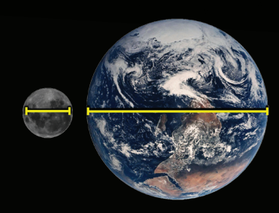
HUMANS IN SPACE

Measuring Distances to Space Destinations

Robotic spacecraft have explored many regions in our solar system, but crewed vehicles have ventured only to the Moon and certain orbiting satellites such as the International Space Station.

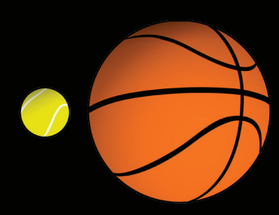
The next chapter in human spaceflight will be sending humans to Mars and back! The mission will last about 2 years. The ISS is an ideal platform for humans to prepare for this and other long-duration missions.



Let's compare the distances between Earth and the space destinations where we've been and where we're headed.

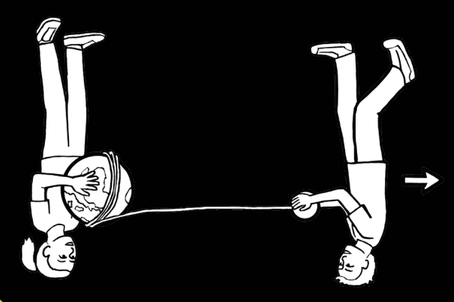
MATERIALS

- Spheres representing Earth and the Moon. The Moon's diameter should be about 1/4 of the Earth's diameter. A good pairing is a basketball for Earth with a tennis ball for the Moon.
- Pin, paper cutout, or other small object representing the ISS
- String about 9 meters (30 feet) long



PROCEDURE

1. Give the Earth to one volunteer and the Moon to another. Ask them to move to positions that they think show the distance between the Earth and the Moon.
2. Ask the Earth volunteer to wrap the string around the planet 9.5 times to approximate the distance between Earth and the Moon. Tape the Earth model to that place on the string.
3. Give the end of the string to the Moon volunteer and ask the volunteers to move apart until the string is extended. The distance is probably farther than they expect!
4. Give another volunteer the object representing the space station and ask how close it should be to the Earth model. If Earth is a basketball, the ISS is just 8 millimeters away!



EXTENSION

Add a red ball to represent Mars. Its diameter should be about half of Earth's. Give Mars to another volunteer and ask where Mars should be in relation to the Earth and Moon. If Earth were the size of a basketball, the average distance to Mars would be 4.2 km (2.6 miles)!

DESIGN A SPACE STATION

The International Space Station was was assembled in orbit from many segments that were built in different countries. It has fourteen pressurized modules plus a truss, huge solar panels, and two robotic arms. It contains two bathrooms, six sleep stations, and areas for exercising and preparing food. It also has many workspaces for maintaining the station's systems and doing science experiments. There is even a small onboard garden where the astronauts can grow fresh vegetables!

YOUR MISSION

Use the engineering design process to create one or more space station modules with the materials provided. Work as a team to assemble everyone's modules into a complete space station.

MATERIALS

- Clean, empty 2-liter bottles
- Utility knife (Safety Note: Requires adult supervision and assistance)
- Tape
- Aluminum foil
- Pieces of cardboard or foam core
- PVC pipe fittings: elbows, T-fittings, and/or 4-way fittings
- Miscellaneous materials (modeling clay, toothpicks, construction paper, craft foam, pipe cleaners, etc.)

ANALYZE AND REFLECT

Discuss as a group:

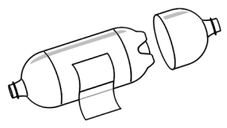
1. Which materials were most important in your space station design?
2. What were advantages and disadvantages to designing and building as a team?
3. What did you learn from seeing the others' creations?
4. After doing this activity, what new questions do you have about the International Space Station? Where will you look for the answers?

IMAGINE AND DESIGN

After visiting **spacestationexplorers.org** and learning about the ISS, brainstorm and write down your ideas. What does a space station need to keep humans alive? What is it like to live, work, eat, and sleep in space? Would you need chairs, tables, or beds? How would you exercise? Where would your electricity and water supply come from?

BUILD

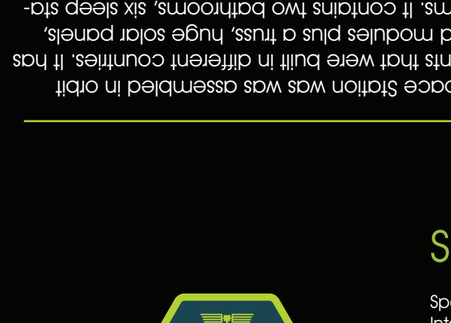
Cut a window in the side of each bottle to access the inside. As you create the interior of your module, you can use all the materials provided or choose only some of them.



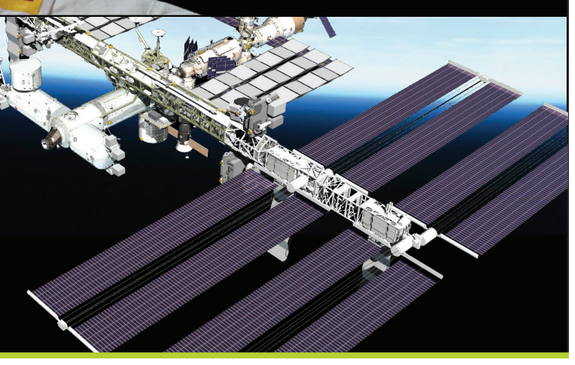
TEST AND REDESIGN

Pick up and rotate your module. Remember that in microgravity there is no sense of up or down and loose items can float freely and get lost. Do you need to modify your module for microgravity?

When you're ready, work with the other builders to assemble all the modules using PVC pipe fittings and tape. Make the solar panels out of cardboard and aluminum foil.



WELCOME TO THE INTERNATIONAL SPACE STATION



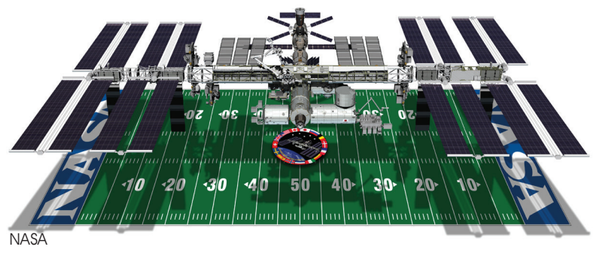
The World's Orbital Laboratory

The International Space Station (ISS) is one of humanity's greatest achievements in engineering and cooperation. It orbits about 400 km (250 miles) above Earth's surface at 28,000 km (17,500 miles) per hour.

In 2005, Congress designated the U.S. segment of the ISS as the newest national laboratory. The many areas of science being explored onboard the ISS National Lab include life sciences, physical sciences, Earth observation, materials science, technology development, and human research.

In the microgravity environment of the ISS, fires burn differently, liquids crystallize differently, and living cells (including the cells in astronauts' bodies) change their behavior. On the station's exterior, experiments can be exposed to conditions including vacuum, increased radiation, and extreme temperature changes.

Research in this unique setting has led to improvements in medicine, technology, and other applications that benefit people here on Earth!



NASA

INTERNATIONAL SPACE STATION FACTS

- Assembling the ISS took 35 space shuttle missions and more than 150 spacewalks between 1998 and 2011.
- The space station, including its large solar arrays, spans the area of a U.S. football field.
- The mass of the ISS exceeds 419,600 kilograms, equivalent to 925,000 pounds or more than 320 cars!
- In one day, the ISS travels the same distance as flying from Earth to the Moon and back!
- The ISS completes one orbit around Earth every 92 minutes, letting astronauts see 15 or 16 sunrises and sunsets every 24 hours.
- The ISS has been continuously inhabited since 2000, usually with six people onboard.
- Since 2011, all crews have traveled to and from the ISS on Soyuz capsules, which fit three people. It takes about 4000 kilograms (8800 pounds) of supplies to support three astronauts for a typical six-month stay.
- As of April 2019, 236 people from 18 countries have spent time on the space station.

Continue exploring the ISS through the activities on these pages and at spacestationexplorers.org!

SPACE STATION EXPLORERS

Space Station Explorers

Space Station Explorers is a consortium of organizations that use the International Space Station to inspire and engage educators, learners, and explorers of all ages. With support from the ISS National Laboratory, consortium partners develop innovative, authentic learning experiences in science, technology, engineering, and math (STEM). Students can talk with astronauts, monitor and contribute to current space-based investigations, and even design their own experiments to launch to the ISS!

spacestationexplorers.org

ISS U.S. NATIONAL LABORATORY

The ISS National Laboratory

In 2005, Congress designated the U.S. portion of the ISS as the nation's newest national laboratory to maximize its use for improving quality of life on Earth, promoting collaboration among diverse users, and advancing science, technology, engineering, and mathematics (STEM) education. This unique laboratory environment is now available for use by non-NASA U.S. government agencies, academic institutions, and the private sector, providing these customers access to a permanent microgravity setting, a powerful vantage point in low Earth orbit, and the extreme and varied environments of space. The ISS National Lab is managed by the Center for the Advancement for Science in Space (CASIS) under agreement with NASA.

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