The NASA "Why?" Files
The Case of the
Inhabitable Habitat

Segment 3

Believing that they have finally found the solution to their habitat food problem, the tree house detectives begin to wonder if it is difficult to adapt to living in space. They visit Dr. D who helps them understand that organisms are constantly changing and adapting to their environment, and that it is not always as easy as it seems. The tree house detectives talk with Dominic Del Rosso at NASA Johnson Space Center to learn how astronauts use the KC-135, sometimes known as the Vomit Comet, to help them learn how to adapt to a space environment. Intrigued to know more about how and why astronauts train to work and live in space, the tree house detectives visit Anthony Uttley at the Sonny Carter Training Facility/Neutral Buoyancy Laboratory in Houston, Texas. Amazed at the intense training the astronauts go through, the tree house detectives decide that they might need to know a little more about the space suit that enables the astronauts to work in space. Amy Ross, at NASA Johnson Space Center, explains all the components that an astronaut must wear, even the MAG, maximum absorbency garment!

Objectives

The students will

- learn that gravity is a force that holds objects to the Earth's surface.
- learn that all organisms must be able to obtain and use resources, grow, and maintain stable internal conditions while living in a constantly changing external environment.
- understand that all organisms have unique adaptations to help them live in their environment.
- understand that regulation of an organism's internal environment involves sensing the internal environment and changing physiological activities to keep conditions within the range required to survive.
- learn that behavior is one kind of response an organism can make to an internal or environmental stimulus.
- learn that human beings depend on their natural and constructed environments.

Vocabulary

adapt - to slowly evolve or change to fit the environment

adaptation - features of organisms that arise over time and enable the organisms to survive in a given environment

altitude - the vertical distance of an object above a given level (such as sea level)

elevation - the height above sea level

gravity - the mutual force of attraction between objects

neutral buoyancy - an object has the same tendency to sink as it does to float

orbital debris - small particles of matter that orbit the Earth

parabola - a plane curve formed by a point moving so that its distance from a fixed point is equal to its distance from a fixed line

sea level - the height of the surface of the sea midway between the average high and low tides

weightlessness - lacking apparent gravitational pull

Video Component

Implementation Strategy

The NASA "Why?" Files is designed to enhance and enrich the existing curriculum. Two to three days of class time are suggested for each segment to fully use video, resources, activities, and web site.

Before Viewing

1. Prior to viewing Segment 3 of *The Case of the Inhabitable Habitat,* discuss the previous segment to review the problem and what the tree house detectives have learned thus far. Download a copy of the Problem Board from the NASA "Why?" Files web site and have students use it to sort the information learned thus far.
2. Review the list of questions and issues that the students created prior to viewing Segment 2 and determine which if any were answered in the video or in the student's own research.
3. Revise and correct any misconceptions that may have been dispelled during Segment 2. Use tools located on the web, as previously mentioned in Segment 1.
4. Focus Questions—Print the questions from the web site ahead of time for students to copy into their science journals. Encourage students to take notes during the show to answer the questions.

View Segment 3 of the Video

For optimal educational benefit, view *The Case of the Inhabitable Habitat* in 15-minute segments and not in its entirety.

After Viewing

1. Lead students to reflect on the "What's Up?" questions asked at the end of the segment.
2. Have students work in small groups or as a class to discuss and list what new information they

have learned about Mars and habitats. Organize the information and determine if any of the students' questions from Segment 2 were answered. Decide what additional information is needed for the tree house detectives to continue designing their habitat for Mars. Have students conduct independent research or provide students with information as needed. Visit the NASA "Why?" Files web site for an additional list of resources for both students and educators.

3. If students are designing their own Mars habitat, have them share their designs thus far and have the class comment on each design by asking questions and offering suggestions.
4. Choose activities from the educator guide and web site to reinforce the concepts discussed in the segment. Pinpoint areas in your curriculum that may need to be reinforced and use activities to aid students' understanding in those areas.
5. If time did not permit you to begin the web activity at the conclusion of Segment 1 or 2, refer to number 5 under "After Viewing" on page 13 and begin the Problem-Based Learning activity on the NASA "Why?" Files web site. If the web activity was begun, monitor students as they research within their selected role, review criteria as needed, and encourage the use of the following portions of the online Problem-Based Learning activity:

   Research Rack - books, internet sites, and research tools

   Dr. D's Lab - interactive activities and simulations

   Media Zone - interviews with experts from this segment
6. Have students write in their journal what they have learned from this segment and their own experimentation and research. If needed, give students specific questions to reflect upon.
7. Continue to assess the students' learning, as appropriate by using their journal writings, checklists, rubrics, and other tools that can be found at the NASA "Why?" Files web site in the "Tools" section of the educators' area.

Careers

pilot
diver
astronaut
payload specialist
engineer
space suit designer

Resources

Books

Hare, Tony: *Animal Habitats: Discovering How Animals Live in the Wild.* Checkmark Book Publishing, 2001, ISBN: 0816045941.

Kozloski, Lillian: *US Space Gear: Outfitting the Astronauts.* Smithsonian Institute, 1994, ISBN: 087474598.

Center for Marine Conservation: *The Ocean Book: Aquarium and Seaside Activities and Ideas for All Ages.* John Wiley & Sons, 1989, ISBN: 0471620785.

Web Sites

Wardrobe for Space
See the latest fashions astronauts wear and learn why space suits are a must if you leave Earth's atmosphere!
http://www.jsc.nasa.gov/pao/factsheets/nasapubs/wardrobe.html

NASA Student Glove Box
Create a glove box to use in the classroom with this NASA Educator Guide. The guide contains instructions for assembly, information about the parts and their functions, as well as a lesson plan for an inquiry-based activity. Artwork for this guide can be obtained for a nominal fee through NASA CORE <http://core.nasa.gov>
http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/NASA.Student.Glovebox/Student.Glovebox.pdf

Send Your Name to Mars
NASA invites you to send your name to Mars on the next Mars Exploration Rover 2003 mission. The project is for people of all ages and is free!
http://spacekids.hq.nasa.gov/2003/

Living in Space
This section of NASA's Human Space Flight Web site includes information on how astronauts eat, sleep, work, and play in space.
http://spaceflight.nasa.gov/living/index.htm

How Stuff Works: How Weightlessness Works
Learn how the human body responds to weightlessness and how astronauts train to overcome many side effects of microgravity.
http://www.howstuffworks.com/weightlessness.htm

How Stuff Works: How Space Suits Work
Great site that takes an in-depth look at past, present, and future space suits, how they work, and what components create the ultimate space suit.
http://www.howstuffworks.com/space-suit.htm

Activities and Worksheets

Newton Would Have Understood the GRAVITY of the Situation

Mass is a measure of the amount of matter in an object, and it depends on the number and kinds of atoms that make up an object. Weight is a term that is sometimes used (incorrectly) interchangeably for mass, but weight is actually a measure of gravitational force on a given mass. Gravitational force is an attractive force that exists between all objects with mass and will vary depending on the mass and distance between objects. The gravitational attraction weakens with greater distance and increases with greater mass. For example, the Moon has much less mass than the Earth, so the Moon has less gravity than the Earth at its surface. A scale measures the force of Earth's gravitational pull on your mass. If you were to weigh yourself on the Moon, the scale would read less than it does on Earth.

To determine your weight when visiting a neighboring planet or the Moon, multiply your current weight in pounds rounded to the nearest 10 by the gravity on each planet.

PLANET	GRAVITY	YOUR WEIGHT
Mercury	0.39	
Venus	0.91	
Earth	1.00	
Earth's Moon	0.16	
Mars	0.38	
Jupiter	2.60	
Saturn	1.07	
Uranus	0.90	
Neptune	1.15	
Pluto	0.05	

Conclusion

1. On which planet did you weigh the least? ________________ the most? ___________________
2. How would knowing the gravity of a planet benefit astronauts before they visit the planet?

Leaf the Wax On

Materials

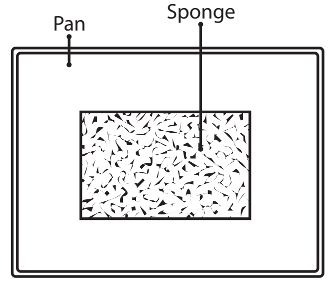
various leaves from deciduous and coniferous trees
2 sponges
water
plastic bag
scissors
2 shallow pans
science journal

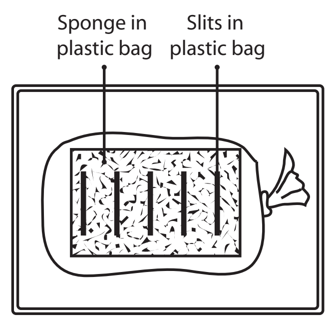
Problem

To learn how some coniferous trees adapt to a dry season

Procedure

1. Observe various leaves from deciduous trees (trees that lose their leaves each winter). Record your observations in your science journal.
2. Observe various leaves from coniferous trees (trees that stay green all year). Record your observations in your science journal.
3. Using your observations, compare and contrast the deciduous and coniferous leaves.
4. To simulate how leaves adapt to a dry environment, perform the following activity. The sponge represents leaves, and the bag represents a waxy coating found on some leaves.
5. Using the scissors, make five small cuts in the plastic bag.
6. Soak each sponge in water and put one sponge in the plastic bag.
7. To seal the bag, tie a knot in the end.
8. Place the bag with cut side up in a shallow pan.
9. Place the uncovered sponge in the other shallow pan.
10. Put both pans in a sunny, warm place.
11. Predict what you think will happen to each sponge after 24 and 48 hours and record in the chart below.
12. Check the sponges each day for three days and record your observations in the chart below.





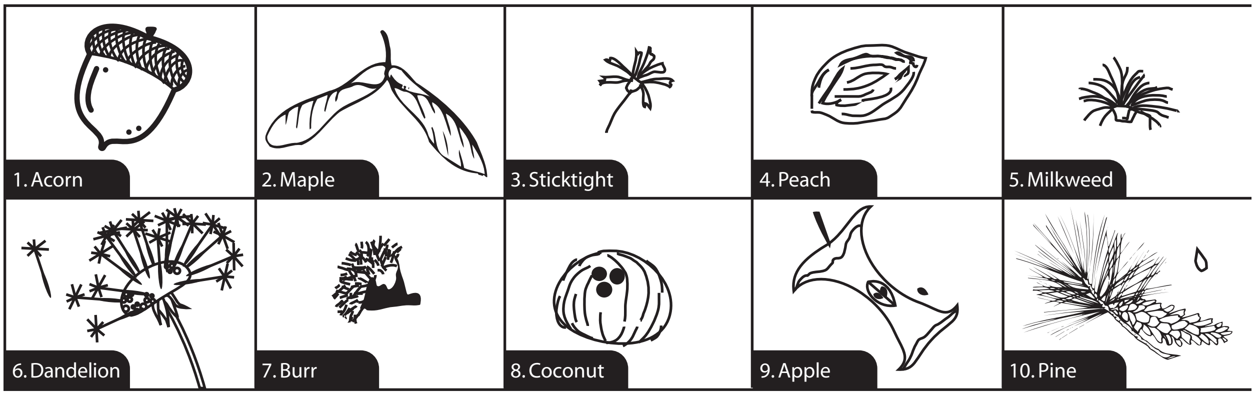
Conclusion

1. Which sponge lost the least amount of water? Why?
2. How might leaves with a wax covering help plants adapt to a dry environment?
3. In your observations of leaves from deciduous and coniferous trees, which ones had a waxy covering?
4. Conduct research to determine which season of the year is the driest, and then explain why coniferous trees might benefit from a waxy covering.

	Prediction 24 hours	Observations 24 hours	Prediction 48 hours	Observations 48 hours
Sponge in Bag				
Uncovered Sponge				

Have Seed Will Travel

Over time, living things make adaptations to survive in their surroundings. If all seeds from a plant fell under the same plant from which they grew, the area would become too crowded and many would not survive. Study the pictures of the seeds below and notice the shapes of the seeds. Think about how the adapted shapes of the seeds might help them to find a new place to grow. List possible ways each seed might travel by using its adaptation. The first one is done for you.



1. acorn an acorn has a hard outer coating that helps it "keep" for a long time. It also tastes good to a squirrel, and squirrels bury acorns in the ground. Lots of times they forget where they buried them, and then the acorn will sprout into a new tree in the spring.

2. maple ______________________

3. sticktight ______________________

4. peach ______________________

5. milkweed ______________________

6. dandelion ______________________

7. burr ______________________

8. coconut ______________________

9. apple ______________________

10. pine ______________________

Star Training

Materials

small hand-held mirror
pencil

Problem

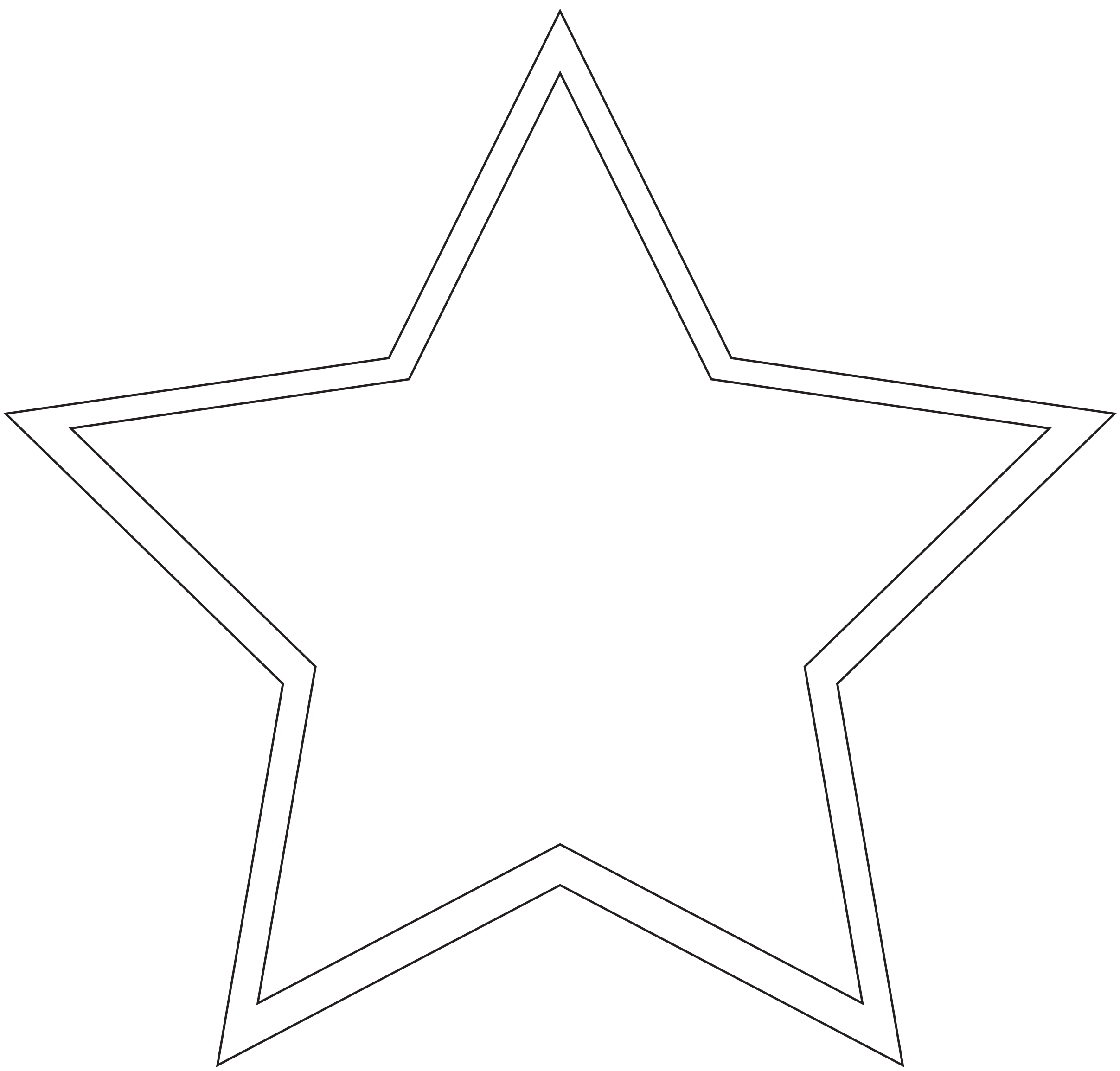
To learn how difficult it is to adapt to a foreign environment

Procedure

1. Hold the mirror next to the star so that you can see the reflection of the star in the mirror.
2. Take a pencil and try to trace the star by only using the mirror to guide you. Don't look at the paper or your hand.
3. After everyone has had a turn trying to trace the star, discuss what was difficult and what was easy about this exercise.

Conclusion

1. Would you get better with practice?
2. Discuss why it is important for astronauts to train and practice their space "work" for many months before going on a mission.

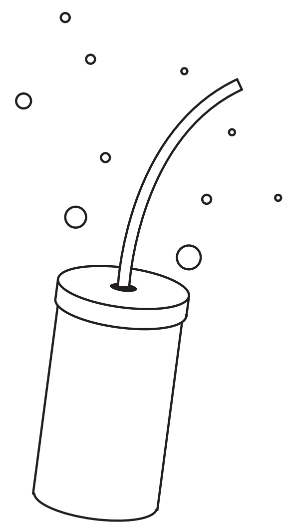


Float or Sink? Neutral Buoyancy

Astronauts simulate microgravity for space suit training in a deep swimming pool (the Sonny Carter Training Facility/Neutral Buoyancy Laboratory). Their space suits are specially weighted to produce neutral buoyancy. Use the two activities below to investigate neutral buoyancy.

Dive, Dive, Dive!

1. With adult supervision, use the scissors to punch two holes in the base of the canister and a hole in the lid.
2. Have an adult hot glue one end of the aquarium tube into the hole in the lid.
3. Add several pennies to the canister and check to see if the canister floats in the water. If not, take a penny out and test the canister again.
4. Place the lid on the canister and put your submarine into the water.
5. Suck the air out of the tube and observe. What happened? Why?
6. Blow air into the canister and observe. What happened? Why?
7. Try to fill the canister with just enough air so that it can "hover" halfway from the bottom to the surface.



Materials

plastic film canister (submarine)
aquarium tubing
pennies
hot glue (adult supervision required)
scissors or sharp, pointed item (adult supervision required)
large bowl, sink, or aquarium full of water

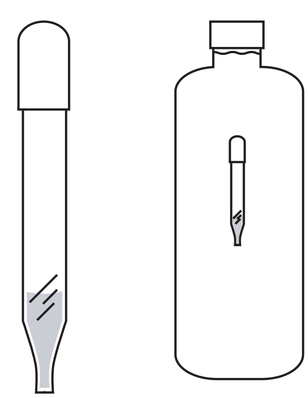
Diver, Stand Your Mark

1. Fill the bottle with water.
2. Fill the eyedropper about 2/3 full of water.
3. Insert the partially filled eyedropper into the bottle and cap the bottle.
4. Squeeze the bottle's sides and observe the diver. What happened? Why?
5. Let go of the bottle and observe. What happened? Why?
6. Try to make the diver "hover" midway in the bottle.

   *Note: The diver may not dive if filled with too much water. Adjust the amount of water in the diver for success.

Materials

plastic 2-liter soft drink bottle
water
eyedropper (diver)



Vomit Comet

Problem

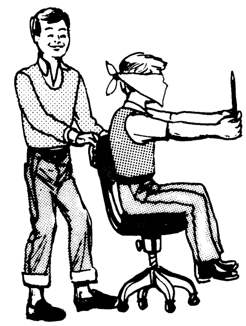
To learn that motion can cause disorientation
To understand why astronauts train to live and work in space

Materials

swivel chair
blindfold
pencil

Procedure

1. Have your partner sit in the swivel chair and put on a blindfold.
2. Ask your partner to place his arms out in front of his/her body while holding a pencil in an upright position. See the diagram.
3. Have your partner point the pencil in the direction of rotation as you turn the chair.
4. Observe the pencil.
5. Slowly stop the chair and then turn it in the opposite direction.
6. Observe the pencil.
7. Repeat steps 3-5, turning the chair in the opposite direction.
8. Remove the blindfold and let your partner sit for a few minutes to regain orientation.
9. Change places with your partner and repeat the experiment.



Conclusion

1. In what direction did your partner point the pencil after the first rotation? When the chair stopped? After the second rotation?
2. How do our senses help orient us in space?
3. When living and working in space, should astronauts trust their eyes or their sense of motion?

Extension

1. Sit in the swivel chair and have your partner spin you for about thirty seconds. Once the chair comes to a stop, try tossing a ball into a wastepaper basket placed 1.5 meters away. Describe what happened and how you felt.
2. Stand facing a friend. Turn around five times fast and face the friend again. Close your eyes. How do you feel? Do you feel like you are still moving? Open your eyes and find out.

** Note: A stirred pot of liquid continues to spin even after the spoon is removed. The fluid in the inner ears also keeps spinning even after your body stops spinning. In free fall, the effect is even more noticeable.

Bending Under Pressure

Problem

To learn how space suits are made mobile

Materials (per group)

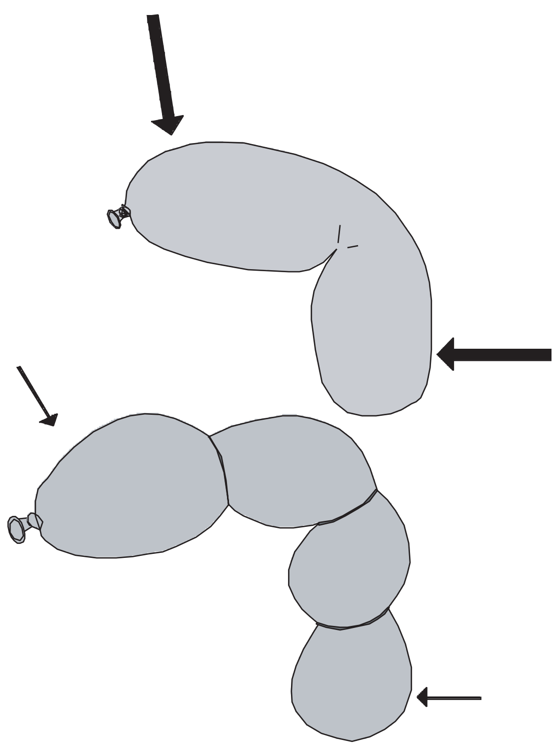
2 long balloons
3 metal craft rings or plastic bracelets

Procedure

1. Inflate one balloon fully and tie off the end. The balloon represents the pressure bladder of a space suit arm.
2. Try bending the balloon.
3. Begin to inflate the second balloon, but while inflating, slide on the craft rings over the balloon so that the balloon looks like sausage links.
4. Observe and record observations in your science journal.
5. Try bending the second balloon with the metal craft rings.
6. Observe and record observations in your science journal.
7. Discuss your observations.
8. Compare and contrast the two balloons.

Conclusion

1. Why is it important to maintain proper pressure inside a space suit?
2. What would happen if there were too much pressure in a space suit?
3. How did the craft rings make the balloon bend more easily?



Properly Gloved

Problem

To experience the difficulty of performing fine motor tasks in space

Materials (per group)

thick, insulated ski gloves or heavy rubber work gloves
miscellaneous tools and other items such as needle-nose pliers, socket wrenches, small machine screws and nuts, Tinker Toys™, Legos™, screwdriver, paper, and pencil

Procedure

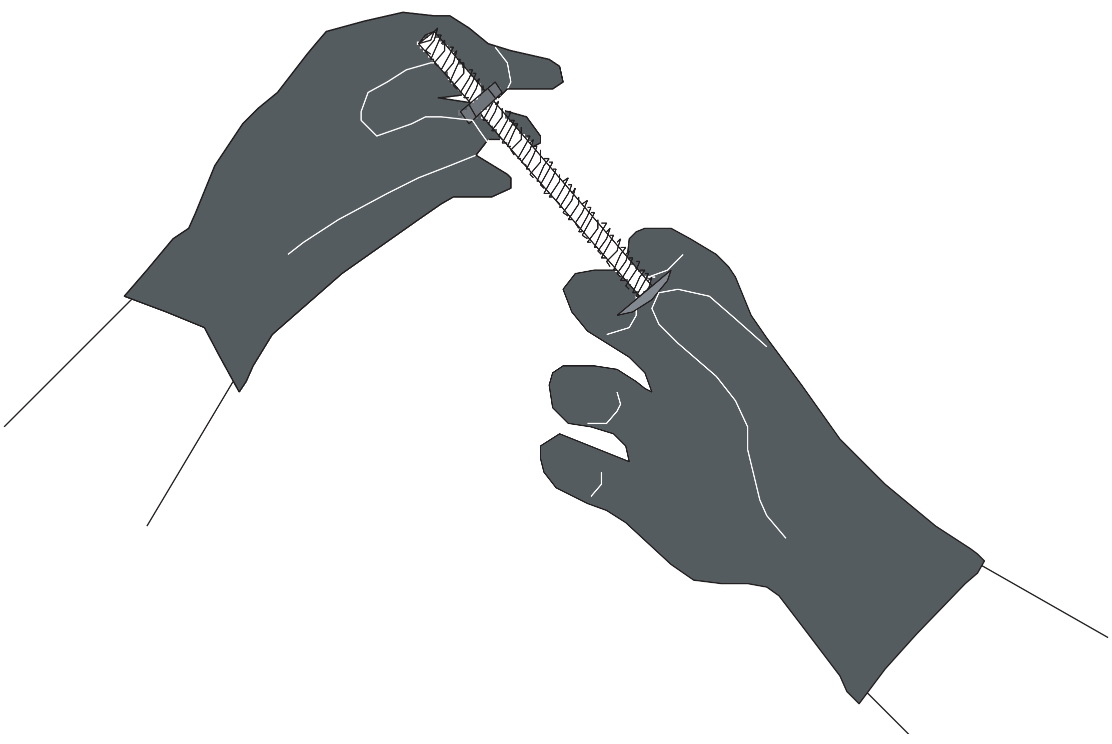
1. Put on a pair of the gloves and flex your fingers to get adjusted to the feel.
2. Using the various objects, try to perform several tasks such as writing your name and address, placing a nut on the end of a machine screw, or creating an object with Legos™.
3. Perform the same tasks without gloves.
4. Compare and contrast performing the tasks with and without gloves.
5. Discuss how to design future tools to make the astronauts work in space easier.
6. Illustrate your new designs.

Background

Space suit gloves can be stiff and hard to work in. The gloves worn by Apollo astronauts on the Moon caused much finger fatigue and abrasion during long Moon walks. Designers for the Shuttle space suit have placed special emphasis on making pressurized gloves more flexible and easy to wear. Designing flexible gloves is not easy because, when inflated, gloves become stiff just like an inflated balloon. Designers have used finger joints, metal bands, and lacings to make gloves easier to use. However, even with very flexible spacesuit gloves, small parts and conventional tools can be difficult to manipulate.

Extension

Put on a pair of thin latex gloves and try performing the same task. Compare the ease of performing the tasks with thin gloves, heavy gloves, and without gloves.



Answer Key

Leaf the Wax On

1. Because the water was able to evaporated more easily, the uncovered sponge had the least amount of water.
2. A wax covering on a leaf would help the leaf to lose less moisture, and this is beneficial during the dry season when there is not a lot of rainfall.
3. Many coniferous trees have a wax covering on their leaves.
4. Typically, the driest season is winter. In most areas, there is not only less sunlight, but there is also less rainfall during the winter months. Less rainfall makes it more difficult for a tree to survive and support any growth activity during winter. Coniferous trees do not drop their leaves and go dormant during the winter months like deciduous trees. They have to develop ways of adapting to the drier winter months. One adaptation is the waxy covering on their leaves.

Have Seed Will Travel

1. Completed on activity sheet (p. 41).
2. This seed has "wings" that let it "fly" away on the wind from its parent plant.
3. This seed is a hitchhiker. It has burr-like fruit that attaches itself to animals by sticking to clothing, hair, or fur and is carried from place to place.
4. This seed is inside a fruit that is eaten by animals. The animal digests the fruit but not the seeds. They pass through the animal and are deposited in various places away from the parent plant.
5. This seed has a tiny parachute attached to it. It can be carried a long way by the wind.
6. Same as 5.
7. Same as 3.
8. This seed may look heavy, but it has a hollow center surrounded by a tough, waterproof coating that enables it to float and be carried to other parts of the coastline or even to other islands.
9. Same as 4.
10. Same as 2.

Star Training

Tracing the star was difficult because you only used the mirror and that made things "backwards" and unfamiliar. With practice you would get better at tracing the star. Practice is important in astronaut training so that the job they have to perform is familiar, making it easier for them to perform the task. Months of practice keeps mistakes to a minimum when an astronaut is in space working on millions and sometimes billions of dollars worth of equipment!

Vomit Comet

1. Answers will vary.
2. Our senses help orient us to our environment. If one sense is not capable of being used, the other senses will become more acute. However, in a space environment, the sense of movement cannot always be trusted!
3. Astronauts should trust their eyes!

Bending Under Pressure

1. It is important to maintain proper pressure inside a space suit so that an astronaut's blood does not boil.
2. Too much pressure in a space suit stiffens the walls and makes it hard to bend. It would be impossible for an astronaut to function effectively in a stiff suit.
3. The craft rings provide breaking points that help make the suit more bendable. The breaking points help form joints that bend more easily than materials that are not jointed.

Neutral Buoyancy

Dive, Dive, Dive: When you sucked the air out of the canister, it caused it to sink because you no longer had an air bubble trapped to help the canister float. When you blew air back into the canister, you created the air bubble necessary for flotation.

Diver, Stand Your Mark: When you squeezed the sides of the bottle, you increased the pressure inside the bottle. The air trapped inside the eyedropper also compressed and created more space in the dropper for water - the more water added, the more weight inside the dropper. It sank. By releasing the sides of the bottle, you released the pressure, causing it to go back to its original state.