



Apollo capsule (Image: NASA)



Earth (Image: NASA)



"Black Eye Galaxy" M64 (Image: NASA)

### INSTRUCTIONAL OBJECTIVES

Students will

- discuss the difficulties astronauts experience while working in space suits;
- examine the structure and function of past, present and future space suits;
- confirm observations and deepen their understanding of space suits through Internet resources; and
- design a space suit for use on Mars.

### BACKGROUND

When humans leave Earth's surface to explore and work in outer space, they must take their environment with them because life sustaining oxygen and atmospheric pressure are not present. Early space suit engineers realized Extravehicular Mobility Units (EMU), commonly called space suits, had to generate an Earth-like environment. The suit needed to protect astronauts from challenges like reduced gravity, extreme temperatures, lack of air pressure, solar radiation and ultraviolet radiation.



Astronaut Bruce McCandless on a space walk using the MMU. (February 1984) (Image: NASA)

Space suits have evolved from custom-made, single-purpose Mercury suits to adjustable, reusable suits that enable shuttle members to perform Extravehicular Activity (EVA) tasks. Those tasks include: refueling and repairing satellites in orbit, retrieving satellites for refurbishment on Earth, and assembling the International Space Station. Pressurized to maintain normal body pressure, the suits also remove heat and moisture generated by astronauts. EMUs consist of two major components. Together, the Life Support System (LSS) and the Space Suit Assembly (SSA) permit astronauts to work comfortably and safely in space.

Astronauts wear white EMUs when conducting space walks or working outside the space craft. White reflects heat and is visible against the black background of space, allowing other astronauts to easily see the space walkers. In addition, since space walking astronauts always work in pairs, one of the suits is marked with red stripes so other astronauts can tell one from another. As part of an astronaut's wardrobe, EMUs are truly work clothes for space.

### NATIONAL EDUCATION STANDARDS

#### National Science Education Standards

- **Science as Inquiry**  
Abilities necessary to do scientific inquiry  
Understandings about scientific inquiry
- **Physical Science**  
Motions and forces
- **Life Science**  
Matter, energy, and organizations in living systems  
Behavior of organisms
- **Science and Technology**  
Abilities of technological design  
Understandings about science and technology
- **Science in Personal and Social Perspective**  
Natural and human induced hazards  
Science and technology in local, national and global challenges
- **History and Nature of Science**  
Science as a human endeavor  
Nature of scientific knowledge  
Historical perspectives

#### National Educational Technology Standards

- Creativity and Innovation
- Communication and Collaboration
- Research and Information fluency
- Critical Thinking, Problem-Solving & Decision Making
- Digital Citizenship
- Technology Operations and Concepts

#### National Council of Teachers of Mathematics

- Algebra
- Measurement
- Problem Solving
- Communication
- Connections
- Representation



Apollo capsule (Image: NASA)



Earth (Image: NASA)



Space Suit Apollo 14  
(Image: NASA)

## ENGAGE

Use the Discovery Now audio clip, MMU to help your students develop an understanding about space suits. The clip can be found at <http://www.discoverynow.us/2008/nasa50.html>

These questions can help guide your discussion:

- Why is it necessary for astronauts to wear space suits?
- How did the MMUs aid in space walking?
- How do space suits protect astronauts from the hazards associated with living and working in space?
- How has space suit technology helped people living on Earth?

## EXPLORE

Imagine trying to turn on a faucet wearing roller blades, a big winter coat, and heavy winter gloves. That's similar to how astronauts feel when they work in a space suit. The bulky suit, with its pressurized atmosphere, life support system, and multiple layers of insulation, make even the simplest jobs difficult. In this EXPLORE activity; students will simulate the experience astronauts undergo when they are performing tasks while wearing space suits.

### A. Simulated Space Suit

1. Prepare for the lesson.
  - Organize the students into teams of three.
  - Explain that the students will take turns "suited up for space."
  - Copy Teacher Resource 1a-c and place on wall for students to view during the lesson.
2. Gather these materials for each team:
  - Heavy coat
  - Thermal Underwear
  - Back pack with 4 large books inside
  - Thick, bulky work gloves
  - Snow boots, ski boots or waders
  - Pair of crew/athletic socks
  - Football helmet with facemask (large)
  - Clear plastic wrap
  - Masking tape
  - Desk with a computer (A laptop may be used)
  - 2 pens or pencils
3. Measure and cut a piece of clear plastic wrap big enough to fit across the football helmet facemask opening.
4. Use masking tape to tape the plastic wrap across the facemask. **\*\*NOTE: If students are claustrophobic, omit covering the facemask with the plastic wrap.**
5. Instruct one student per team to:
  - a. Put the thermal underwear on over school clothes.
  - b. Pull on the crew socks and the snow boots, ski boots or waders.
  - c. Put on the coat and button it up.
  - d. Put on the football helmet.
  - e. Put on the gloves and tuck them into the coat sleeves.
6. Place the four books in the backpack and have the student put on the backpack. **\*\*Students may need assistance when putting on the backpack.**

# Work Clothes for Space



## Lesson Development (continued)

GRADES 9-12



Apollo capsule (Image: NASA)



Test Pilots of H-10 Series Lifting Aircraft in Space Suits (Image: NASA)



"Black Eye Galaxy" M64  
(Image: NASA)

7. Instruct the "suited" students to sit at their desks. Ask them to use the computer to write a sentence describing how they feel.
8. Place two pens on the floor by each student and ask them to pick up the pens. \*\*Teammates are to "stand by" in case the students fall and are unable to get up without assistance.
9. Repeat Steps 5 -8, until all students complete the activity.
10. Using Teacher Resource 1a-c, lead your students in a discussion about the difficulties they experienced while wearing their "space suits." Discuss how the students have gained a better understanding of the adjustments astronauts must make when performing tasks while wearing space suits. Examine the photos in Teacher Resource 1a-c to determine how space suits have changed from the Mercury suit to the Shuttle suit.

### EXPLAIN

A. Use these questions to help lead a discussion with your students about the EXPLORE experience:

- How were you able to perform your duties?
- What are some limitations to the heavy, bulky space suit?
- How would the reduced gravity environment affect your ability to perform your job while wearing a space suit?
- How did the backpack inhibit your movements?
- What have you learned about the design and fit of space suits?

### ELABORATE

A. Share these resources with your students to deepen their understanding about the research and technology surrounding space suits.

1. Space Suits
  - A Brief History of the Pressure Suit  
<http://www.dfrc.nasa.gov/airsci/er-2/pshis.html>
  - Suiting Up For Space  
<http://www.hq.nasa.gov/office/pao/factsheets/nasapubs/wardrobe.html>
  - Wardrobe in Space  
<http://www.jsc.nasa.gov/pao/factsheets/nasapubs/wardrobe.html>
  - Space Suit Evolution: From Custom Tailored To Off The Rack  
[http://history.nasa.gov/space\\_suits.pdf](http://history.nasa.gov/space_suits.pdf)
  - Space Suits For Spacewalking  
<http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Suited.For.Spacewalking/Suited.for.Spacewalking.pdf>
  - Space Suits Cleared by NASA Following EMU Incident:  
<http://www.nasaspacelight.com/content/?cid=5286>
  - More Favored Than the Birds: The Manned Maneuvering Unit in Space:  
<http://history.nasa.gov/SP-4219/Chapter13.html>
  - Human Body in a Vacuum:  
[http://imagine.gsfc.nasa.gov/docs/ask\\_astro/answers/970603.html](http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/970603.html)
2. Bio-Suits
  - Bio-Suit Overview: Extra-Vehicular Activity (EVA) Research @ MVL  
<http://mvl.mit.edu/EVA/biosuit/>
  - High-Tech Spacesuits Eyed for 'Extreme Exploration'  
[http://www.space.com/business/technology/technology/spacesuit\\_innovations\\_050126.html](http://www.space.com/business/technology/technology/spacesuit_innovations_050126.html)





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Earth (Image: NASA)



NACA/NASA Test Pilot Joe Walker, mid 1950s (Image: NASA)

B. This activity is a modification of a lesson: Designer Space Suits found at:

[http://media.nasaexplores.com/lessons/03-061/9-12\\_1.pdf](http://media.nasaexplores.com/lessons/03-061/9-12_1.pdf)

1. Challenge your students to imagine they are working for NASA and given the task to design a new space suit for the exploration of Mars. Your students are to consider these questions when designing their suit:

- Will the wearer require assistance when getting into the suit?
- Is it a multipurpose suit, or designed for a specific task?
- Are the suit's shoes designed for multiple tasks?
- What materials will be used to construct the space suit?
- What happens if the suit is torn while it is being worn?
- How many layers or parts does the space suit have?
- What is the significance of each layer?
- Are the suit parts interchangeable?
- What are some special features, or accessories, on the space suit?

2. Remind the students to consider the following factors when designing their space suits. The space suit must:

- Supply oxygen
- Maintain air pressure
- Remove carbon dioxide
- Allow astronauts to move
- Protect astronauts from radiation, space debris, and extreme temperature
- Include a method of communication

3. Challenge your students to create and present their design in a PowerPoint™ presentation.

The students may find it helpful to review this Nortel LearnIT video tutorial when creating their PowerPoint™ presentations. The tutorial can be found at: [http://nortellearnit.org/technology/PowerPoint\\_Presentations/](http://nortellearnit.org/technology/PowerPoint_Presentations/)

Encourage your students to put a descriptive title screen, credits and references at the end of the project. Please remind students to use only images that they have permission to include. Review copyright and copywongs by watching the Nortel LearnIT video tutorial at: [http://nortellearnit.org/technology/Digital\\_Ethics/](http://nortellearnit.org/technology/Digital_Ethics/)

### EVALUATE

Through discussion and the results of the EXPLORE experience, determine if your students have an accurate and deeper understanding of the differences and similarities between the Apollo 11 capsule and the Orion CEV.

To evaluate PowerPoint™ slides, use a rubric found at the Nortel LearnIT site:

- PowerPoint™ Presentations  
<http://nortellearnit.org/resources/Handouts/>



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## EXTEND

These activities may be used to extend or continue your students' exploration.

- A. Ask students to answer this journal prompt to assess their understanding of the important role space suits play when living and working in outer space.
- Without the protection of space suits, astronauts would be unable to live in space. Describe how you think the human body reacts without the protection of a spacesuit.
- B. You may also wish to share these additional Discovery Now audio clips from previous Discovery Now seasons:
- Fashionable Space Suits <http://www.discoverynow.us/2007/shuttle.html>
  - Ski Boot Spin-off <http://www.discoverynow.us/2007/science.html>
  - Training for Spacewalks <http://www.discoverynow.us/2007/shuttle.html>
  - Astronaut Glove Challenge <http://www.discoverynow.us/2007/shuttle.html>
  - Space Suits for Mars <http://www.discoverynow.us/2007/exploration.html>
  - Space Suit Dilemma <http://www.discoverynow.us/2007/mars.html>
  - Space Suit Tailors: <http://www.discoverynow.us/2008/shuttle.html>

Once your students have listened to the clips, urge them to write and record their own radio commercial advertising the space suit they created in the ELABORATE section.



Image: NASA  
STS-95 space shuttle mission  
\*\*NOTE: John Glenn is in the middle of the photo.



Image: NASA  
Original Mercury 7 astronauts at NASA Langley Research Center



Image: NASA  
Alan Shepard in Mercury Space Suit showing  
Hoses for oxygen and cooling



Image: NASA  
Mercury Space Suit Parts