PEANUTS and SPACE FOUNDATION

Spacesuit Repair

OBJECTIVES

Students will:

- Read *Snoopy, First Beagle on the Moon!* and *Shoot for the Moon, Snoopy!*
- Learn about the Extravehicular Mobility Unit (EMU) spacesuit.
- Use materials to repair a hole in a simulated damaged spacesuit in order to protect the inside from water, radiation, and punctures.

SUGGESTED GRADE LEVELS

3rd – 5th

SUBJECT AREAS

Space Science, Engineering Design

TIMELINE

30 – 60 minutes

NEXT GENERATION SCIENCE STANDARDS

- 3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
- 3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
- 3-5 ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

21st CENTURY ESSENTIAL SKILLS

Critical Thinking/Problem Solving, creativity/imagination, collaboration and teamwork, communication, information literacy, leadership, initiative, organizing concepts, constructing explanations, designing solutions, obtaining/evaluating/communicating ideas

BACKGROUND

- NASA has proudly shared an association with Charles M. Schulz and his American icon Snoopy since Apollo missions began in the 1960s. Schulz created comic strips depicting Snoopy on the Moon, capturing public excitement about America's achievements in space. In May 1969, Apollo 10 astronauts traveled to the Moon for a final trial run before the lunar landings took place on later missions. Because that mission required the lunar module to skim within 50,000

PEANUTS and SPACE FOUNDATION

Spacesuit Repair

feet of the Moon's surface and "snoop around" to determine the landing site for Apollo 11, the crew named the lunar module Snoopy. The command module was named Charlie Brown, after Snoopy's loyal owner.

- These books are a united effort between Peanuts Worldwide, NASA and Simon & Schuster to generate interest in space among today's younger children. The character of Snoopy has been allowed to be reimagined for this special partnership and for the opportunity to head into outer space.
- Spacesuits help astronauts in many ways. The suits protect astronauts from getting too hot or cold. Spacesuits also provide astronauts necessary oxygen to breathe while they are working in space. The suits hold water to drink. They also keep astronauts from getting hurt by space dust. Space dust may not sound very dangerous but when it moves faster than a bullet in space, the dust can hurt someone. The suits even have special gold-lined visors to protect astronaut's eyes from bright sunlight.
- A spacesuit is made up of many parts. One part covers the astronaut's chest while another part covers the arms and connects to the gloves, the helmet protects their head, and the last part covers the astronaut's legs and feet. Some parts of the suit are made of many layers of material and each layer does something different. Some layers keep oxygen in the suit while others protect astronauts from space dust.
- Under the suit, astronauts wear another piece of clothing called the Liquid Cooling Garment (LCG). It covers their whole body except for the head, hands and feet. Tubes are woven into it allowing water to flow through the tubes to keep the astronaut cool. And finally, a water tank in the backpack contains the cooling water.
- On the back of the spacesuit is the backpack which stores oxygen that astronauts can breathe. It also removes the carbon dioxide that astronauts have breathed out or exhaled. The backpack also supplies electricity for the suit and houses a fan which moves the oxygen through the spacesuit.
- The Apollo extravehicular mobility unit was designed to meet a unique set of mission needs. To assure the maximum return of scientific information from the moon, a method was required for collecting samples, deploying retrieving instruments, and performing experiments on the lunar surface as well as in free space. Astronauts had to be able to operate safely in free space and provide an emergency mode of translation from the Lunar Module to the Command Module, in the event a complete linkup could not be accomplished following the lunar lift-off. Since

PEANUTS and SPACE FOUNDATION

Spacesuit Repair

the weight required to provide a redundant pressure vessels for each spacecraft would have been prohibitive, a space suit was required.

- The extravehicular mobility unit (EMU) design was a solution to those needs. The unit consisted of a highly mobile, anthropomorphic pressure vessel and a portable life support system (PLSS). The pressure vessel, known as the pressure garment assembly (PGA), when operated in conjunction with the Command Module and Lunar Module life support systems, provided pressurization backup during critical mission phases, including launch and return. It provided primary pressurization for the extravehicular activity conducted from the Command Module during the missions of Apollo 15, 16, and 17. Traverses of four to seven hours' duration were made with the PLSS on the lunar surface to perform the lunar science tasks. All background information is available on NASA.gov.

VOCABULARY

Spacesuit, Extravehicular Mobility Unit (EMU), radiation, water resistant, design, teamwork

MATERIALS

- 12"x 12" square of cotton material with 4" diameter hole cut in the middle (one per group)
- Several small scraps of various types of fabric
- Small squares of bubble wrap
- Plastic wrap
- UV beads
- Ultraviolet light (either artificial or sunlight, bulbs are sufficient)
- Masking tape
- Scissors
- Water
- Dixie cups
- Adult scissors (1 pair)

LESSON PROCEDURES

1. Read *Snoopy, First Beagle on the Moon!* and *Shoot for the Moon, Snoopy!* to the entire class to give students some background knowledge.
2. Teach students about the Extravehicular Mobility Unit (EMU) spacesuit. Focus on it's purpose, it's layers, the difficulties of working in space while wearing the EMU. Show a few images of astronauts wearing and working in the EMU.

PEANUTS and SPACE FOUNDATION

Spacesuit Repair

3. Teach students about radiation from the sun and astronauts' risks of exposure to radiation. Using a UV bead is a great way to test for ultraviolet radiation, as they change color when exposed to UV light.
4. Explain that students will be repairing a "spacesuit" that has been damaged.
5. Repairs must allow the new "spacesuit" to be water resistant, block out ultraviolet radiation, and resist punctures from various objects (teacher will perform puncture tests).
6. Hand out one "damaged spacesuit" to each group (12"x 12" square of cotton material, with a 4" diameter hole in the middle).
7. Students must use the materials provided to create new layers to cover the 4" diameter hole (students may not simply tape the hole closed). Materials include small scraps of different types of fabric, plastic wrap, bubble wrap, and masking tape. Amount of masking tape should be limited to one foot in length per group.
8. Ask students to illustrate their repair designs.
9. The repair should be no more than three layers thick.
10. Once their fabric square is repaired, they can test their repairs.
11. Teacher or other adult helpers should perform the tests.
    a. Test 1 Radiation:
        - Lay repaired material on desk or table.
        - Place 4-5 UV beads under the repaired area.
        - Hold UV light above material for 10 seconds.
        - Turn UV light off and remove.
        - Remove material and see if the beads changed color.
        - If conducting this test using sunlight, place 4-5 UV beads in hand and cover with repaired material.
        - Expose to sunlight for 10 seconds, then go back inside while still covering beads with the material.
        - See if bead color changed and record results.
    b. Test 2 Puncture:
        - .Place fabric on a desk or table.
        - Instructor uses a pair of adult-size scissors and strikes the repaired area from a height of six inches above the surface of the fabric (firmly, but not dangerously).
        - Check if the scissors damaged the repaired area on the "inside" layer. Record results.

PEANUTS and SPACE FOUNDATION

Spacesuit Repair

c. Test 3 Water Resistance:
   - .Students hold the fabric at the corners.
   - Instructor pours a dixie cup full of water onto the repaired area of the fabric.
   - Students watch for any leakage on the underside of the repaired area. Record results.

12. When all groups have completed all tests, have students discuss and write/draw their design, results, and conclusions.

EXTENSIONS

- Have students test single layers of other various materials to see how they hold up against the three tests.
- Students may discuss how they could complete a larger repair, perhaps up to a foot in diameter, and what kind of materials would be needed.

RESOURCES

Schultz, Charles M. (2019). *Snoopy, First Beagle on the Moon!* New York, NY: Simon & Schuster.

Schultz, Charles M. (2019). *Shoot for the Moon, Snoopy!* New York, NY: Simon & Schuster.

Administrator, N. A. S. A. C. (2014, April 28). Facts About Spacesuits and Spacewalking. Retrieved from https://www.nasa.gov/audience/foreducators/spacesuits/facts/index.html

Dunbar, B. (2015, May 12). What Is a Spacesuit? Retrieved from https://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-a-spacesuit-k4.html

Garcia, M. (2018, July 9). NASA and Peanuts Celebrate Apollo 10's 50th Anniversary. Retrieved from https://www.nasa.gov/feature/nasa-and-peanuts-celebrate-apollo-10-s-50th-anniversary

Tate, K. (2013, July 17). How NASA Spacesuits Work: EMUs Explained (Infographic). Retrieved from https://www.space.com/21987-how-nasa-spacesuits-work-infographic.html

Retrieved from https://history.nasa.gov/SP-368/s6ch6.htm