



National Aeronautics and
Space Administration



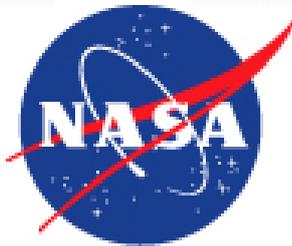
Suits: Step into the Void

An Educator Guide for grades 9-12



Suits: Step into the Void

A Digital Learning Network Experience



**National Aeronautics and
Space Administration**

This Program is Designed To Share

NASA's Space Exploration Program

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Digital Learning Network (DLN) Expedition

A DLN Expedition is a one time connection that allows students to experience NASA first-hand. Each expedition features an integrated educational package of grade-appropriate instruction and activities centered around a 50 minute videoconference. Students will actively learn with a NASA education specialist or a NASA Subject Matter Expert.

The sequence for a DLN Expedition include:

- Students review vocabulary words and complete pre-classroom activities.
- A one time DLN videoconference connection with in-formal student participation.
- Students completing the post-activity assessment and online evaluation for teacher and students.



Expedition Overview

Grade Level(s) 9-12

Focus Question

The National Aeronautics and Space Administration, or NASA, has accomplished many milestones which have broadened human kind's knowledge of outer space. Perhaps the most visual symbol of space exploration is the astronaut conducting a space walk. What is a spacesuit and how does it assist in extravehicular activities (EVAs)? What are some math considerations of EVAs? How does NASA expect to carry out future EVAs?

5 E model of Suits: Step into the Void!

1. **Engagement-** Students will recognize the excitement of a spacewalk before they appreciate the science of an EVA (Extravehicular Activity).
2. **Exploration-** Students will realize the characteristics of outer space and why a space suit is required during an EVA.
3. **Explanation-** Students will relate how various components of the space suit correspond to objects in their own life.
4. **Elaboration-** Students will understand what may happen during an EVA if a single component of a space suit was removed.
5. **Evaluation-** Students will be able to determine how all the various parts of the space suit work together to keep the astronaut safe and comfortable while on an EVA.

Benefits

This program is designed to be cross curricular with STEM (Science, Technology, Engineering, and Math) subject matter. History will also be an important feature of this module. This program will heighten the public's interest in NASA in general, while focusing student's awareness on NASA's successful and historical record of space walks. Excitement will also be generated by discussing what future space walks will look like and how students today will be the ones carrying them out.

SEQUENCE OF EVENTS

Pre-Conference Requirements

A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included. This tool can be found on pg 11.

Expedition Videoconference

The *Suits: Step Into the Void* module is intended to be an all encompassing lesson on space suits with special attention paid to extravehicular activities. It can be suited to a K-12th grade audience. As NASA is celebrating its 50th anniversary in 2008, this lesson will serve to show students how using modern technology, humans will use space suits to further our understanding of the cosmos now, and in the years ahead. This module contains various teaching methods that will aim to increase interest in human space exploration.

The DLN's hope is to inspire the next generation in becoming more involved with science and technology. By demonstrating all the great things NASA has accomplished in the past, and what NASA will achieve in the future, we hope to realize this goal.

Post-Conference Requirements

A post-assessment tool is available to determine changes in student levels of understanding. This tool can be found on pg 14.



National Standards

**The following standards will be met as a result of students participating in this videoconference. Two pre-activities are also available for this module and can be found at <http://dln.nasa.gov>. These activities will also meet the standards below. We certainly encourage the completion of these pre-activities as it gives students a broader background of the science involved with space suits.*

National Standards

National Council of Teachers of Mathematics (NCTM)
Measurement

International Technology Education Association (ITEA)
Standard 9 –Engineering design

Standard 10 –Role of troubleshooting, research and development, inventions and innovation, and experimentation in problem solving

National Council of Teachers of Mathematics (NCTM) (from www.nctm.org)

Mathematics (9-12)	Taking the SAFER way back	Getting the Right Fit
Measurement Understand measurable attributes of objects and the units, systems, and processes of measurement	X	X

Content Standard –Measurement

Understand measurable attributes of objects and the units, systems, and processes of measurement

(9-12) *understand and use formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders*

International Technology Education Association (ITEA) (from www.iteaconnect.org)

Technology (9-12)	Taking the SAFER way back	Getting the Right Fit
Standard 9: Engineering design		
(9-12) J: Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.	X	X
Standard 10: role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving		
(9-12) J. Technological problems must be researched before they can be solved.	X	X

Standard 9 –Students will develop an understanding of engineering design.

(9-12) Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly –*In educating students about engineering design, a teacher must stimulate the curiosity of the students so that they become interested in the design process and motivated to learn more about it.*

Standard 10 –Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

(9-12) Technological problems must be researched before they can be solved –*Students should realize that knowledge from many fields of study is required to solve technological problems.*



Pre-Conference Requirements

Pre-Assessment

A week before the event, please give students this pre-conference assessment. It will gauge what your students already know about space suits and EVAs. Shortly after the conference, give them the same questionnaire in order to determine student comprehension after participating in *Suits: Step into the Void*.

Pre-Conference Assessment Questions

1. What must be provided to humans in order for them to survive in outer space?
2. Why is the color white best to wear on a hot sunny day?
3. What conditions are found on Earth?
4. How might NASA train astronauts for a spacewalk?
5. What do objects weigh in outer space?
6. Why must mountain climbers sometime wear oxygen masks?
7. What is a vacuum?
8. What conditions are found in outer space?

Answers to Pre and Post Assessment Questions:

1. What must be provided to humans in order for them to survive in outer space?

All of the requirements of life must be provided to humans in order to survive in outer space. This includes oxygen, atmospheric pressure, a suitable temperature, food, and water. Humans can adapt to microgravity however.

2. Why is the color white the best color to wear on a hot sunny day?

The color white does a good job of reflecting light. Since there is more “light” in outer space, it is also hotter. The more light that is reflected, the cooler the space suit can be. The color black does a good job of absorbing light, which means a black suit would become hotter than a white space suit.

3. What conditions are found on Earth?

On the Earth’s surface, there is gravity, land, water, an atmosphere of air, and a small temperature range (-30-130 F). These are all the things that make life possible here on Earth.

4. How might NASA train astronauts for a spacewalk?

Currently the most effective way to train for space walks is to submerge astronauts inside their space suit under water. By attaching a certain amount of weights to a space suit, the astronaut inside will become neutrally buoyant (neither sinking nor floating). Astronauts then closely experience what microgravity is like in outer space. NASA uses a facility called the Neutral Buoyancy Laboratory (NBL) for practicing space walks. It is an enclosed body of water that is 202 by 102 feet wide and 40 feet deep.

5. What do objects weigh in outer space?

Objects in space weigh essentially nothing. This is because in orbit, objects are in a state of “free fall”, or constantly falling around the Earth. Because objects weight nearly nothing, astronauts on an EVA must work and move differently than on Earth.

6. Why must mountain climbers sometime wear oxygen masks?

The Earth’s atmosphere gets thinner as altitude increase. This means that there is less oxygen for humans to breathe. Mountains that are

higher than 26,250 feet may have a 1/3 of the oxygen that is found at sea level. Mountain climbers attempting to scale very high mountains must sometimes breathe pure oxygen through a mask to help their body deal with the oxygen deprivation.

7. What is a vacuum?

A vacuum is a volume of space that is void of most of everything. Basically, it is anyplace that is empty of “air”. A vacuum chamber is able to “suck” out all of the air inside a glass chamber to simulate what the conditions are in outer space.

8. What conditions are found in outer space?

Outer space is a vacuum. There is no air, atmospheric pressure, and reduced gravity in outer space. In low Earth orbit, temperatures can vary widely (-250- 250F) and there is an increase in solar radiation and micrometeorites. Outer space can also be described as a “vacuum”.



Expedition Videoconference Guidelines

Audience Guidelines

Teachers, please review the following points with your students prior to the event:

- Videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.
- Students are expected to be respectful to the presenter. A quiet atmosphere should be maintained at all times to enhance the experience for all involved.
- *Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.*

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	1. Print a copy of the module.
	2. Have the students complete the pre-assessment.
	3. Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	4. Review the audience guidelines.
Day of the Conference Requirements	
	1. The students are encouraged to ask the NASA presenter qualifying questions about the expedition.
	2. Follow up questions can be continued after the conference through e-mail.
Post - Conference Requirements	
	1. Students are administered the post-assessment to demonstrate their new knowledge of the subject.



Expedition Videoconference Outline

Summary of *Suits: Step into the Void* Videoconference

Perhaps the most iconic image of space exploration is the space-walking astronaut. Outer space is absent of all that we are used to here on Earth. In order for humans to explore this environment, they must be protected from against the extremes of outer space. The space suit serves this purpose and extends the human reach beyond Earth.

After successfully putting men into orbit inside the Mercury space capsule, NASA pushed the envelope by conducting the first space walk during Program Gemini. Following Ed White's historic EVA, space walking technology advanced to the point that in 1969, humans walked on the Moon.

After the remarkable manned lunar explorations of the 60's and 70's, NASA saw permanent space stations and the space shuttle come to prominence. This led to the development of the current space suit, known as the Extra Mobility Unit or EMU. The EMU in particular is the culmination of cutting edge technology and its development has led to spin-offs found in the home and industry.

NASA's current Space Exploration Program calls for humans to return to the Moon by 2020 and establish a permanent base in preparation for future missions to Mars and beyond. This ambitious goal will be accomplished through a program called Constellation. Already the development of the next generation of space suits has begun. These suits will be referred to as the Constellation Space Suit System (CSSS).

General Outline for Video Conference (50 minutes)

- I. Welcome
- II. Introduction
- III. What it is like on Earth and in outer space
- IV. The need for a space suit
- V. Humans in space (1960-1981)
- VI. The EMU and the EVA
- VII. Training for an EVA
- VIII. Future space suits and EVAs
- IX. Careers/Website
- X. Q&A/Good-Bye



Post-Conference

Online Post-Assessment

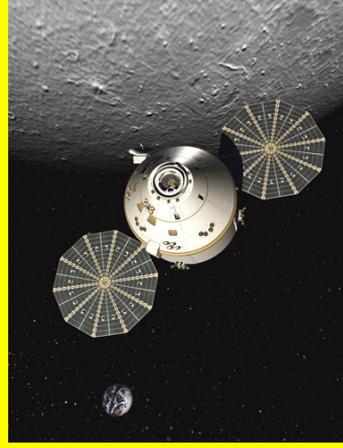
After the event, students will need to take this post-conference assessment. (These questions are the same questions used in the pre-assessment.) This short assessment will help you measure student learning and help us identify any changes that need to be made in future programs.

Post-Conference Assessment Questions

1. What must be provided to humans in order for them to survive in outer space?
2. Why is the color white the best color to wear on a hot sunny day?
3. What are the conditions found on Earth?
4. How might NASA train astronauts for a spacewalk?
5. What do objects weigh in outer space?
6. Why must mountain climbers sometime wear oxygen masks?
7. What is a vacuum?
8. What conditions are found in outer space?



NASA's Digital Learning Network



Presents this

Certificate of Completion

to

for

Suits: Step Into the Void

EVA SYSTEMS



Vocabulary

*Some of these terms will be mentioned during this module. Use this list as a reference for student knowledge.

Vocabulary Terms

1. **Atmospheric Pressure**- Relates to the amount of air that is found on Earth at different levels. As the altitude increases, there are fewer air molecules and thus a lower atmospheric pressure.
2. **Constellation Space Suit System (CSSS)** – the next generation space suit that will be used for microgravity, and lunar EVAs.
3. **Desert RATS**- NASA conducted EVA field trials that are tested on Earth landscapes that closely simulate conditions found on the Moon or Mars. Suit and rover prototypes are evaluated for their effectiveness and usefulness for extra-terrestrial exploration.
4. **Ed White**- the first American to conduct a space walk during Gemini 4 in 1966.
5. **Extra Vehicular Activity (EVA)** - Operations that are performed outside of a spacecraft. The astronaut must wear a pressurized suit in order to be protected from the vacuum of space. Also referred to as a spacewalk.
6. **Extravehicular Mobility Unit (EMU)** - NASA's current space suit. It is used when astronauts conduct EVAs during Space Shuttle or International Space Station missions.
7. **Microgravity**- A very small amount of gravity (1/1,000,000 of gravity). This condition occurs when an object is in a state of free-fall. When the Space Shuttle or ISS are in orbit around the Earth, they are constantly “falling” around the Earth and experience microgravity or “weightlessness”.
8. **Micrometeorites**- Very tiny particles of rock that travel at very high speeds in outer space. Space suits must provide protection from these micrometeorites.
9. **NEEMO**- NASA extreme Environment Mission Operations, an underwater habitat that is located near Key Largo, FL. “Aquanauts” remain aboard NEEMO for several days in order to simulate the experience of outer space habitation. EVAs are also practiced on the surface of the ocean to simulate space walks.
10. **Neil Armstrong**- The first person to step foot on the Moon. The space suit he wore was called the A7L and was specially designed to be self contained so astronauts could freely explore the Moon.
11. **Neutral Buoyancy Laboratory**- A large body of water that contains 6.2 million gallons of water. It provides a simulation of microgravity when astronauts become neutrally buoyant underwater by attaching weights to their space suit.
12. **Program Constellation** – The program responsible for how NASA plans to return to the moon and travel elsewhere in the solar system.
13. **Reduced Gravity Plane**- A NASA airplane that flies consecutive parabola's (or hills). As the plane approaches the crest of a hill, occupants inside will experience microgravity for 25-30 seconds.
14. **Solar radiation**- The sub-atomic particles that are continually given off by the sun. The Earth's magnetosphere and atmosphere acts as a protective shield from these particles. When humans explore outer space, they must monitor their exposure to solar radiation.

15. **Space Debris**- Various metal or plastic pieces that have been discarded by humans in outer space. Space debris can be very small or very large. There is a considerable amount of space debris in outer space and NASA has the technology to track most of it.
16. **Space Suit**- A pressurized garment that an astronaut wears when outside a spacecraft. It is basically a miniature spacecraft that provides all the requirements of life (air, pressure, and suitable temperature).
17. **Spin-off**- Technology that was first created by NASA for space exploration that has now found its way in different forms into the common home and in industry.
18. **Vacuum**- A volume of space that is empty of matter (e.g. no air, or atmospheric pressure). Outer space is considered a vacuum.

(ARL) Acronym Reference List

ACES- Advanced Crew Escape Suit
CSSS- Constellation Space Suit System
DCM- Display and Control Module
Desert RATS- Desert Research and Technology Studies
ECLS- Environmental Control and Life Support
EMU- Extravehicular Mobility Unit
EVA- Extravehicular Activity
HUT- Hard Upper Torso
LCVG- Liquid Cooling and Ventilation Garment
LTA- Lower Torso Assembly
MAG- Maximum Absorption Garment
MMU- Manned Maneuvering Unit
NBL- Neutral Buoyancy Laboratory
NEEMO- NASA Extreme Environment Mission Operations
PGT- Pistol Grip Tool
PLSS- Primary Life Support System
SAFER- Simplified Aid for Extravehicular Activity Rescue
SAW- Solar Array Wing
STS- Shuttle Transport System



Resources

NASA

www.nasa.gov

NASA 50th anniversary

<http://www.nasa.gov/50th/home/index.html>

NASA Constellation Project

www.nasa.gov/constellation

ILC Dover- history of space suits

<http://history.nasa.gov/spacesuits.pdf>

Suited for Space Walking

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Suited_for_Spacewalking_Educator_Guide.html

Personal conversation with Heather Paul, space suit engineer- 7/2008

Personal conversation with Robert Durkin, NBL facilitator- 7/2008



Background Information

Websites:

Space Suit Evolution from Custom Tailored to Off-the-Rack

<http://history.nasa.gov/spacesuits.pdf>

Dress Me for Space (K-4)

<http://www.nasa.gov/audience/forstudents/k-4/playandlearn/dress-me-for-space.html>

NASA Spacesuits and Spacewalks website

<http://www.nasa.gov/audience/foreducators/spacesuits/home/index.html>



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