National Aeronautics and Space Administration

NASA EXPLORATION EXPERIENCE

EDUCATOR GUIDE

NASA Office of STEM Engagement Next Gen STEM

Developed in collaboration with AIAA and Students To Launch. Activity photos provided by Students To Launch.

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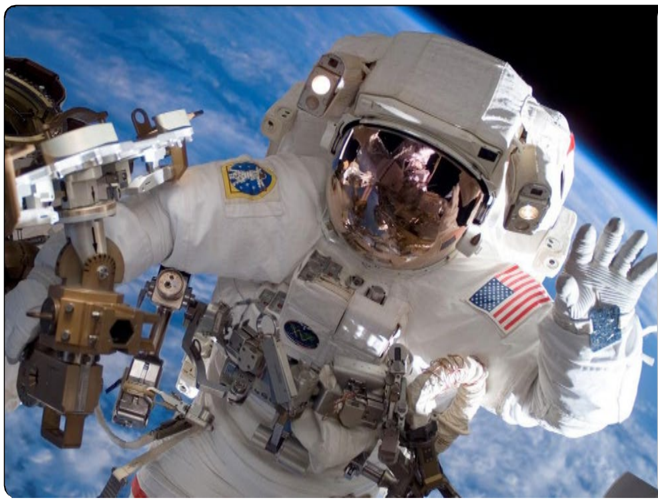
SPACESUIT GLOVE DEXTERITY and GETTING A GRIP ON THE MOON

EDUCATOR GUIDE



Welcome Mission Directors (informal and formal educators)! This guide contains two hands-on sections. The first section is the Engagement activity. This is a 45-minute activity where participants explore the constraints of **spacesuit** design and test a glove that can be used to perform work on the Moon. The second section is the Experience activity. It is a 3-hour experience which is broken up into three 1-hour phases. During the Experience, participants will create and modify a geological tool to collect rock samples on the lunar surface.

GETTING STARTED

For Mission Directors:

Be sure to read through the entire Educator and Student guides. It is suggested to make copies of the Student guide for the teams and add them to a binder. The groups should read and discuss the safety considerations. These procedures should be strictly followed to ensure a safe activity. You will see that there are Mission Briefings for both the Engagement and the Experience sections. The Mission Briefings help participants activate prior knowledge and provide you with ideas to enhance the activity.

Engagement: Spacesuit Glove Dexterity

In the Engagement activity, participants will consider the constraints of **mobility** and **dexterity** in spacesuit design and extrapolate the spacesuit design's impact on performing work on the Moon and on tool design. Participants will test a multi-layered spacesuit glove's performance.

Connection to NASA

For the Artemis missions, astronauts will visit and work in permanently shadowed regions of the lunar South Pole. Conditions here, especially in the craters, feature some of the lowest temperatures in the solar system – down to -414 degrees Fahrenheit (-248 degrees Celsius). Astronauts will also have to work in an environment where the dust on the lunar surface is sharp, so they must be protected. Gloves help to protect astronauts from the dangerous space environment. What features of the spacesuit glove provide that protection? The first is layering. The gloves are made of between 11-13 layers and are reinforced with silicone, which makes the gloves thicker. Second, gloves are equipped with heaters so that astronauts' fingers are kept warm while still being able to use tools.

Experience: Getting a Grip on the Moon

In the Experience activity, participants will modify a geological tool (referred to herein as tool) to prepare the lunar surface for rock sample collections. For this activity, it is important to understand that the tools needed for the Artemis missions are different from the Apollo missions because the working environment will be much different.

Connection to NASA

Bringing back samples is a major component of the science objectives for Artemis just as it was for the Apollo missions. In the Apollo era, tools were modified for almost every mission, which is why they are not being reused for the Artemis missions. Tools have evolved in response to new knowledge, and the Artemis missions will require a greater number of samples with smaller average weight, so developing new tools is essential. Developing these new tools requires using knowledge from the Apollo era. NASA researched designs used on the lunar surface in the Apollo era, why they were used, which designs were not used, what worked well, which designs changed throughout the mission, and why they changed. Out of this research, new tools are being developed for the Artemis missions.

What types of tools will be needed for the Artemis missions? Artemis astronauts will be visiting the South Pole of the Moon, a site that has never been visited by humans. NASA has learned that the site is actually very similar to the Apollo 16 highlands area, where the rocks and **regolith** are not as dark in color as other areas of the Moon. The terrain, created from magma that extruded onto the surface and cooled over time, contains mostly light-colored anorthosite, or calcium-rich, material. What is most challenging about the South Pole is that it is a mostly shadowed area. The Artemis astronauts' suits and tools will need to adapt to the wide swings in temperatures between sunny and shaded areas. The South Pole has permanently shadowed areas containing volatiles — substances that easily evaporate — and NASA wants to research and mine these volatiles. The types of compounds that are frozen into the regolith can cause chemical interactions with tools, so the tools may need a special coating to prevent those chemical reactions. Another important issue regarding volatiles is that as they heat up, they will turn from a solid to a liquid and then to a gas. In some cases, volatiles will get to the gas phase dangerously quickly. Astronauts may need to store these samples in a freezer to protect themselves from potentially harmful compounds. These freezers must be designed to contain the volatile compounds until their return to Earth, where scientists can study them in the safety of a laboratory.

Participants will use the problem-based learning (PBL) framework for the Experience activity. In Phase I, participants will meet the problem and explore the knowns and unknowns by creating a tool such as those used in the Apollo era and testing it. In Phase II, participants will continue to explore knowns and unknowns as they test their tool and collect data. They will also generate possible solutions and consider consequences by modifying the tool so that it is better equipped for the Artemis missions. In Phase III, participants consider the consequences and present their findings.

Watch the video "**NASA Prepares to Explore Moon: Spacesuits, Tools**"

Artist's rendering of the Apollo moon boot print on the surface of the moon. Credits: NASA

PROBLEM-BASED LEARNING PROCESS

NASA astronauts Zena Cardman and Drew Feustel wearing mockup spacesuits after performing an engineering test run before a week of simulated moonwalks. Credits: NASA

- Meet the Problem: Identify the problem, introduce new vocabulary, and discuss previous experiences with the problem
- Explore Knowns and Unknowns: Use resources to explore the knowns and unknowns
- Generate Possible Solutions: Brainstorm possible solutions based on resources and prior experience with the problem
- Consider Consequences: Examine the pros and cons of each solution to determine a viable solution
- Present Findings: Communicate and discuss the process and solutions as a team

Note: For educators looking for more of an engineering design challenge for this activity, check out: **AstroTools Alternate Activity** OR **Robotools (First Woman Camp Experience with instructional video)**

CAMP OVERVIEW

Activities

1. Engagement: Spacesuit Glove Dexterity (45 minutes)
2. Experience: Getting a Grip on the Moon (Phase I, Phase II, and Phase III) (3 hours)

Sample Camp Schedule

8:00 – 8:10 a.m. ....Welcome - Watch "**Artemis I: Launch to Splashdown Highlights**"

8:10 – 8:30 a.m. ....Break (Set-up for Engagement Activity)

8:30 – 9:30 a.m. ....Engagement: Spacesuit Glove Dexterity

Note to Educator: The Engagement activity can be stand-alone or incorporated into the camp day schedule.

9:30 – 10:00 a.m. ....Break

10:00 – 11:00 a.m. ....Experience: Getting a Grip on the Moon Phase I

11:00 a.m. – 12:15 p.m. ......Lunch/Recess

12:15 – 1:15 p.m. ....Experience: Getting a Grip on the Moon Phase II

1:15 – 1:30 p.m. ....Break

1:30 – 2:30 p.m. ....Experience: Getting a Grip on the Moon Phase III

2:45 – 3:15 p.m. ....Wrap up

3:15 – 3:30 p.m. ....Artemis video – "**Artemis II: Mission Overview**"

On Dec. 13, 1972, scientist-astronaut Harrison H. Schmitt is photographed standing next to a huge, split lunar boulder during the third Apollo 17 extravehicular activity (EVA) at the Taurus-Littrow landing site. Credits: NASA/Gene Cernan