
FROM THE DIRECTOR OF
IMAX
HUBBLE 3D
IMAX
A BEAUTIFUL
PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE
NARRATED BY JENNIFER LAWRENCE
IMAX ENTERTAINMENT PRESENTS "A BEAUTIFUL PLANET"
IN COOPERATION WITH THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NARRATED BY JENNIFER LAWRENCE DIRECTOR OF PHOTOGRAPHY/ ASTRONAUT TRAINING MANAGER JAMES L. NEIHOUSE, ASC
SPACE OPERATIONS MARSHA IVINS WRITTEN AND EDITED BY TONI MYERS MUSIC BY MICKY ERBE AND MARIBETH SOLOMON
SOUND DESIGN PETER THILLAYE EXECUTIVE PRODUCER GRAEME FERGUSON CO-PRODUCER JUDY CARROLL PRODUCED AND DIRECTED BY TONI MYERS
G GENERAL AUDIENCES All Ages Admitted
IMAX
IMAX.COM/ABP
Distributed by IMAX CORPORATION, ©2016 IMAX CORPORATION
IMAX® IS A REGISTERED TRADEMARK OF IMAX CORPORATION
EXCLUSIVELY IN IMAX AND IMAX 3D THEATRES
GIBRALTAR STRAITS AS PHOTOGRAPHED BY
THE INTERNATIONAL SPACE STATION

EDUCATOR'S RESOURCE GUIDE Grades 3-5

IMAX® A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

Dear Teacher:

Take your students on an awe-inspiring trip around our world: a magnificent blue planet, dotted with gossamer clouds and gleaming in sunlight, whose beauty transforms and evolves with each passing day.

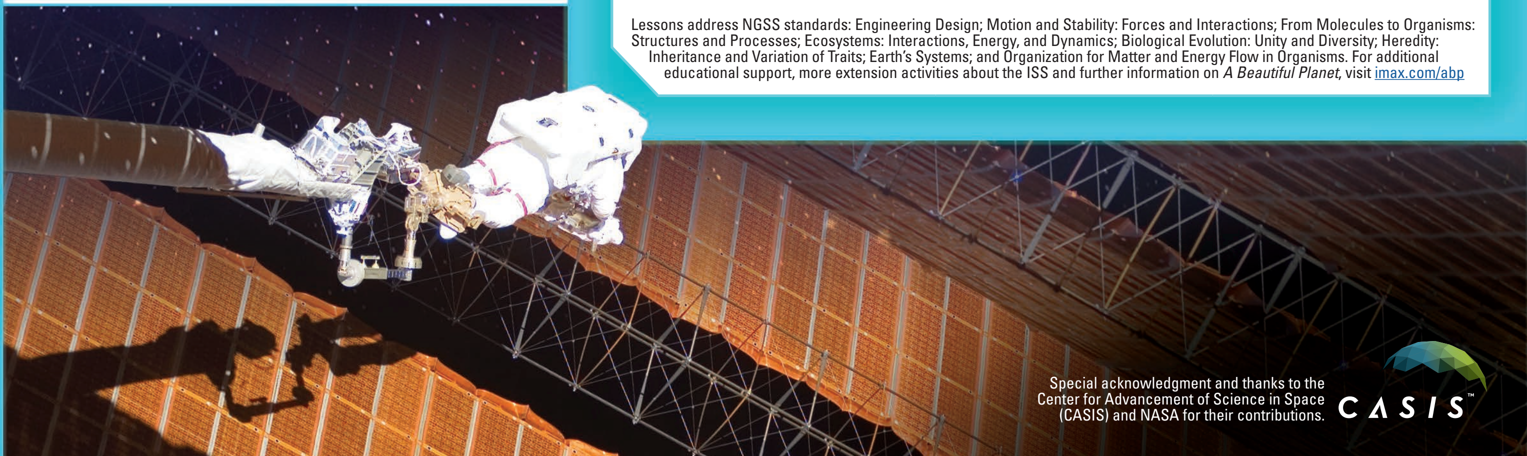
We invite you and your students to look through the eyes of astronauts on the International Space Station (ISS), witnessing breathtaking views of Earth and taking a hopeful look into the future of humanity and beyond in *A Beautiful Planet*. Book a field trip to your local IMAX® theatre to give your students a closer look at the wonders of our world. The engaging classroom activities in this guide, inspired by the film, will enhance your students' understanding of the Earth, the importance of the ISS, and the work that's being done to conserve our planet and its resources. Visit **imax.com/abp** for additional activities and fun facts.

Enjoy the show!

To book a field trip, contact your local IMAX theatre today. Visit www.imax.com/subscribe to sign up for the latest news and updates on IMAX educational programs and events. For locations near you, visit IMAX.com.

	EARTH OBSERVATION FROM THE ISS	ENGINEERING MARVEL	DESIGN A SPACE STATION
Objectives	Students will identify the regions, landmarks, and activities presented by each astronaut photograph taken from the ISS.	Students will understand the uniqueness and importance of the ISS from a science, engineering, and cultural point of view.	Students will use teamwork to design, engineer, and build their own Space Station.
Teacher Prep	Introduce students to an overhead perspective of Earth from the ISS approximately 250 miles above the planet's surface. Discuss how parts of the planet may look different from space than they do from the ground. Once students complete the activity, lead a discussion based on each image.	Begin by going over all the different modules of the ISS with students and discuss why each part is important to the Space Station's success. Discuss why the ISS and the astronauts who live on it are important.	Lead students in a discussion on what rooms, or modules, a house has; for example, a kitchen, a sleeping area, a bathroom, and a living room. The ISS has the same rooms that a house might have in addition to a laboratory for experiments. Use the items below to demonstrate how to connect bottles with PVC connectors in order to build their own Space Station. **You Will Need:** PVC pipe connectors (T-connectors, elbow connectors, and straight connectors); two-liter bottles; stiff cardboard; foil; sharp scissors; glue; tape; colored permanent markers.
Extension Activity	Visit http://www.windowsonearth.org to see more beautiful images of the earth from space.	Engage students by visiting the following website and watching videos about the ISS: http://www.SpaceStationExplorers.org These videos will highlight all the modules of the ISS and give students a more visual understanding of the Space Station as a whole.	Try adding a robotic arm to service your Space Station. Learn more about the robotic arm of the ISS at: http://bit.ly/Canadarm2

Lessons address NGSS standards: Engineering Design; Motion and Stability: Forces and Interactions; From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Heredity: Inheritance and Variation of Traits; Earth's Systems; and Organization for Matter and Energy Flow in Organisms. For additional educational support, more extension activities about the ISS and further information on *A Beautiful Planet*, visit imax.com/abp



Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

WHAT ON EARTH IS THAT?

EARTH OBSERVATION FROM THE INTERNATIONAL SPACE STATION

GRADE NAME

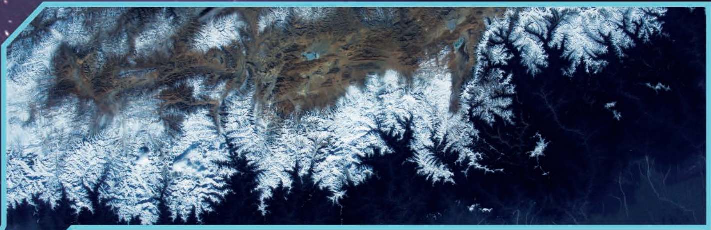
The International Space Station (ISS) has a module, or room, called the cupola. The cupola is a dome-shaped room with seven windows where astronauts control the Space Station's robotic arm, communicate with other crew members, and observe spacewalks. It is also a favorite hangout for astronauts who take hundreds of photos of the Earth each day! These photos help us understand and appreciate our home planet.

YOUR MISSION

Below are five images of different locations on Earth. Pay close attention to the details in each image to determine its location.

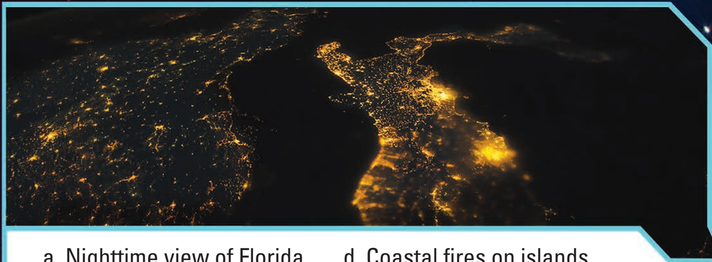
YOUR TASK

Select the correct description to become an Eagle-Eye Astronaut!



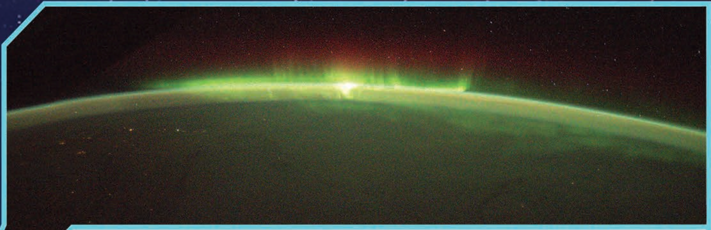
1

a. Cotton fields in the southern United States
b. Puffy, cumulus clouds over the eastern coast of Africa
c. Air pollution over Beijing, China
d. Glaciers atop Mt. Everest in the Himalayan Mountains
e. An iceberg floating in the Arctic Ocean



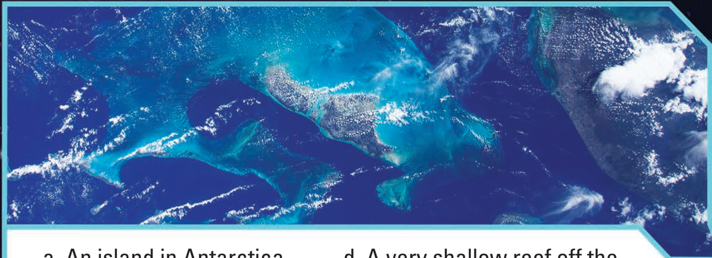
2

a. Nighttime view of Florida
b. Nighttime close-up of a city near a Russian mountain range
c. Nighttime view of Italy
d. Coastal fires on islands off mainland China
e. Highway lights at night in Chile, near Patagonia



3

a. Snow swirling on massive ice floes near Barrow, Alaska
b. A rare tropical snowstorm
c. Northern lights (Aurora) over the North Pole in winter
d. Close up of clouds over mountains above a city
e. Transportation routes between Russia and the United States in winter



4

a. An island in Antarctica
b. An island in the Bahamas off the U.S. coast
c. The Great Barrier Reef in Australia
d. A very shallow reef off the coast of South America
e. An underwater mountain in the middle of the Pacific Ocean

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

BONUS An astronaut on the Space Station photographed Hurricane Olaf as the orbiting laboratory passed over the Pacific Ocean, as part of a study on severe storms.

Hurricanes north of the equator spin, in a counterclockwise direction. Which way do hurricanes rotate south of the equator?

a. They do not rotate
b. Clockwise direction
c. Counterclockwise direction

THE INTERNATIONAL SPACE STATION

AN ENGINEERING MARVEL

NAME

GRADE

YOUR MISSION

Read the passage on the right about the International Space Station (ISS). Even though there are missing words, can you guess which word belongs in each blank? Use the Word List to complete the selection. Each word will only be used once.

WORD LIST

- crane
- Space Station
- modules
- solar arrays
- soccer
- Earth
- telescope
- sleeps
- orbit
- plant
- spacewalk
- 90 minutes
- automobiles

The ISS is an engineering marvel! It was constructed in space by 16 different countries over 10 years. The ISS weighs 460 tons – that's more than 320 ____________________! It is approximately the size of a U.S. football field, or more than 1.5 __________________ fields. A crew of six people live and work on the ISS, which travels at a speed of 5 miles per second (8 km per second). At that speed, it takes ____________ ______________ to make one complete path, or ______________, around the Earth! This is why astronauts on the ISS see about 15 sunrises and sunsets every 24 hours.

The ISS is made up of many rooms, or _________________. Some are used for storage and contain life-support systems, and others are where the crew works and _______________. In 2005, Congress designated the U.S. part of the ISS as the nation's newest national laboratory. It is here that astronauts work on life and _______________ science experiments that may benefit people living on Earth. The Cupola module is a favorite spot for astronauts. It is a 7-window observation area where astronauts can view __________ from 250 miles (402 km) straight up!

More than one acre of ____________ _____________ provide power to this orbiting laboratory, making it the third-brightest object in the night sky. The ISS is so bright, that it can be seen without a __________________ at night. It looks like a fast-moving airplane, but it is many times higher and travels much, much faster than an airplane.

Another important feature of the ______________ _______________ is the Canadarm2. It is a huge, remote-controlled robotic arm that works like a ______________. It can be used to help astronauts perform tasks outside of the Station during a ______________________.

For a tour of the ISS visit:
http://www.SpaceStationExplorers.org

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

ANSWERS (in order): automobiles, soccer, 90 minutes, orbit, modules, sleeps, plant, Earth, solar arrays, telescope, Space Station, crane, spacewalk.

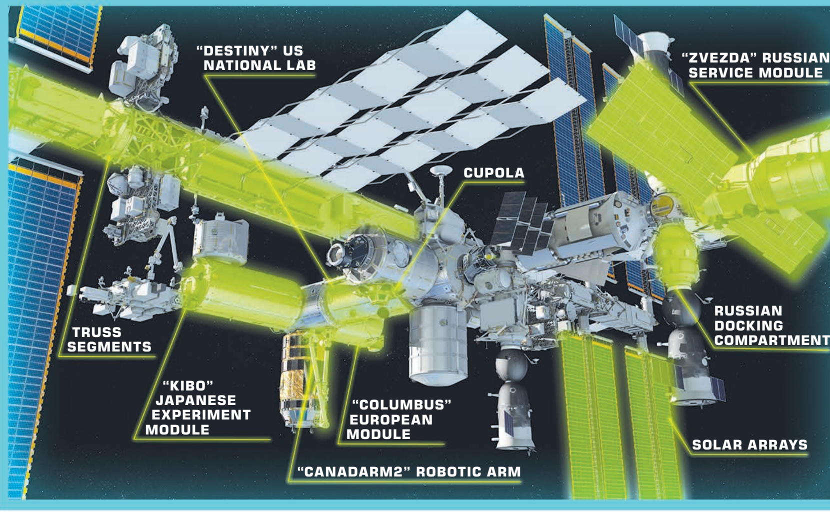
GRADE NAME

DESIGN A SPACE STATION

The International Space Station (ISS) travels in a path, or orbit, above Earth. It makes one complete orbit every 90 minutes traveling at 5 miles per second, or 17,500 mph (28,163kph)! Astronauts live and work there conducting science experiments and learning about life in space. Astronauts are transported to the ISS via rocket.

YOUR MISSION

An engineer designs tools and machines to solve problems. Imagine you are an engineer. How could you design a Space Station like the one the astronauts are living and working in?

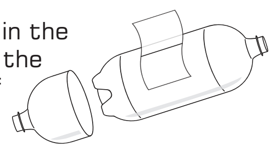


YOUR TASK

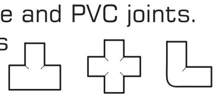
1 BRAINSTORM Work as a team to brainstorm a design for your Space Station. What does a Space Station need to keep humans alive? What is it like to live in space? Would you float instead of walk? How would you sleep? How would you exercise? How will you provide electricity for living and working?

2 LIST Examine the materials your teacher has made available. Make a list of the materials you will use to create your Space Station and draw a sketch of your team's design before you build it.

3 DESIGN Cut out a window in the side of each one of the bottles and design the inside of each room, or module.



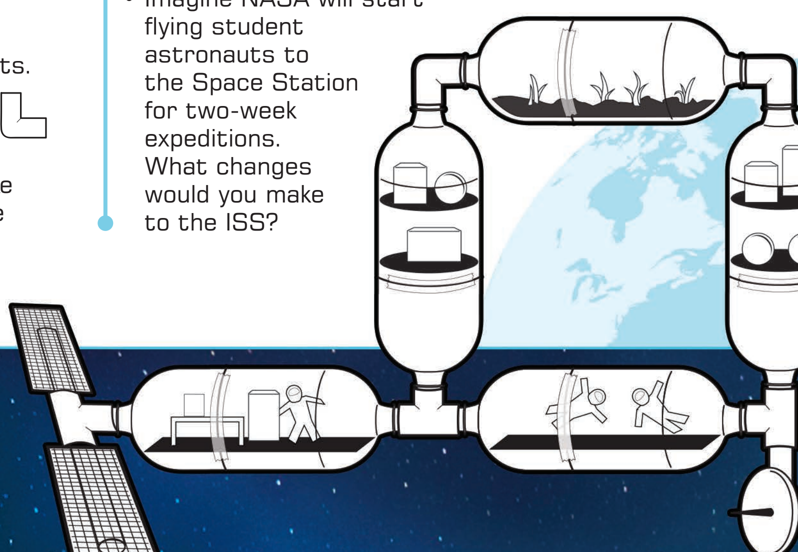
4 ASSEMBLE Connect your Space Station's modules using glue and PVC joints. You can use tape to hold the joints together while the glue dries.



5 TEST Test your team's Space Station to make sure it is strong and will not break where the modules connect. List the strengths and weaknesses of your design and note any ways you could make it more functional and livable.

6 DEBRIEF Discuss with your team:

- Did your team use all the materials provided? Why or why not?
- Which materials were most important in your Space Station design?
- How did working as a team help in the design process?
- Were there any disadvantages to designing and building as a team?
- What did you learn from seeing what the other teams developed?
- What advice would you give to a team that was about to complete this same task?
- Imagine NASA will start flying student astronauts to the Space Station for two-week expeditions. What changes would you make to the ISS?



IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

DESIGN A SPACE GARDEN

RESEARCH ON THE ISS

NAME

GRADE

OBJECTIVE	TEACHER PREP	EXTENSION ACTIVITY
Students will design and build their own plant growth chamber.	Encourage students to brainstorm answers to the following questions: • What environments and nutrients do plants require to grow? • How do astronauts get food sent to them and how do they grow plants and vegetables on the ISS? **You will need:** Computer with Internet connection, cardboard, Styrofoam supermarket trays, egg cartons, clay and plastic pots, plant seeds, soil and water.	Encourage students to research microgravity and its effects on the human body and the atmosphere.
These lessons address NGSS standards: Engineering Design; Motion and Stability: Forces and Interactions; From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Heredity: Inheritance and Variation of Traits; Earth's Systems; and Matter and Energy in Organisms and Ecosystems.		

BACKGROUND

The U.S. National Laboratory on the International Space Station (ISS) is different from laboratories on Earth because there is very little gravity. Because of this, scientists like to study how plants respond to their environment in microgravity. As they discover more about changes in growing "space plants," the possibilities of growing plants on other planets becomes more likely.

DID YOU KNOW?

- For the first time in history, astronauts ate lettuce that they grew and harvested on the ISS in August of 2015.
- Plants like rice, tulips, onions, peas, radishes, lettuce, wheat and cucumbers have been grown on the ISS.
- Astronauts on the ISS have to perform many different experiments each day. Some experiments include living plants and animals.

Top: Japan Aerospace Exploration Agency (JAXA) astronaut Kimiya Yui unpacks a supply of fresh fruit delivered to the ISS.

Bottom: Japan Aerospace Exploration Agency (JAXA) astronaut Kimiya Yui and NASA astronauts Kjell Lindgren and Scott Kelly sample space-grown lettuce from the Vegetable Production System on the ISS.

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

DESIGN A SPACE GARDEN

RESEARCH ON THE ISS

NAME

GRADE

1

YOUR MISSION

Scientists are always exploring how to improve the different ways we grow food. With so many people on the planet, researchers and farmers need to find creative and efficient ways to grow crops. Your mission is to use the knowledge you've gained about plants in space to design and build your own unique plant growth chamber.

YOUR TASK

PART 1: HOW DOES YOUR GARDEN GROW IN SPACE?

1. Watch this NASA video about growing plants in space. https://www.youtube.com/watch?v=SgpUO8WJmOc
2. Talk about the video and steps to growing a garden in space as a group.
3. Watch this NASA video of astronauts taking their first bites of fresh space-grown lettuce on the ISS. https://www.youtube.com/watch?v=Yp6zLISoTOk

PART 2: HOW CAN I ENGINEER A PLANT GROWTH CHAMBER?

1. Use **Handout A – Research and Design: Space Station to Home: Design Your Own Plant Growth Chamber** to guide your engineering path. Start by doing research on the Internet or at the library about various plant growth chambers. Pay close attention to how the different containers help the plants being grown in them.
2. Write down questions you have about creating a plant growth chamber.
3. Draw some design ideas for your plant growth chamber and label the parts. Make a list of materials you will use to build your plant chamber.

PART 3: LET'S BUILD!

1. Select your favorite design for a plant growth chamber from the designs you created on Handout A.
2. Get the design approved by your teacher. Build your growth chamber from the materials provided by your teacher. Set up the seeds or plants for growth.

PART 4: TRACK RESULTS AND SHARE!

1. Use **Handout B – Observation and Results: Space Station to Home: Design Your Own Plant Growth Chamber** to track your results over time.
2. Share your results with your class. Be sure to share your plant growth results, your design build from start to finish and how you can improve your design.

IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

DESIGN A SPACE GARDEN

RESEARCH ON THE ISS

NAME

GRADE

HANDOUT A
RESEARCH AND DESIGN

Space Station to Home:

DESIGN YOUR OWN PLANT GROWTH CHAMBER

RESEARCH NOTES

MY QUESTIONS

MY PLAN

Draw and label your design

DESIGN A SPACE GARDEN

RESEARCH ON THE ISS

NAME

GRADE

HANDOUT B

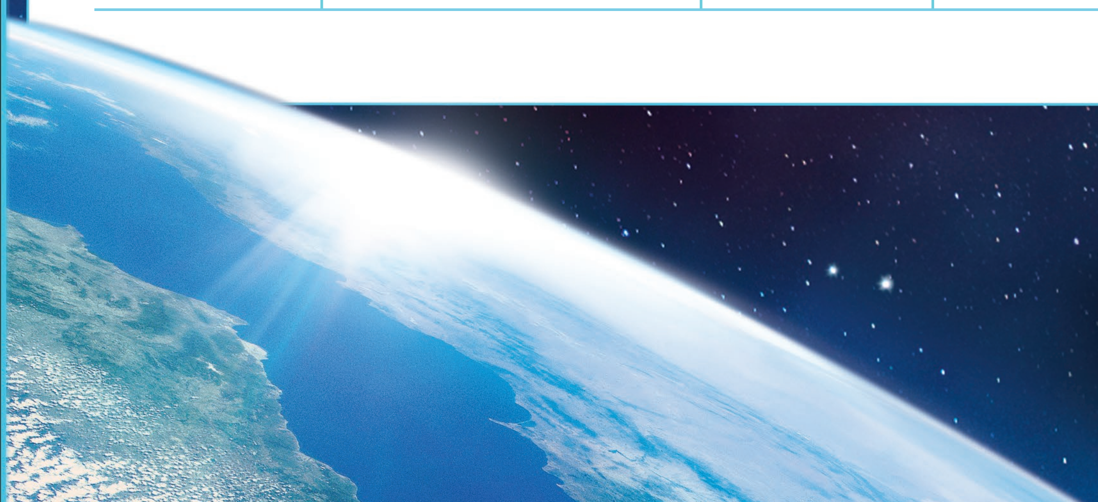
OBSERVATION AND RESULTS

Space Station to Home:

DESIGN YOUR OWN PLANT GROWTH CHAMBER

Track your results on this data chart.

DATE	OBSERVATION	HEIGHT	CHANGES FROM LAST DATE



IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

2

SCIENTIFIC METHOD

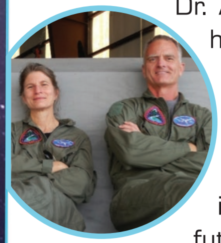
RESEARCH ON THE ISS

NAME

GRADE

OBJECTIVE	TEACHER PREP
Students will learn about the importance of the scientific method by identifying the steps in the experiment below.	Discuss the scientific method with your students. • What are the steps of the scientific method? • Why is the scientific method important?
These lessons address NGSS standards: Science and Engineering Practices: Asking Questions; Defining Problems; Planning and Carrying out Investigations; Analyzing and Interpreting Data; Using Mathematics and Computational Thinking; Constructing Explanations; Obtaining, Evaluating and Communicating Information.	

BACKGROUND



Dr. Anna-Lisa Paul and Dr. Rob Ferl study how plants respond to extreme conditions like the microgravity environment on the International Space Station (ISS). Their goal is to discover changes in how plant cells develop in space, which may improve growing food on Earth and help future astronauts live on Mars.

YOUR TASK

A new group of scientists are trying to repeat Dr. Paul's and Dr. Ferl's experiment, but they forgot to include section titles in the report on their findings, and now it is all mixed up! Use Dr. Paul's and Ferl's notes from their plant experiment below to help these new researchers label their report. Write the letter from the Experiment Sections below in the circle next to the Research entry it best matches. Each letter will only be used once.

EXPERIMENT SECTIONS

Q **QUESTION:** The question is the first part of the scientific process. What question do I want to answer?

H **HYPOTHESIS:** A hypothesis is a statement that can be proven true or false. It is often written in the form "if"…."then"….

E **EXPERIMENT:** The experiment is an activity that is used to test if your hypothesis is true or false.

D **DATA:** Data are the results of the experiment.

C **CONCLUSION:** The conclusion is a final statement that describes what you learned from the experiment and results.

RESEARCH

1 Do plants need gravity to grow? ◯

2 I will test how plants grow without gravity by observing how their roots grow in the microgravity environment of the ISS. ◯

3 If the plant roots grow slanted and branch out, or skew, then plants do not need gravity to grow. ◯

4 Experiment and data show that plants do not need gravity to grow. ◯

5 ◯

DAY 1: Seed germinates

DAY 4: Root emerges from the seed coat

DAY 6: Small roots emerge from the seed and leaves emerge from seed coat

DAY 10: Roots are 2 centimeters long

DAY 14: Roots are beginning to skew, or grow slanted toward the right

DAY 21: Roots are 4-5 cm long and are branching out

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

ANSWERS: 1Q, 2 E, 3H, 4C, 5D

SCIENTIFIC METHOD

RESEARCH ON THE ISS

NAME

GRADE

DID YOU KNOW?

CO2 AS PLANT FUEL Plants grown on the ISS can consume carbon dioxide (CO2) that people produce and generate small amounts of oxygen – all through the fundamental plant growth process called photosynthesis.

NO SOIL! Astronauts grow plants in space without soil using hydroponics. The minerals (food) that plants need are dissolved in water that circulates through the root system.

TASTE TEST In August 2015, for the first time ever, astronauts harvested and ate the lettuce they grew in space.

SPACE VEGGIES Plants like rice, tulips, onions, peas, radishes, lettuce, wheat, and cucumbers have been grown on the ISS.

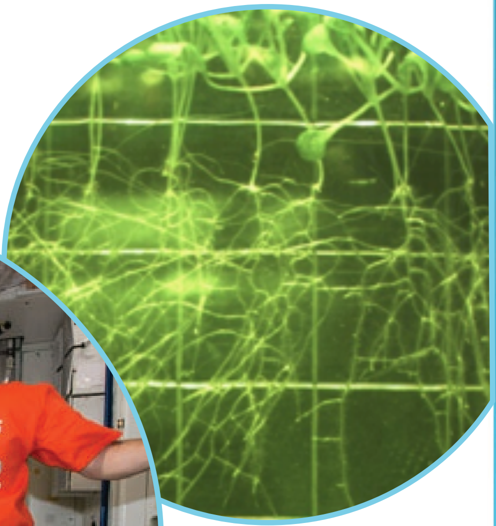
JUST LIKE ON EARTH Seeds germinated on the ISS sprouted roots that behave like they would on Earth, growing toward water and nutrients.

A LIVING LABORATORY! Astronauts on the ISS have to perform many different experiments each day. Some experiments include living plants and animals.

BIG DISCOVERIES Scientists can learn a lot about how plants live and better ways to grow plants by studying their growth on the ISS.

THE PERFECT CROP Leafy greens grow quickly and are ideal for growing on the ISS.

WHAT TO PLANT NEXT? Dwarf tomatoes and peppers may be the next crops grown in space.



Left: Russian Federal Space Agency (RSA) cosmonaut Anton Shkaplerov and NASA Commanders Barry (Butch) Wilmore and Terry Virts strike a Zero-G pose inside the ISS.

Right: "Space plants" do not need gravity to grow.

IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

3

GET A LEG-UP

LIVING IN SPACE

NAME

GRADE

OBJECTIVE	TEACHER PREP	EXTENSION ACTIVITY
Students will learn about the way gravity affects their bodies. Students will gather data by measuring the circumference of the mid-calf portion of their legs before and during the simulation. Students will use these data to explain changes observed in the circumference of their leg.	This lesson has a suggested dress code for all – pants and shirts. Students should be placed into pairs for this activity. **You will need:** Measuring tapes (one per group), rulers, yarn (blue painting tape may be used instead of yarn as it can be written on with marker and comes off easily).	Use a digital camera or smart phone to take a photo of your teammate's face before the activity and immediately afterward, before standing up. Compare the two photos. Write down any changes you see.
These lessons address NGSS standards: Engineering Design; Motion and Stability: Forces and Interactions; From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Heredity: Inheritance and Variation of Traits; Earth's Systems; and Matter and Energy in Organisms and Ecosystems.		

DID YOU KNOW?

Being in space affects astronauts' bodies, with some visible and measurable effects starting within the first 10 minutes. On Earth, gravity causes most of the body's fluids to be distributed below the heart. However, in space there is less gravity, allowing fluids to spread equally throughout the body. Within a few days of coming back to Earth, astronauts' circulation returns to normal. Before going to space, astronauts go through many simulations to experience what a lack of gravity does to their bodies. On Earth, simulation in low gravity is done underwater in a giant swimming pool. This simulation is called neutral buoyancy.

In the U.S., astronauts practice in the NASA Neutral Buoyancy Laboratory. It is 62 meters (202 feet) in length, 31 meters (102 feet) in width and 12 meters (40 feet) in depth — 6 meters (20 feet) above ground level and an equal distance below ground. Astronauts spend seven hours training in the water for every hour they will spend spacewalking during a mission. Astronauts in the pool have two-way communication capability with flight controllers in the Mission Control Center, several miles away. An Extravehicular Mobility Unit, (EMU) suit worn by each astronaut in the pool weighs about 127 kilograms (280 pounds).

BACKGROUND

When astronauts first travel to the International Space Station (ISS), they feel as if they have colds and their faces look puffy. The circumference of their legs also becomes smaller. This happens because there is little gravity in space to pull the fluids in their bodies outward, like blood from their heads down to their feet. Consequently, astronauts get puffy faces and skinny bird legs. Within a few days of coming back to Earth, astronauts' bodies return to normal.

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

GET A LEG-UP

LIVING IN SPACE

NAME

GRADE

YOUR MISSION

Simulate the fluid shift felt by astronauts when they travel to space.

IMPORTANT!

While team members are completing their turns on the floor they should brainstorm with each other and invent two exercises astronauts can do while on the ISS that would keep blood flowing throughout their bodies. Every astronaut is required to exercise for two hours every day; help them from getting bored by suggesting new exercises to do. Write your ideas on the back of your data sheet and share with the class later.

YOUR TASK

PART 1

1 With a partner, stand up and tie a piece of yarn around the widest part of your calf.

2 Your partner should measure the distance around the mid calf portion (widest part) of your leg where the yarn is.

3 Record the measurement in the data table on the following page. Repeat steps 1-3 with your partner.

PART 2

1 Predict what will happen to the distance around your leg if you lie down for 10 minutes.

2 Record your predictions on the data table.

PART 3

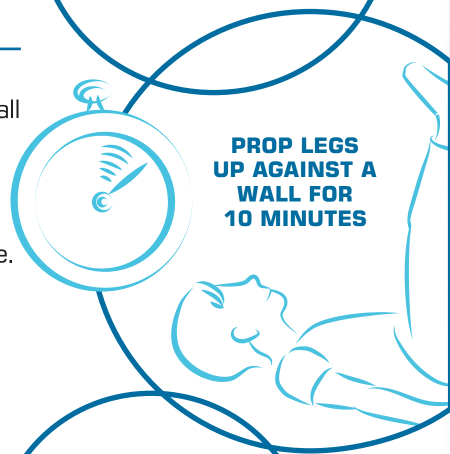
1 You and your partner take turns lying down on the floor with legs raised against the wall at a 90 degree angle for 10 minutes.

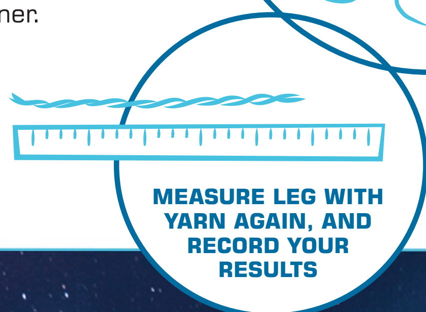
2 After 10 minutes, before you stand up, have your partner measure the distance around your calf using the yarn as a guide.

3 Record the measurement on the data sheet.

4 Repeat steps 1-3 for your partner.

5 Compare your results to your partner's results.





IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

GET A LEG-UP

LIVING IN SPACE

3

GRADE

NAME

DATA SHEET

NAME

MEASUREMENT STANDING

PREDICTIONS Will my leg become smaller? Larger? Remain the same?

MEASUREMENT LYING DOWN

QUESTIONS

1 What happened to the distance around your leg after it was raised for 10 minutes? ....

Why do you think this happened? ....

2 Do your results compare with what might happen to astronauts when they are on the ISS? ....

3 Why do astronauts get a puffy face and bird legs when they are on the ISS? ....

Did you get bird legs during this activity? ....

4 What do you think astronauts do to help lessen the effects of this problem? ....

Left: NASA Commander Barry (Butch) Wilmore enjoys Zero-G.

Right: NASA Commander Terry Virts exercises on a treadmill onboard the ISS. The crew is required to exercise at least two hours every day.

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

EARTH OBSERVATION FROM THE ISS

LIVING IN SPACE

NAME

GRADE

OBJECTIVE	TEACHER PREP	EXTENSION ACTIVITY
Students will create one of the following pieces of artwork from an astronaut photograph that explores how the view of Earth from the International Space Station (ISS) teaches us about our planet and its systems: • 2D Drawing • Scaled Drawing (for more advanced students) • 3D Model	Visit the Windows on Earth website, www.windowsonearth.org, and study the photographs taken by astronauts from the cupola on the ISS. **You will need:** Large chart paper and drawing materials for student brainstorming, computer with Internet connection, and a variety of art materials. Students can utilize mobile devices to help with research and can work independently or in pairs to create their artwork.	Students can recreate printed images from the Windows on Earth website by using the grid method.
These lessons address NGSS standards: Engineering Design; Motion and Stability: Forces and Interactions; From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Heredity: Inheritance and Variation of Traits; Earth's Systems; and Matter and Energy in Organisms and Ecosystems.		

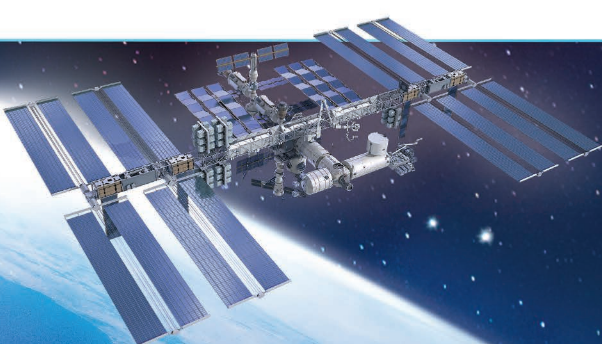
YOUR MISSION

Scientists are always looking for new views of our planet to learn more about its climate, surface, cycles and how humans are impacting the planet. Imagine you are an astronaut capturing images of the Earth from the cupola of the ISS. What science do you view in your images, and how could you share your camera view of the planet through artwork?

Top: The frozen Great Lakes of the Midwest.

Middle: NASA Commander Barry (Butch) Wilmore shoots a scene with the IMAX® camera through the window of the International Space Staton's Cupola Observation Module.

Bottom: The entire North East of Canada, the United States and beyond.



IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

EARTH OBSERVATION FROM THE ISS

LIVING IN SPACE

NAME

GRADE

YOUR TASK

PART 1: HOW DO WE VIEW THE EARTH FROM THE ISS?

What is the cupola? Begin by exploring the parts of the ISS on the CASIS Academy site. Start with the tour of the Space Station at www.spacestationexplorers.org/explore/earth/intro. Keep your eyes open for the cupola, which appears at 1:25 minutes.

PART 2: WHAT DO IMAGES FROM THE ISS LOOK LIKE? WHAT DO THESE VIEWS SHOW US?

Go to the *Windows on Earth* website (www.windowsonearth.org) and find a view of Earth that captures your attention. Do the astronaut photographs of Earth look how you thought they would from space?

PART 3: LET'S ZOOM IN ON AN IMAGE!

1 Select an image from the "Regions" section of the *Windows on Earth* website to explore in more depth. By beginning in a specific region, you can narrow down your focus. You may want to try comparing the astronaut image to a map view using Google Maps, an iPad map app, or a wall or book map.

2 Use the next page to sketch out your image and relative location of the area. Research the science and the location about the region or image content (types of clouds and weather, areas of the planet and landforms).

PART 4: CREATE AND SHARE!

1 Select art supplies from the materials your teacher provides. You can create a 2D drawing or a 3D model to represent your image.

2 Share your artwork and describe the science you have learned about from researching your image.

NASA Commander Terry Virts shoots through the window of the International Space Station's Cupola Observation Module.

IMAX
A BEAUTIFUL PLANET
EXPERIENCE EARTH LIKE NEVER BEFORE

EARTH OBSERVATION FROM THE ISS

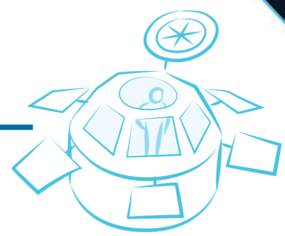
LIVING IN SPACE

NAME

GRADE

MY IMAGE, MY VIEW

Draw sketches of your selected image and its relative location.



MY IMAGE

LOCATION OF MY IMAGE

NOTES ABOUT MY IMAGE

IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

ISS AS A SPACE SHIP

COMMUNICATION ON THE ISS

GRADE 5

NAME

OBJECTIVE	TEACHER PREP	EXTENSION ACTIVITY
Students will learn about the importance of teamwork and communication on the ISS. By creating a visual barrier between teammates, students will work together and learn to communicate creatively to reach a common goal.	Discuss teamwork with your students: • How have they worked together on any activity, from simple to complex? • What were the difficulties? What were the successes? • Was it sometimes hard to communicate? How did you explain things? • Did you use words only, or use pictures, too? • What about speaking and using your hands to explain things? There are many ways to say something or to express what you mean. Relate this activity of working together with barriers to the assembly of the International Space Station (ISS) and conducting research on the ISS. Sixteen countries had to work together and find ways to communicate effectively to build the greatest engineering feat of all time. Scientists on the ground may speak different languages than the astronauts who are carrying out their experiments. **You will need:** Ziploc bags filled with matching colored blocks and connectors, clipboards, drawing paper, and pencils.	Check out the ISS assembly animation on the following website: https://youtu.be/h8kOAroNNAo. Also, visit the site https://www.nasa.gov/mission_pages/station/main/onthestation/facts_and_figures.html to learn more details about the station.
These lessons address NGSS standards: Engineering Design; Motion and Stability: Forces and Interactions; From Molecules to Organisms: Structures and Processes; Ecosystems: Interactions, Energy, and Dynamics; Biological Evolution: Unity and Diversity; Heredity: Inheritance and Variation of Traits; Earth's Systems; and Matter and Energy in Organisms and Ecosystems.		

DID YOU KNOW?

Communication has always been an interesting problem in space. Internet connectivity on the ISS is structured around a network of tracking and data relay satellites that NASA engineers also use to communicate with astronauts on the ISS. Astronauts were finally able to directly access the Internet in 2010, a move that NASA said would help improve their quality of life and help them feel less isolated in space. It seems funny that it took so long to get something as simple as basic Internet up to the Space Station while humans on the ground have had complicated robotic devices and lasers doing very cool things for a long time! Now astronauts have tablets onboard they can use for various operational tasks. They also like to use them to hold video conferences with family and friends on the ground. The connection however, is incredibly slow compared with broadband Internet speed back on Earth, mostly because of the distance that data has to travel. When an astronaut clicks a link on a website in space, that request travels to a network of satellites 22,000 miles (35,000 kilometers) above Earth, even though the ISS is only 250 miles (402 kilometers) up. The satellites then send that request to a receiver on the ground, which processes the request before returning the response along the same path to the ISS.

NASA Commander Barry (Butch) Wilmore on a spacewalk to repair the exterior of the ISS. It's almost 300°F on the sun side of the ISS and -275°F in the shade!

IMAX A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

Special acknowledgment and thanks to the Center for Advancement of Science in Space (CASIS) and NASA for their contributions.

CASIS™

5

ISS AS A SPACE SHIP

COMMUNICATION ON THE ISS

NAME

GRADE

BACKGROUND

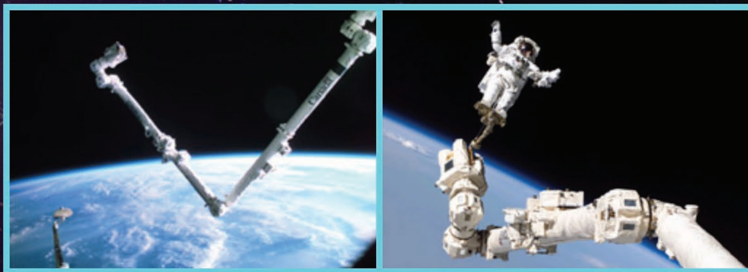
The ISS is an amazing example of how countries from around the world can work together, even though not all of the employees, engineers and astronauts speak the same language. By working together, space agencies from the United States, Russia, Japan, Canada and several European countries have developed an orbiting research station that can benefit people on Earth. NASA and other space agency employees often go through intensive training where they must learn how to communicate with each other by using words, hand and eye movements, drawing shapes on paper and holding up for others to see, memorizing steps, singing out certain sounds or tones, and using color and "body language" (stiff, relaxed, scared, happy) to indicate to the next person what is happening or needs to be done. This exercise will introduce you and your partner to different ways of communicating and show how effective you are!

YOUR MISSION

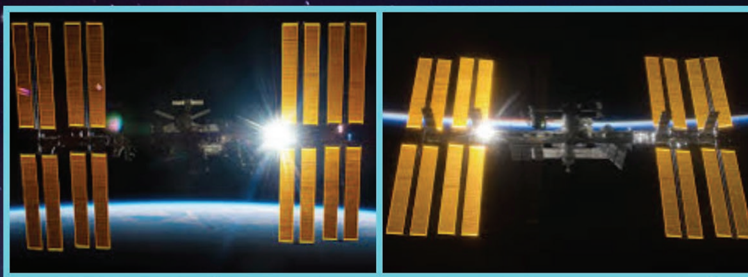
Each of the three sets of pictures (to the right) represent a section, or module of the ISS. Each member of your team will select one set of pictures and recreate that section of the ISS using matching colored blocks and connectors. One team member will be the engineer and the other team member will be the astronaut. Each will have a turn at building while the other tells the builder how to make the module. Each person will have a set amount of time to build.

Use one set of images for each module.

CUPOLA



CANADA ARM



SOLAR ARRAYS

IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE

ISS AS A SPACE SHIP

COMMUNICATION ON THE ISS

NAME

GRADE

YOUR TASK

You will take turns building the module your teammate selected.

1 Each team should find a good place to sit, back to back. Decide who will be the ASTRONAUT and who will be the ENGINEER.

2 ENGINEER, use the blocks to build your module. Write down each step on a sheet of paper. Do not let your astronaut see what you have built.

3 ASTRONAUT, open your bag of blocks but do not take anything out yet. While your partner is building, you can sketch possible module types you think can be built.

4 ENGINEER, using the steps you wrote down to build your module, communicate with the astronaut by explaining how to use the materials to re-create what you just built.

5 ASTRONAUT, listen carefully to the engineer as he/she explains how to build the module. You may ask questions as you build. Tell the engineer when you have completed the "mission."

6 ASTRONAUT, turn around and show the engineer your completed module. Discuss if together you successfully accomplished your goal of building the same structure.

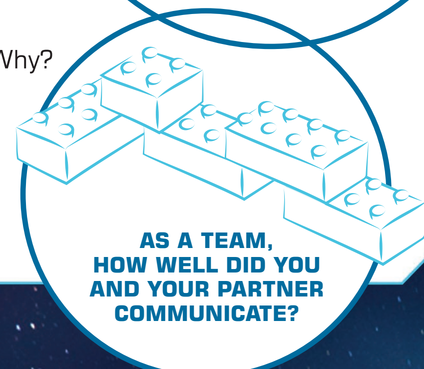
Now switch roles and repeat the steps above with your teammate.

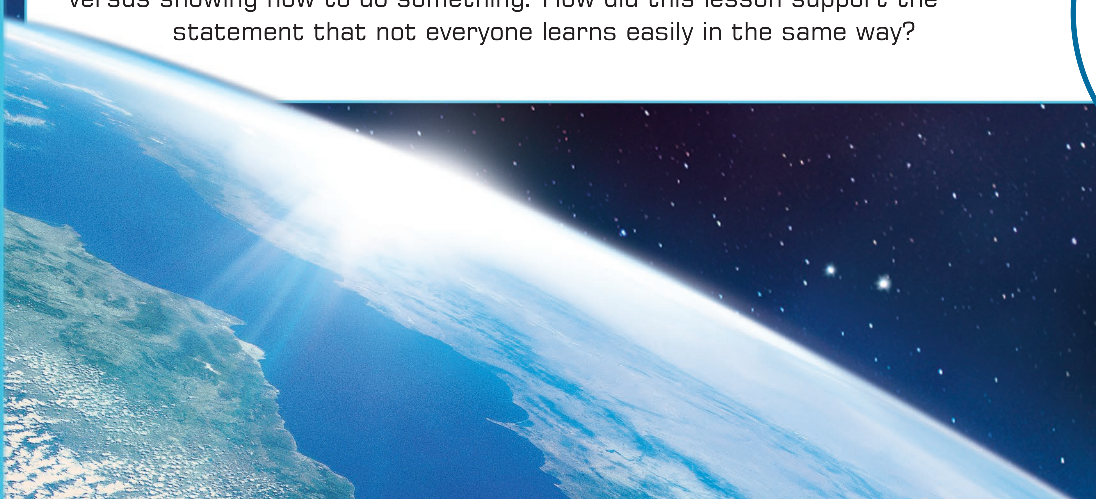
WHAT DID YOU LEARN?

Do you think team members become more skilled at building over time? Does communication become easier over time? If it does, how?

How important does your team think communication is in this building process? Why?

Share your team results with other members of the class. Discuss the differences your teams experienced between describing how to do something versus showing how to do something. How did this lesson support the statement that not everyone learns easily in the same way?





IMAX

A BEAUTIFUL PLANET

EXPERIENCE EARTH LIKE NEVER BEFORE