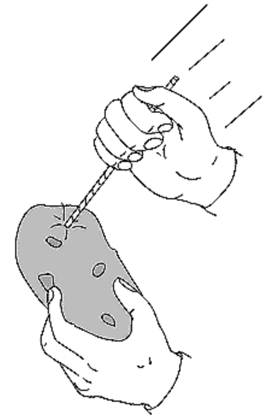
Civil Air Patrol's ACE Program



Astrospud Spacesuit Design Challenge
Grade 5 Academic Lesson #6

Topics: spacesuits, safety, cost-benefit analysis, compare and contrast (science, math, engineering, language arts)

Length of Lesson: 50-70 minutes

Lesson Reference:

[NASA Quest]

NASA's Potato Astronaut at [Lunar Nautics]

Objectives:

- Students will use critical thinking skills to design a protective covering for a potato.
- Students will simulate a micrometeoroid or space debris hitting a spacesuit.
- Students will consider the possible effects of micrometeoroids and space debris on spacesuits.
- Students will identify characteristics and purposes of spacesuits.

Next Generation Science Standards:

- Obtain and combine information about ways individual communities use science ideas to protect the earth's resources and environment. (5-ESS3-1)
- 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-ETS1-1)
- 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-ETS1-2)
- 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. (3-5-ETS1-3)

CCSS Math:

- 5.NBT.5 - Perform operations with multi-digit whole numbers and with decimals to hundredths.

Background Information: (from NASA)
Astronauts on spacewalks are likely to encounter fast-moving particles called meteoroids. A meteoroid is usually a fragment of an asteroid consisting of rock and/or metal. It can be very large with a mass of several hundred metric tons, or it can be very small- a micrometeoroid, which is a particle smaller than a grain of sand. Micrometeoroids are usually fragments from comets. Every day, Earth's atmosphere is struck by millions of meteoroids and micrometeoroids. Most never reach the surface because they are vaporized by the intense heat generated by the friction of passing through the atmosphere. It is rare for a meteoroid to be large enough to survive the descent through the atmosphere and reach solid Earth. If it does, it is called a meteorite.

In space there is no blanket of atmosphere to protect spacecraft from the full force of meteoroids. It was once believed that meteoroids traveling at velocities averaging 43 miles per second would prove a great hazard to spacecraft. However, scientific satellites with meteoroid detection devices proved that the hazard was minimal. It was learned that the majority of meteoroids are too small to penetrate the hull of spacecraft. Their impacts primarily cause pitting and sandblasting of the covering surface.

Of greater concern to spacecraft engineers is a relatively recent problem--spacecraft debris. Thousands of space launches have deposited many fragments of launch vehicles, paint chips, and other "space trash" in orbit. Most particles are small, but traveling at speeds of nearly 16, 199 miles per hour, they could be a significant hazard to spacecraft and to astronauts wearing Extravehicular Mobility Units (EMUs), outside spacecraft while on extravehicular activities.

Engineers have protected spacecraft from micrometeoroids and space trash in a number of ways, including construction of double-walled shields. The outer wall, constructed of foil and hydrocarbon materials, disintegrates the striking object into harmless gas that disperses on the second wall. Spacesuits provide impact protection through various fabric-layer combinations and strategically placed rigid materials.

Maintaining proper pressure inside a spacesuit is essential to astronaut survival during a spacewalk. A lack of pressure will cause body fluids to turn to gas, resulting in death in a few seconds. While making spacewalks possible, pressure produces its own problems. An inflated spacesuit can be very difficult to bend. In essence, a spacesuit is a balloon with an astronaut inside. The rubber of the balloon keeps in oxygen that is delivered to the suit from pressurized oxygen tanks in the backpack. But, as pressure inside the balloon builds up, the balloon's walls become stiff, making normal bending motions impossible. Lack of flexibility defeats the purpose of the spacewalk-mobility and the ability to do work in space.

Thus, spacesuit designers have learned that strategically placed breaking points at appropriate locations outside the pressure bladder (the balloon-like layer inside a spacesuit), makes the suit become more bendable. The breaking points help form joints that bend more easily than unjointed materials. Other techniques for promoting bending include stitching folds into the restraint layer that spread apart and contract with bending, and building joints into the restraint layer like ribs on vacuum cleaner hoses.

You may wish to watch this video (or share it with your class): "Taternauts" and Spacesuits: How Astronauts Stay Safe in Space - ISS Science from Smithsonian National Air and Space Museum.

Materials:

- either Internet and LCD projector OR student copies of "Spacesuits" article

- copies of "Astrospud Spacesuit Design Challenge" (one per pair of students)
- copies of "Astrospud Spacesuit Score Sheet" (one per pair of students)
- variety of "covering" materials such as aluminum foil, wax paper, notebook paper, construction paper, felt, paper towels, old pillow cases or sheets, plastic wrap, plastic grocery bags, gift wrapping paper, nylon hose, etc.
- display of available design materials and cost of each on board or chart paper
- rigid plastic drinking straws (one per student)
- potatoes (two per pair of students)
- scissors
- paper towels - tape - 4 paper towel tubes - screw driver (or similar object)

NOTE:
Flexible straws do not work well for this experiment. Straws with small diameters may not work well. Straws that are too long may also be problematic.

Visit Tailored for Space: Micrometeoroids and Space Debris for a 2 minute clip explaining spacesuit safety in terms of micrometeoroids and a demonstration of the potato activity that is similar to this lesson. (You may wish to bring in "air pressure" – see enrichment/extension activity suggestion.)

Below is a possible list of materials and prices for this activity. Make revisions to suit your needs. Post a copy of your available items and cost for each item in the classroom for students to see. Have the materials organized for easy student access.

ITEM	COST/layer
Notebook paper/Copy paper	$1,000.00
Paper Towel	1,000.00
Construction paper	1,200.00
Newspaper	1,200.00
Wax paper	3,000.00
Plastic (bag or self-sealing sandwich bag)	1,200.00
Nylon hose	3,000.00
Aluminum Foil	4,000.00
Cotton (from sheets or pillowcases)	5,000.00

Prior to the lesson, assemble a long tube through which the screw driver can pass. Assemble the tube by attaching the 4 paper towel tubes to form one long tube.

If time is an issue, you may provide a brief background regarding spacesuits including step #3 (the "SPORT" acronym), and then start with step #4 in the lesson plan. Students, however, find the information in the video and "Spacesuits" article very interesting.

For this lesson, give each student a partner for the design challenge of creating a protective "spacesuit" for the potatoes.

Consider the following pacing suggestion:

- Overview (intro, video clip or article): 6-7 min.
- "SPORT" review: 1 min.
- Conduct numbers 1-4 of the "Astrospud Spacesuit Design Challenge" data sheet with the class, then discuss design challenge: 5 min.
- Partners discuss and experiment (#5 on data sheet): 5-10 min.
- Prepare potato for final competition; determine the cost of their spacesuit (numbers 6 and 7 on data sheet): 5 min.
- Take turns allowing partners to come to front of room for performance test; then answer numbers 8 and 9 on the data sheet: 15-25 min.
- Clean up: 5 min.
- Wrap up discussion: 5 min.

Lesson Presentation:

1. Tell students to name things they wear when going outside on a cold winter's day. Ask students why they select to wear these items. (to protect them from the cold) Explain to students that when astronauts leave the safe environment of their spacecraft or their space station, they must wear a spacesuit to protect them from the harsh environment of space. Ask students if they can name some specific reasons why astronauts wear spacesuits.

2. Inform students about the importance of spacesuits by either watching the spacesuit video at "How Do Space Suits Work?" OR by distributing student copies of "Spacesuits" (or project the article in the room) to read aloud in class.

3. Tell students that "SPORT" is an acronym that can help them remember some of the important reasons astronauts must wear spacesuits.

S = Space Debris: Astronauts must be protected from things such as micrometeroids, paint chips, and other debris that is flying in space.
P = Pressure: Astronauts must have a pressurized suit to maintain a survivable atmospheric pressure.
O = Oxygen: There is no oxygen in space, so astronauts must have a supply of oxygen.
R = Radiation: Earth's atmosphere helps protect us from much solar radiation; however, in space, there is no atmosphere. A spacesuit is needed to protect the astronauts from radiation.
T = Temperature: Due to the extreme cold and hot temperatures of space, a space-suit must provide appropriate temperatures to support human life.

4. Tell students that today, they will be conducting an experiment relating to "S" – space debris. A bolt or nut lost in space by an astronaut could become "space trash" and a "projectile" that could damage a future space mission due to an accidental collision. Other materials in space, such as micrometeoroids, which are small pieces of rock and may contain metal, travel through space at high speeds. Even with a very small projectile, the speed at which the object travels determines the damage that can be done to another object in space if there is a collision.

   To explain further about speed and projectiles, have the students discuss what happens when a car is traveling slowly and has a collision with a wall and when a car is traveling at a fast rate of speed and collides with a wall. Compare how the speed difference affects the amount of damage done to both the car and the wall.

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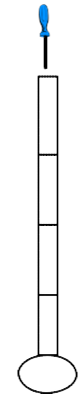
5. Tell students that they will create a spacesuit today for a potato, which today will be known as astrospud. Give each pair of students two small potatoes (one for testing and one for the competition). Provide the pairs with paper towels and two straws. Distribute the "Astrospud Spacesuit Design Challenge" data sheet.

6. Guide students through steps 1-4 on the data sheet.

7. Explain the design challenge to the students. Just like a spacesuit has layers to help protect astronauts from micrometeoroids and small space debris, the students should create a protective "spacesuit" to protect their astrospud. (You may or may not wish to make this a competition. If it is a competition, explain how the activity will be judged. Use either your own judging rules or the scoring sheet included in the activity sheets for this lesson plan.)

8. After providing the explanation and answering questions students may have about the challenge, tell students the exact number of minutes they have to discuss their ideas and experiment with the testing potato. (Suggest 5-10 minutes.)

9. Once the time is up, tell the students that they have just a few minutes to complete numbers 6 and 7 on their data sheet. They should "dress" their potato for the competition and determine the cost of their astrospud spacesuit.



10. Allow each pair to come to the front of the room and explain their design. Give the astrospud spacesuit its performance test by placing it on a piece of cardboard or box and dropping a screwdriver (or similar object) twice over two different places on the potato. (Use the long paper towel tube that you assembled to help keep the screwdriver on target.) The partners may immediately "unzip" their astrospud to see if it was punctured after the second impact. Have students write the results of their spacesuit (numbers 8 and 9) on their data sheet.
11. Distribute the "Astrospud Spacesuit Scoring Sheet." Allow students to fill in their information except for the "teamwork" points.
12. Collect students' worksheets and clean up. While students are cleaning up, review the scoring sheets, insert the appropriate "teamwork" points for the pair of students, calculate the final scores, and announce the winner.

Summarization:
Ask the students what they learned about real spacesuits. Tell them that although their spacesuits only cost thousands of dollars today, a real spacesuit costs millions of dollars (around 9-12 million dollars). Their spacesuit was very light. A real spacesuit used to work in the microgravity environment of space weighs around 300 pounds on Earth! The Apollo astronauts who walked on the moon wore a spacesuit that weighed about 180 pounds.

Regarding the astrospud spacesuits, ask students the following questions:

- Which materials seemed to be the best for this task?
- Which materials seemed to be the worst for this task?
- What was more important to you and why: trying to earn points for fewer layers or trying to earn points for a low cost? Was either strategy helpful? Why or why not?
- If your spacesuit was successful during this challenge, do you think it is because of the number of layers of material you had, the material you chose to use, or a combination of both? In other words, what was it about your design that really made it successful?
- If your spacesuit was successful during this challenge, do you think your current spacesuit design could be successful if a heavier "impact" object was used or if the object impacted the astrospud at a great speed? Why or why not?

Character Connection: Ask students if they can think of ways they could improve upon the current design of their spacesuits. Explain that scientists and engineers develop things, test them, make close observations, and then think about what happened and how they can make improvements. Usually, they find mistakes with their first designs, and they find ways to correct the problems. This process leads to successful outcomes.

Just like these scientists and engineers, we need to think about the things we want to do or have done. We should strive to make improvements in our daily lives. Whether it's learning from mistakes or learning from successes, we should strive to reflect on our experiences and always try to continually make improvements. We are lifelong learners. Encourage students to identify problems in their character development and see if they can design a plan to make improvements.

Assessment:

- teacher observation of students' participation and class discussions
- construction of astrospud spacesuit
- completed "Astrospud Spacesuit" worksheets

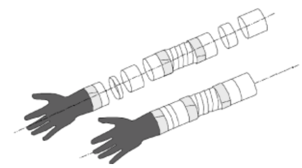
Additional activity ideas to enrich and extend the primary lesson (optional):

- Allow students to make modifications to their astrospud spacesuit and try again.
- Conduct a similar activity, but use balloons instead of potatoes. For details go to Balloon Astronaut.
- Have students experiment to see if holding one's thumb over the top of the straw while piercing the potato results in the straw traveling deeper into the potato. Explain that air is trapped inside the straw. Does the air pressure affect the results? If conducting this activity in a spacesuit while outside in space, would covering the opening of the straw make a difference in the results? (No. Remind students that there is no air or pressure in the near vacuum of space.)
- Show the students pictures of early astronaut suits, suits of today, and prototype suits of tomorrow (included). Then, have students design and sketch a spacesuit using the "Future Spacesuit" page.
- Watch a short 3 minute video by clicking Our World: The Importance of Spacesuits. After watching the clip, have students write a paragraph explaining what safety item they would like to design and why.
- Have students work in teams to create an arm section of a spacesuit. Give each team one rubber glove and several pieces of dryer vent material, duct tape, and heavy cardstock to make additional segments of the arm portion of the space suit. Instruct students to complete the project while computing measurements of segments needed to be able to have the arm portion fit perfectly on one of the student's arms.

  The teams should create the arm portion of the space suit without allowing the student model to try it on for correct fit.

  When each team has completed the project, or when time is up for the project, the teacher will then give each team an opportunity to share with the rest of the class the "unveiling" of the project and the "fitting" of the project on the student model. Each team should be able to explain their calculations used to ensure the arm portion of the suit would fit the student model.

The arm portion of the space suit should fit the model, being ale to bend at exactly the correct points of the arm- the wrist and the elbow.



- Explore other NASA and You: Spacesuits lessons at the following link:
- Thousands of space launches have left many fragments of launch vehicles, paint chips, and other "space trash" in orbit. Research the effects that "space trash" has on space exploration.
- Using the links below, explore prototype spacesuits that are being designed for future astronaut space walks. Use the following links for such research. Have students then design a future space suit using new materials to be less "bulky" and more flexible while maintaining the protective essence needed in the environment of space. The Dava Newman Biosuit looks most promising.
  High-Tech Spacesuits Eyed for 'Extreme Exploration

  Slimming Down Future Spacesuits

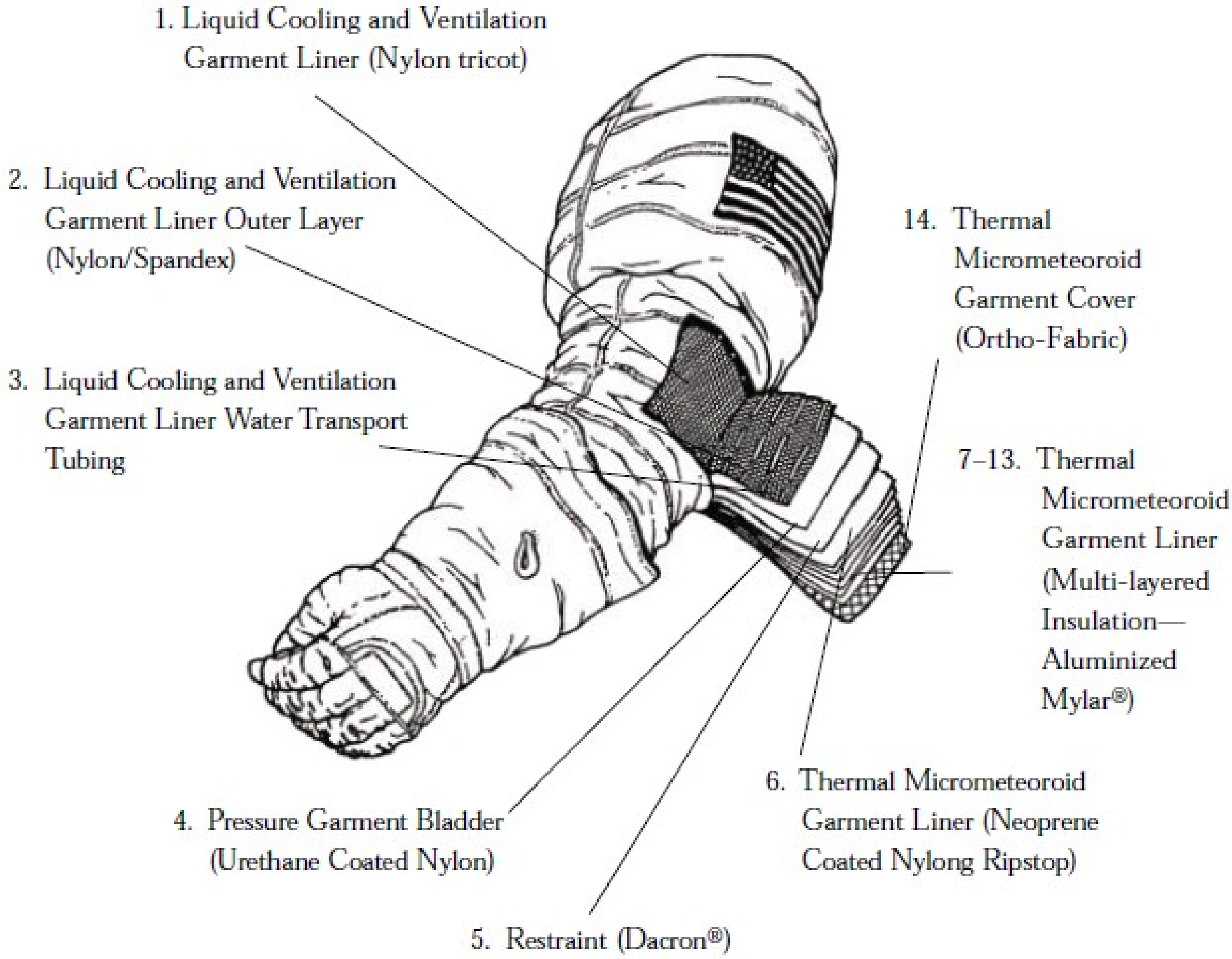
  NASA: Suit Up

  Shrink-wrapping spacesuits

- Allow students to learn about the parts of a spacesuit at NASA: Interactive Spacesuit Experience or NASA: Space Wardrobe, and then allow them to play a "parts of a spacesuit" matching game at NASA: Blastoff Boutique.

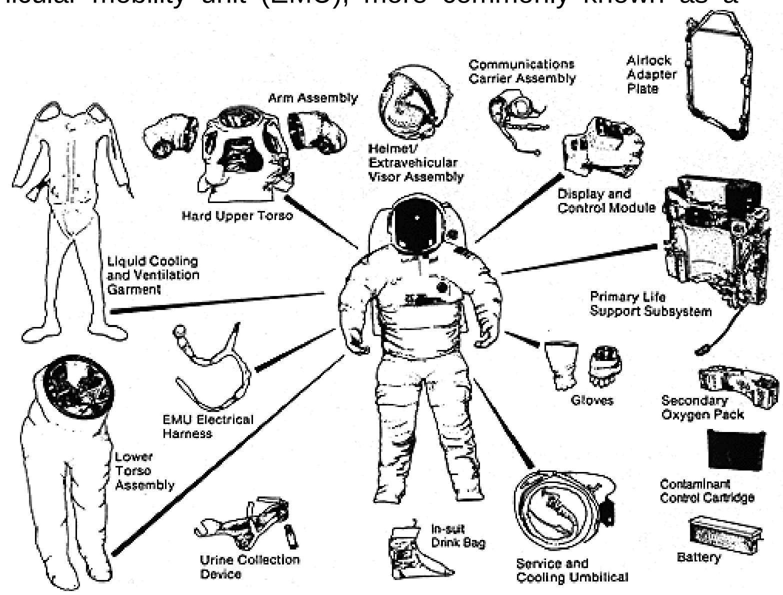
Associated Website Resources:
Learn more about spacesuits at the following websites:

- NASA: Against the Elements
- How Space Suits Work
- The Space Shuttle Extravehicular Mobility Unit (EMU)
- Suited for Spacewalking Educator Guide
- Space Educators' Handbook: The Spacesuit


1. Liquid Cooling and Ventilation Garment Liner (Nylon tricot)
2. Liquid Cooling and Ventilation Garment Liner Outer Layer (Nylon/Spandex)
3. Liquid Cooling and Ventilation Garment Liner Water Transport Tubing
14. Thermal Micrometeoroid Garment Cover (Ortho-Fabric)
7–13. Thermal Micrometeoroid Garment Liner (Multi-layered Insulation—Aluminized Mylar®)
6. Thermal Micrometeoroid Garment Liner (Neoprene Coated Nylong Ripstop)
4. Pressure Garment Bladder (Urethane Coated Nylon)
5. Restraint (Dacron®)

SPACESUITS

You might be able to get by for a little while without a raincoat in a storm or a winter coat in snowy weather. But none of us could survive the harsh environment of space for even a second without the right clothes. While working outside of a space vehicle or International Space Station during a mission, astronauts wear an extravehicular mobility unit (EMU), more commonly known as a spacesuit, for protection.



Oxygen

The principle environmental factor of outer space is the vacuum, which is nearly total absence of gas molecules. The EMU provides oxygen for the astronaut to breathe. Air inside unprotected lungs would immediately rush out. A lack of oxygen to the brain would result in unconsciousness in less than 15 seconds.

Temperature

The temperature range found in outer space provides a second major hazard for humans. At Earth's distance from the Sun, the sunlit side of objects in space may climb to over 248° F (120° C), and the shaded side may plummet to lower than -148° F (-100° C). Spacesuits provide astronauts with comfortable temperatures in which to work in space.

Micrometeoroids, Space Debris, and Solar Hazards

Micrometeoroids are usually very small bits of rock and metal left over from the collisions of comets and asteroids. Though small in mass, these particles travel at very high speeds and can easily penetrate human skin and thin metal. Equally dangerous is debris from previous space missions. A tiny paint chip traveling at thousands of kilometers per hour can do substantial damage. Spacesuits are made of multiple layers of different materials to help protect astronauts from debris impacts.

Spacesuit layers along with the visor on the helmet of the spacesuit help protect the astronaut from the Sun. Solar radiation emitted from the Sun can cause radiation sickness and increase the risk of cancer. The glare from direct sunlight can damage the eyes.

Pressure

On Earth, the atmosphere exerts pressure in all directions. In space, the pressure is nearly zero. Without a spacesuit, the skin would expand much like an inflating balloon. Bubbles that would form in the bloodstream would cause blood to be ineffective to transport oxygen and nutrients to the body's cells. Furthermore, the sudden absence of external pressure, which balances the internal pressure of body fluids and gases, can rupture fragile tissues such as eardrums and capillaries. The effect on the body due to lack of pressure would be swelling and tissue damage.

Additional EMU Information

EMUs have interchangeable parts so it can be assembled to fit different astronauts. The EMU has a liquid cooling garment, which is a one-piece suit made of spandex, and keeps the astronaut cool while in the suit. The unit also contains headphones and microphones, a drink bag of water, a personal life support system (PLSS) containing oxygen, and a urine collection device (a diaper). Gloves are included along with a helmet and a visor. All of this is necessary to protect the astronaut from micrometeoroids, radiation, temperature changes, pressure changes, and oxygen deprivation (lack of oxygen).

Article Sources: NASA (including NASA Quest and StarChild)

Liquid Cooling and Ventilation Garment
Most long underwear keeps people warm. This underwear keeps spacewalkers cool.

In-Suit Drink Bag
A plastic, water-filled pouch attaches to the inside of the Hard Upper Torso using Velcro. A plastic tube with a valve sticks out of the bag. The tube and valve can be adjusted to be near the astronaut's mouth. Biting the valve opens the tube so the spacewalker can take a drink. Releasing the bite closes the valve again.

Upper Torso
The top of the spacesuit includes the Hard Upper Torso (HUT) and the arm assembly.

Helmet
The bubble is covered by the Extravehicular Visor Assembly. The visor is coated with a thin layer of gold that filters out the sun's harmful rays. A TV camera and lights can be attached to the helmet.

Arms
Spacewalkers do not wear custom-made suits. Different sizes of arm assembly parts are available.

EVA Gloves
Astronauts must be able to work with and pick up objects while wearing spacesuit gloves. EVA gloves are made to protect astronauts from the space environment. They are also made so spacewalkers can move their fingers as easily as possible. The fingers are the part of the body that gets coldest in space. These gloves have heaters in the fingertips. A piece called a bearing connects the glove to the sleeve. The bearing allows the wrist to turn.

Lower Torso Assembly

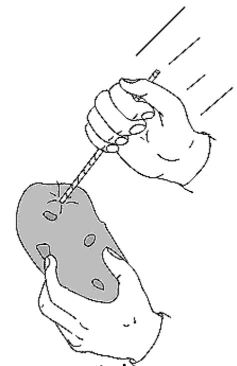
This section is made up of spacesuit pants, boots and the lower half of the waist closure.

Some suits are plain white; some have red stripes; and others have candy cane stripes. These variations help to tell one spacewalker from another.

Primary Life Support Subsystem
The PLSS is worn like a backpack. It provides astronauts many of the things they need to survive on a spacewalk. Its tanks supply oxygen for the astronauts to breathe. It removes exhaled carbon dioxide. It contains a battery for electrical power. The PLSS also holds water-cooling equipment, a fan to circulate oxygen and a two-way radio. A caution and warning system in this backpack lets spacewalkers know if something is wrong with the suit.

Source: Spacesuits and Spacewalks

Astrospud Spacesuit Design Challenge



Names ____

One reason that astronauts wear spacesuits is to protect themselves from potential micrometeoroid and space debris impacts. Small objects traveling at thousands of miles per hour in space can damage spacecraft and spacesuits. Spacesuits are designed with protective layers of material to help keep astronauts working outside a spacecraft safe.

Take on the role of a spacesuit designer in this design challenge. Can you keep your astrospud safe from objects that will try to break through (penetrate), its outer skin? Follow the directions below to guide you through the design challenge.

1. Set one potato aside for the final design presentation.

2. Hold the other potato (the testing potato), in one hand. While grasping the straw with the other hand, stab the potato with a **slow motion**. Observe how deeply the straw penetrates the potato. Record and sketch the results in the box below.

Results

3. Repeat #2, but this time, stab the potato with a fast motion. Observe how deeply the straw penetrates the potato. Record and sketch the results in the box below.

Results

4. Write at least one sentence comparing the results of steps 2 and 3. _______________

____

____

5. Think of ways to protect the astrospud from fast moving objects using the materials your teacher has available for you. **Your astrospud spacesuit must have at least 2 <u>different</u> layers. It cannot have more than 5 layers**!

6. Once you have decided on your final design, put it on the potato you set aside for your presentation. Use tape for layer attachment purposes. Think of the tape as a "zipper" for your astrospud's spacesuit.

7. List the layers you used for your spacesuit starting with the layer that is closest to the potato's skin. The last item you list should be the layer that is on the outside of the astrospud. You should have at least 2 layers, but no more than 5.

Layers	COST
1.	
2.	
3.	
4.	
5.	
FINAL TOTAL	

Finish numbers 8 and 9 below after the performance test.

8. Sketch and record the results of your astrospud spacesuit's performance. Indicate any layer(s) that was penetrated.

9. Explain any changes you would make to your next astrospud spacesuit.

____

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____

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Astrospud Spacesuit Score Sheet

FINAL SCORE

add all points below

Names ____

Complete the information below. The team whose spacesuit scores the highest number of points will win!

1. Layers of astrospud spacesuit
   2 layers..................15 points
   3 layers..................12 points
   4 layers..................10 points
   5 layers.................. 5 points

Points for # of layers

2. Cost of astrospud spacesuit
   $2,000-$3,999............20 points
   $4,000-$6,999........... 18 points
   $7,000-$9,999........... 15 points
   $10,000-$13,999.........12 points
   $14,000-$17,999.........10 points
   $18,000-$21,999...........5 points
   $22,000-$25,000 ....2 points

Our spacesuit cost:

$ ______________

Points for cost

3. Performance
   Astrospud was not punctured during either of the impacts......40 points
   Astrospud was punctured during one of the impacts, but not both impacts........20 points
   Astrospud's potato skin was punctured each time............0 points

Points for performance

4. Teamwork (to be scored by teacher and team)
   Worked very well together (no problems)......20 points
   Some problems, but quickly resolved by team members...... 18 points
   Team required teacher attention at least once...15 pts
   Team required teacher to address issues more than once for not staying on task, using materials incorrectly, arguing, etc. (Points will be determined by the teacher.)

Points for teamwork

Future Spacesuit *(extension activity)*

Name___________________________________

Directions:

Draw your own concept, or idea, of a future spacesuit. Make sure that your "bending points" would match where an astronaut would need to move freely while walking in space. Label important parts of your spacesuit.

Spacesuit History (view Spacesuit Glallery) The photos below are courtesy of NASA. Written information is from How Space Suits Work.

When jet aircraft were developed, pilots needed pressurized flight suits to cope with the low atmospheric pressure and lack of oxygen at high altitudes. Most of these suits were designed to be used only when the pressurized cabin failed. The suits consisted of neoprene rubber-coated fabric that could inflate like a balloon, and a more rigid fabric over the neoprene to restrain the suit and direct the pressure inward on the pilot. Hoses were attached from the plane to the suit to provide oxygen.

Original Mercury 7 Astronauts 1959

When NASA's Mercury program started, the spacesuits kept the designs of the early pressurized flight suits, but added layers of aluminized Mylar over the neoprene rubber. Astronauts found it difficult to move in the Mercury spacesuit when it was pressurized; the suit itself was not designed for spacewalking. However, when NASA's Gemini program began, spacesuits had to be designed not only for emergency use, but also for spacewalking, so some changes had to be made.

To cope with the space environment, the Gemini spacesuit had a human-shaped neoprene rubber bladder that was constrained by netting. Over the bladder, the suit had layers of Teflon-coated nylon to protect the wearer from micrometeoroids. The spacecraft supplied the oxygen and air-cooling through an umbilical cord (shown in the photo below). After the Gemini program, astronauts learned that cooling with air did not work very well. Often, the astronauts were overheated and exhausted from spacewalking; and their helmets often fogged up on the inside from excessive moisture. In the following section, we'll talk about the changes that were made to the spacesuit design for the Apollo.

Gemini Program: Ed White 1965

Apollo Program: Astronaut Jim Lovell

Project Apollo Spacesuit (right picture)

Because Apollo astronauts had to walk on the moon as well as fly in space, a single spacesuit was developed that had add-ons for moonwalking. The basic Apollo spacesuit, which was worn during liftoff, was the backup suit needed in case cabin pressure failed.

present day spacesuit

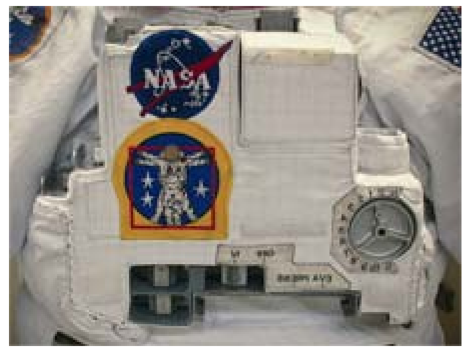
AX-5 hard suit concept developed for future space missions

Future Spacesuits:

Read an article about the BioSuit, "Slimming Down Future Spacesuits."

For more information about the spacesuit designed for the Constellation Program.

Can you design a spacesuit for future astronauts?



Maximum Absorption Garment
Because spacewalks typically last more than six hours without a break, spacewalkers wear adult-sized diapers with extra absorption material under their spacesuits.

Displays and Control Module
This module is the control panel for the mini-spacecraft. Switches, controls, gauges and an electronic display are on the module. The astronaut can operate the Primary Life Support Subsystem from this module.

Communications Carrier Assembly
The CCA is sometimes called the Snoopy Cap. The astronaut wears the cap under the helmet. It has earphones and microphones. It connects to the radio on the spacesuit. Using the CCA, astronauts can talk with the rest of the crew and hear the caution and warning tones.