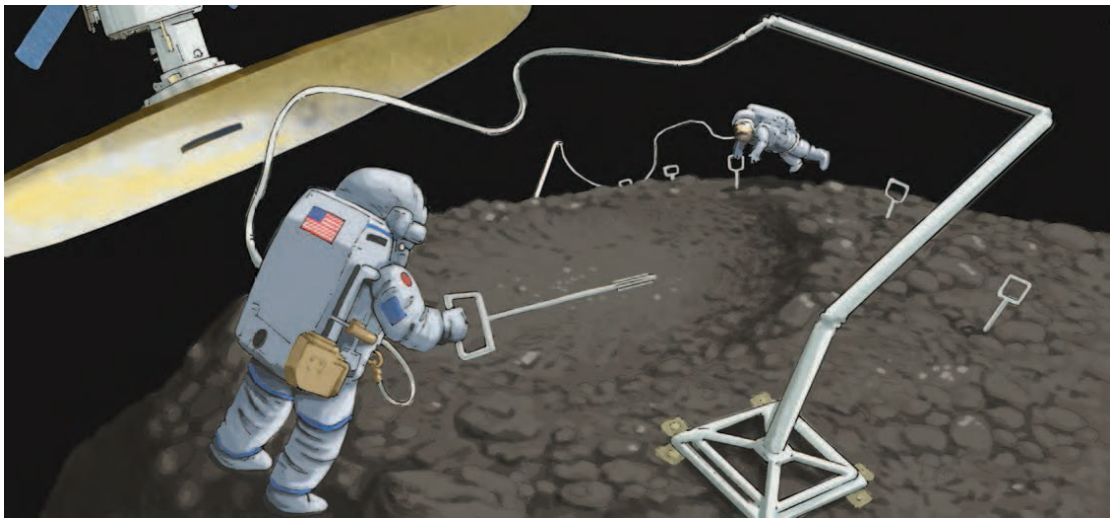
An idea for the type of suit astronauts would use on Mars.

Photo courtesy of NASA.

Asteroids

Mine asteroids for their minerals.





Your model space glove should

- protect from both **cold** and **impact** hazards.
- allow you to open a jar and type on a calculator.
- be removable.

Your model space glove cannot

- use more than 3 materials.
- use more than 3 feet of tape.
- have any materials or parts fall off after testing.

Did You Know?

Asteroids are small, rocky objects that are sometimes called "minor planets." Most asteroids in our solar system are found in the Asteroid Belt between Mars and Jupiter. No humans have visited asteroids.

Some asteroids are made of materials that have been around since the solar system formed 4.5 billion years ago.

A spacecraft collecting a sample from a near-Earth asteroid.

Photo courtesy of NASA.

Minerals on the asteroid Vesta are represented using different colors.

Photo courtesy of NASA.

An astronaut testing equipment in space.

Photo courtesy of NASA.

Moon

Build a radio tower on the far side of Earth's moon.

Your model space glove should

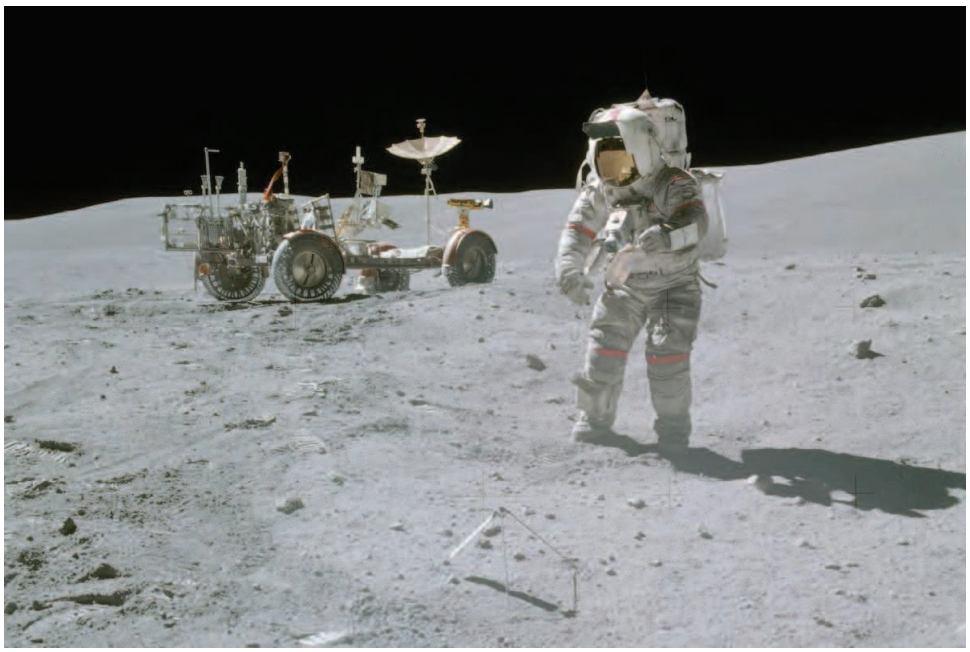
- protect from both **cold** and **dust** hazards.
- allow you to open a jar and type on a calculator.
- be removable.

Your model space glove cannot

- use more than 3 materials.
- use more than 3 feet of tape.
- have any materials or parts fall off after testing.

Did You Know?

We always see the same side of the Moon from Earth. This is called the "near side." Sometimes the far side is called the "dark side," but it actually gets the same amount of sunlight as the near side!



An astronaut on the Moon.

Photo courtesy of NASA.

Moondust can cause a lot of damage to suits and equipment.

Photo courtesy of NASA.

The night side of the Moon is much colder than the day side.

Photo courtesy of NASA.

Engineering Adventure 7: The Final Test: Improving a Space Glove

Educator Preview

Adventure Snapshot

Learners improve their space gloves and test them in a final test.

Timing | 50 minutes

Get Ready & Team Up	5 min.
Improve	40 min.
Reflect & Wrap Up	5 min.
Total	**50 min.**

Level Up Activities 5-15 min. each

Prep Snapshot*

Prep Time 30 min.

- Set up materials stations.
- Invite people to Share-Out.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Creativity

Habits of Mind

- Make evidence-based decisions.
- Persist and learn from failure.

Guiding Question

How can we make our space gloves stronger, easier to use, or more protective?

Learners Will Do

Use test results to redesign space gloves so they are more effective.

Learners Will Know

Engineers think about, change, and improve their designs.

Connecting Across Adventures

Adventure 6: Creating a Space Glove	Adventure 7: Improving a Space Glove	Adventure 8: Preparing for the Engineering Share-Out
Last time, learners planned, created, and tested gloves to protect against space hazards.	**Today**, learners improve their space gloves and test them again.	**Next time**, learners will prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/cb66655d

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
- chart paper and markers
- Testing Stations from Adventure 6
1. Mission Test Setup Instructions, pg. 81
- Engineering Adventure 6 Mission Profiles Handout, pg. 84

For the Materials Table

- leftover materials from Adventure 6

For each group of 4

- model space glove designs from Adventure 6
- 2 pairs of scissors

For each learner

- Engineering Notebook (PDF)

Adventure 7 Materials Preparation (30 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.

In Your Space

2. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.
3. See Mission Test Setup Instructions, pg. 81.
4. Set up a Materials Table. See list above.

Teaching Tip

Save the space gloves for the Engineering Share-Out. Invite staff, family, and community members to attend.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We planned and created gloves, then tested how well they protected against cold, impact, and dust. We also tested how easy they were to use and how strong they were.)* Draw learners' attention to their work on the *Our Ideas* poster about test results.

2. Say: **Today you will work on the Improve cycle of our engineering design process by improving your model gloves.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **How can we make our space gloves stronger, easier to use, or more protective?**

3. Organize learners into their groups of 4 and distribute Engineering Notebooks.

Improve (40 min.)

4. Have groups revisit *Test Results*, pg. 20 in their Engineering Notebooks. Ask: **How can you improve your design?** Have groups record ideas on *Improved Plan*, pg. 22 in their Engineering Notebooks.

5. Have groups improve their model space gloves. If gloves were damaged during testing, learners must repair them or create new ones.

6. When each group is ready, have them test. Have them record results on *Test Results: Improve*, pg. 23 in their Engineering Notebooks.

7. After all groups of learners have tested, collect the gloves and store them.

Reflect & Wrap Up (5 min.)

8. Revisit the Guiding Question on the *Our Ideas* poster: **How can we make our space gloves stronger, easier to use, or more protective?** Ask: **What parts of your design are you improving? How are the materials working together? How do you think your improved glove will protect against hazards?**

9. Say: **Next time, you will prepare to share what you learned about materials, space hazards, and their engineering design process.** Hand out copies of Engineering Adventure 7 Share-Out Invitatiion, pg. 97, for learners to give to caregivers, family, and friends.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Support Learner Differences

If you have learners who speak multiple languages, encourage them to share in their preferred languages.

Teaching Tip

Learners may want to use their first gloves and improved gloves in the Showcase. Encourage each group to save both designs.

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for use in Adventure 8.
   - Keep gloves for Adventure 8.
   - Dispose of materials that cannot be reused. Save materials for learners to repair damage to their gloves.
2. Plan for Engineering Adventure 8. See Engineering Adventure 8 Preparation on pg. 100.
3. Take time to reflect on the following educator prompt. **How did you support constructive group work during this adventure?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Improve cycle. We improved our space gloves by creating and testing new plans.)* (5 min.)
- If you can, show and then discuss the NASA video clip Spacesuits for the Next Explorers (Full feature) (12:00), which discusses improvements needed to spacesuits for exploring planets. (15 min.)
- NASA is constantly modifying and improving equipment, sometimes even after it's been launched! Check out this article about how astronauts fixed and improved the Hubble Space Telescope while it was orbiting Earth: "Missions to Hubble - NASA Science" (5 min.)
- Ask these story prompts: **Can you tell me a story about something you built that didn't work as well as you wanted it to? What did you do to improve it?** Tell learners, if anyone asks what they did today, they can tell them "We tested and improved our astronaut glove," and then ask them the above story prompts. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

Engineering Share-Out Invitation

You're invited to the Engineering Share-Out

Come see your young engineer showcase their space glove design!

Date: _____

Time: _____

Location: _____

Grantee

Engineering Adventure 8: Spread the Word: Preparing for the Engineering Share-Out

Educator Preview

Adventure Snapshot

Learners prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.

Timing | 45 minutes

Get Ready & Team Up	10 min.
Preparing the Presentation	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 5–25 min. each

Prep Snapshot*

Prep Time 20 min.

- Invite people to Share-Out.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Collaboration
- Communication

Habits of Mind

- Make evidence-based decisions.

Guiding Question

What design recommendations do we have for space gloves?

Learners Will Do

Plan how to discuss what they have learned with members of their community.

Learners Will Know

Engineers have valuable knowledge to share about the problem they have solved.

Connecting Across Activities

Adventure 7 Improving a Space Glove	Adventure 8: Preparing for the Engineering Share-Out	Adventure 9: Engineering Share-Out
Last time, learners improved their space gloves and tested them again.	**Today**, learners prepare to communicate their ideas about designing space gloves in the Engineering Share-Out.	**Next time**, learners will communicate their ideas about designing space gloves in the Engineering Share-Out.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/70ade2d1

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
- materials to repair damage to gloves
- materials to make and display signs, posters, pictures, and so forth, to go with the presentations (optional)

For each group of 4

- final gloves from Adventure 7
- previous gloves from Adventure 6 (optional)
- 20 fuzzy sticks (optional)

For each learner

- Engineering Notebook (PDF)

Adventure 8 Materials Preparation (20 min.)

Ahead of Time

1. Invite people from the community, including families and friends of learners, to the Engineering Share-Out.

In Your Space

2. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.

Teaching Tip

The Engineering Share-Out is a chance for learners to share with staff, families, and friends! Encourage learners to invite guests. This will help them take ownership of their designs. Consider setting up Testing Stations if learners want to share the tests.

Example Glove Display

Adventure Guide

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We improved our gloves using results from previous tests, then tested them again.)*
2. Say: **You'll be sharing your space gloves, and the story of how you used an engineering design process to make them, with others.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **What design recommendations do we have for space gloves?** Explain that first, everyone needs to prepare for this Share-Out.
3. Have learners join up with their space glove groups from Adventures 6 and 7 and distribute Engineering Notebooks.

Preparing the Presentation (25 min.)

4. Give each group time to think about the following question: **What ideas do you think we should share?** *(Why space gloves are important; how they protect against cold, impact, and dust; how we designed space gloves; things other people should think about when designing space gloves.)* **How should we share them?** *(By demonstrating, talking, writing, drawing, discussing with others, and making records such as videos and audio recordings.)* When everyone is ready, discuss as a whole group.

Support Learner Differences

- If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).
- If you have learners who speak multiple languages, encourage them to share in their preferred languages.

5. The Share-Out is a chance for learners to explain their thinking and reflect on what they learned about space gloves and hazards throughout the unit. As a group, agree upon a structure for the Share-Out. Possible structures include the following:
   - **Gallery Walk** where each group stands at their station and explains how well their space gloves would work on Mars, Asteroids, or the Moon, while other groups rotate through. Groups may include posters, graphs, writing, drawings, audio or videos on small devices in their presentations.
   - **Screening** of whole-group video, slide show, audio files, or other media about learners' work.
   - **Performance** where learners play scientists who ask questions to find out which gloves are best for their mission to Mars, Asteroids, or the Moon. Or learners can develop script cards so adults can play the scientists.
   - **Discussion** in which learners, family, and community members share their knowledge.

6. Once learners have chosen a structure for the Share-Out, tell them they can prepare notes on *Communicate*, pg. 24, Engineering Notebook. Say: **Think about the languages spoken by your family and friends, and possible guests. Try to include those languages if you can.** Give groups time to fix any damage to their gloves and make other preparations.

7. As groups are preparing, rotate among them and provide support.

Reflect (10 min.)

8. Have groups pair up and discuss the Guiding Question on the *Our Ideas* poster: **What design recommendations do we have for space gloves?**

Support Learner Differences

Some learners may disengage if the Share-Out contains too much whole-group discussion. Think about what your learners need and ensure they choose an appropriate Share-Out structure.

If you have learners who speak multiple languages, encourage them to share in their preferred languages. Circulate and ask groups: **Where can you include your preferred language or other languages you know in your share-out?** Encourage learners to make welcome signs and present in different languages spoken by the audience.

All learners should contribute to the Share-Out, but not everyone will feel comfortable presenting in the same style. Indigenous learners may feel it is inappropriate to present directly as the center of attention. Ensure nonverbal presentation methods are available, and encourage participation behind the scenes, not only presenting in front of the group.

Teaching Tip

- If some learners missed sessions or are just joining and don't have a work group, consider using the Performance approach, and have those learners participate as the scientists. Share *Test Results: Improve*, pg. 23, Engineering Notebook as background for glove performance.
- Have groups use fuzzy sticks to create a stand to display their model gloves (see pg. 101).

9. Say: **Next time, you will share your designs with an audience. Communicating with others is an important part of an engineering design process.** Have each group discuss: **Why is it important to share what we have done and learned with others?** *(So others can build on our knowledge; so they don't make the same mistakes.)*

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 9.
   - Save each group's design and presentation materials for the Engineering Share-Out.
2. Take time to reflect on the following educator prompt: **What methods did learners choose to present their designs? What did you learn from the methods they chose?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Level Up!

- Ask this story prompt: **Can you tell a story about a previous time you've presented your ideas and how you did it?** *(Possible responses include stories about sharing ideas in school, family, and community settings.)* Have learners share with a partner (note that the sharing can take forms other than speaking aloud). Consider returning to learners' ideas at the start of the next adventure. (5 min.)
- Tell learners, if anyone asks them what they did today, they can tell them "We prepared to share about the space gloves we designed." (5 min.)
- Invite family and community members to participate in the Engineering Share-Out by sharing their stories and expertise. (25 min.)

Engineering Adventure 9: Sum It Up: Engineering Share-Out

Educator Preview

Adventure Snapshot

Learners share their designs and how they used the Engineering Design Process.

Timing | 45 minutes

Get Ready & Team Up	5 min.
Engineering Share-Out	35 min.
Reflect & Wrap Up	5 min.
Total	**45 min.**

Level Up Activities 5 min. each

Prep Snapshot*

Prep Time 20 min.

- Set up Materials Table.
- Invite people to Share-Out.

*See Materials & Preparation for full info.

21st Century Skills

Connection

- Communication

Habits of Mind

- Weigh the implications of solutions.
- Communicate effectively.

Guiding Question

How can we share our space glove designs with others?

Learners Will Do

Share design recommendations for engineering space gloves.

Learners Will Know

Engineers have valuable knowledge to share about the problem they have solved.

Connecting Across Adventures

Adventure 8: Preparing for the Engineering Share-Out	Adventure 9: Engineering Share-Out	Science Pathway
Last time, learners prepared to communicate their ideas about designing space gloves in the Engineering Share-Out.	**Today**, learners communicate their ideas about designing space gloves in the Engineering Share-Out.	**Next time**, learners will experience the science of this topic in the PLANETS Space Hazards Science Pathway (optional).

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/8a607e60

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document)
  Examples | Templates
- Sharing materials prepared in Adventure 8

For each group of 4

- final gloves from Adventure 7
- previous gloves from Adventure 6 (optional)

For each learner

- Engineering Notebook (PDF)

Adventure 9 Materials Preparation (20 min.)

Ahead of Time

1. Invite people from the community, including families and friends of learners, to the Engineering Share-Out.
2. Decide what to do with learners' designs and presentation materials after the adventure.

In Your Space

3. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.

Support Learner Differences

To ensure the Share-Out is accessible as possible, provide tactile, audio, and video resources from throughout the pathway to attendees as appropriate.

Adventure Guide

Get Ready & Team Up (5 min.)

1. **If you did the last activity, what did you do and why?** *(We made a plan to share our recommendations for designing space gloves.)*

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

2. Say: **You'll be sharing your space gloves, and the story of how you used an engineering design process to make them, with others.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **How can we share our space glove designs with others?** Explain that first, everyone needs to prepare for this Share-Out.
3. Have learners join up with their space glove work groups from Adventures 6–8 and distribute Engineering Notebooks.
4. Give learners five minutes to set up for the Share-Out so they can present in the ways that they have planned.

Engineering Share-Out (35 min.)

5. When learners are ready, invite guests into the room and explain how the Share-Out will proceed. Carry out the steps of the Share-Out as the group has planned.
6. As they experience the Share-Out, invite families and other guests to think about their family, cultural, or other knowledge related to what they observe and share that knowledge with learners individually or the event as a whole. Ask: **Can you tell me a story about a time when you shared with others something you built or created, and how it worked? What did you learn about space hazards and materials engineering? What have you learned that you can now use to help your family and the communities you belong to?**
7. Ask or encourage attendees to ask the following questions: **What is your mission? What are the hazards? Which materials did you use? Why? Where did you place the materials? Why? Which phases of your engineering design process did you use? What suggestions do you have for other people designing space gloves?**
8. At the end of the Share-Out, congratulate your group on doing a great job being materials engineers and protecting astronauts from space hazards. Thank any guests who came to the Share-Out..

Reflect and Wrap Up (5 min.)

9. Congratulate learners on their great work engineering space gloves. Choose a way to recognize their accomplishments in hazard mitigation, such as by shaking their hands or providing them with badges.
10. Either collect materials or use a fair method to decide who can take home the space gloves, if more than one learner in each group is interested.

After the Adventure

1. Clean up:
   - Collect the Engineering Notebooks.
   - Decide if you want to keep the *Our Ideas* poster.
   - Reset the space in which you held the Share-Out.
2. Take time to reflect on the following educator prompt. **What methods did learners choose to share their designs? What did you learn from the methods they chose?**
3. If time permits, read *Space Hazards: Preparing for a NASA Mission* and consider implementing it so that learners can extend their understanding of space hazards and the relationships between scientists and engineers.

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/940428f7

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(Responses will vary. We shared our engineering work from all the phases of the EDP with the community.)* (5 min.)
- Encourage learners and their families to try out the PLANETS At Home (weblink) activities and those at yes.mos.org/families, which include more challenges to do together. (5+ min.)
- If your learners enjoyed this planetary engineering design challenge, they would also enjoy the Rover Observation and Discoveries in Space (ROADS) student challenges. Show your learners the NASA National Student Challenges (weblink). (15 min. to review; 10–15 hours per challenge)