Study Guide

Stage 1 at Blume Studios
in the Iron District

blume studios
A BLUMENTHAL ARTS EXPERIENCE

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Mission Statement

To present the best in the performing arts and in partnership with others, share and employ the arts as a major catalyst to strengthen education, build community cohesiveness and advance economic growth.

Our Organization

We manage five venues where the curtain goes up on more than 1,000 events annually, including performances by our 16 resident companies. More than 8.3 million people attended events in our theaters during our first 30 seasons.

Our Education Department

Blumenthal Arts' Education Department strives to enhance relationships with community organizations, schools, and individuals throughout the Central Carolinas. Through a variety of educational and enrichment programs, we seek to bring the performing arts to a diverse population within our extended community. Examples of the Education Department's 20+ programs include: weekday school shows for student groups, hosting affinity group gatherings for teachers (Arts Educator Network) and students (Charlotte Live! Teens), and holding Community Cues to engage the community on the content and relevance of the themes seen in shows that travel through our venues.

Visit www.BlumenthalArts.org/Education for more information.

Venue Address for Space Explorers: THE INFINITE
Stage 1 at Blume Studios
904 Post Street
Charlotte, NC 28208

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The Creatives Behind THE INFINITE

INFINITY Experiences is a joint venture founded in April 2020 between **PHI Studio** and **Felix & Paul Studios**, two major pioneers in the XR industry. It endeavors to create and distribute cutting-edge large-scale projects through spatial and immersive exhibitions, such as the ground-breaking Location-Based Entertainment experience Space Explorers: THE INFINITE. This first production redefined the industry standards for immersive location-based experiences through creative innovation technologies that allow 150 visitors to simultaneously go into space and visit the International Space Station (ISS), creating the world's first large-scale interactive and collective experience around space exploration.

PHI STUDIO has developed a reputation as an incubator for talent at the vanguard and as a catalyst for the conception and implementation of immersive multidisciplinary projects. They are continually exploring the ways in which technology can lead to new forms of artistic expression and storytelling. PHI Studio is committed to collaborating with artists, producers, and partners to foster the creation and development of innovative artworks at the vanguard, shaping the future of the immersive experience. Above all, they are a contemporary arts company merging art, light, and space.

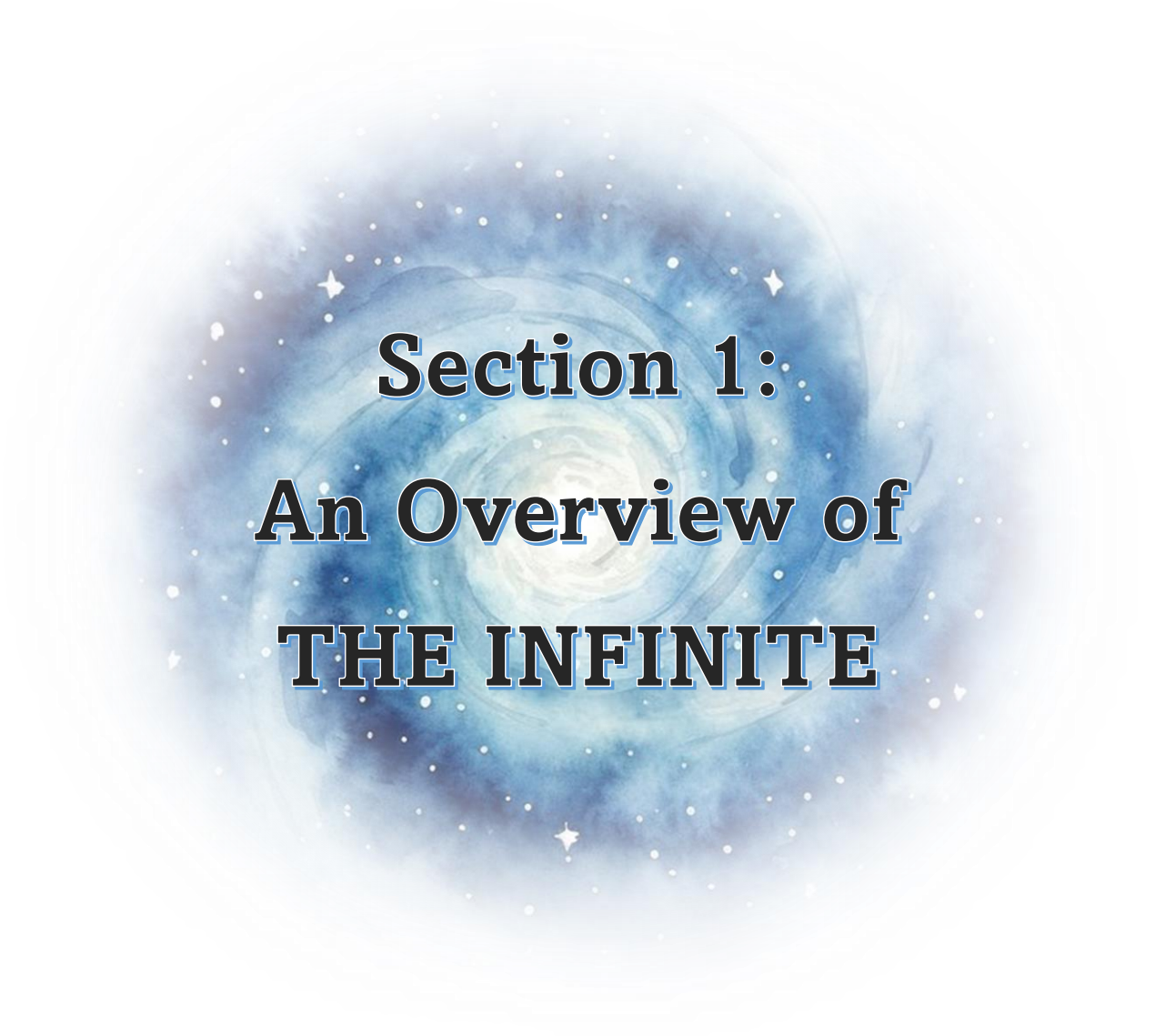
Felix & Paul Studios is an EMMY® Award-winning creator of immersive entertainment experiences, creating unparalleled, highly engaging and inspired virtual reality, augmented reality and mixed reality experiences for audiences worldwide. The studio's content is available for distribution in a range of immersive formats including 360-degree mobile on 5G-enabled smartphones and tablets, 360-degree full-dome projection in domes and planetariums, fully-immersive virtual reality (VR) on Oculus headsets, giant screens, and life-scale immersive exhibits. A groundbreaking augmented reality (AR) experience is also in production.

Felix & Paul Studios is the only media company in the world recognized as an "Official Implementation Partner" by the ISS U.S. National Laboratory.

Félix Lajeunesse

Paul Raphaël

Blumenthal Arts is a proud presenter of Space Explorers: THE INFINITE.



Section 1:
An Overview of
THE INFINITE

A First-of-Its-Kind School Show

This school show opportunity takes the vastness of space and makes it a human experience. Space Explorers: THE INFINITE is the first multisensory VR experience, but it certainly won't be the last. Below is a breakdown of what your students will experience during this field trip and a great starting point to learn more about it.

What to Expect
From exclusive encounters with astronauts to serene moments of Earth-gazing, every sensation will deepen their connection to the universe and their place within it. Through the transformative lens of immersive VR headsets, students will be transported 250 miles above Earth to the International Space Station.

On your field trip, students will:

1. Take part in the first-ever spacewalk captured in virtual reality and discover breathtaking views of Earth and majestic sunrises.
2. Explore a 3D model of the International Space Station, through individual virtual reality headsets, traveling seamlessly between the exterior and interior of the station with exclusive content shot in space via VR cinematography.
3. Gain insight into the astronauts' daily life orbiting Earth and be inspired by their remarkable personal stories told by the astronauts themselves.
4. Explore inertia with Groundswell, an interactive sound art installation which invites participants to move collaboratively across a platform that tilts under their collective weight, setting in motion thousands of metal balls that create oceanic waves of sound.
5. Gaze at Luke Jerram's Gaia, exploring NASA's images of Earth on a grand scale.
6. View space-inspired installations created by local Charlotte artists and makers.

Why it's Important
While this experience is certainly a platform to study space, our accomplishments within it, and the importance of the ISS, this VR experience lends itself to a more personal, transformative experience for students rooted in perspective. This voyage offers more than just mere observation; it will immerse them in the essence of space exploration without ever leaving the ground. It's more than just a simple expedition, it's an emotional odyssey that leaves a lasting impression.

Where to Start
As a starting point before you go any further, ABC 13 Houston created an incredible introductory video that explores the background of this immersive experience. It also provides an opportunity to meet the creators and astronauts who were a part of the filming and get a sneak peek at what it looks like inside the experience.

Goals of THE INFINITE & Its Timeline

THE INFINITE is an immersive virtual reality experience that takes participants to the **International Space Station**, where you will wander through the station, hear stories from the astronauts and cosmonauts on board, and *venture outside the ISS* to follow these astronauts on spacewalks! Inspired by humanity's shared fascination with the universe beyond our atmosphere, Felix & Paul Studios began to work with PHI Studio to **bring space down to Earth**. This project took ten years to curate the ideas and develop the technology necessary to create such an experience. Then, in 2018, astronaut David Saint-Jacques (you can learn more about him on page 22!) from the Canadian Space Agency (CSA) brought the two cameras that were developed for the project with him as he traveled to the ISS, where they stayed for two and a half years to document the everyday lives of the inhabitants of the space station. This includes their research and experiments, their pastimes, and what it takes to maintain the ISS for present and future visitors.

THE INFINITE is a highly collaborative project. Not only does it involve the more practical intersection of immersive theatre, museum curation, and space travel, but its creation required a complex level of working together on a very human level. Constructing THE INFINITE involved people **all around the world *and* in space** working together, including technology developers, VR creators, immersive experience producers, visual artists, scientists and engineers from various space agencies, and, of course, astronauts on Earth and on the ISS. In its collaboration with agencies such as NASA and the CSA, THE INFINITE turned astronauts and cosmonauts into the directors, crew members, and creators of these digital diaries. Everyone working on THE INFINITE relied on one another to make the project work, from the development of the technology and the story on the ground, to the astronauts and cosmonauts creating the content in space.

The immensity of the project is a reflection on what its creators sought to highlight: the truly human experience of going into space, and humankind's ability to work together for a common dream, whether this dream be reaching the stars or experiencing it from the ground. Marie Brassard, writer and designer of THE INFINITE with PHI Studio, said that journeying to the International Space Station "is first and foremost a human quest." This essence of humanity is highlighted in the testimonies of astronauts, when they talk about looking up at the night sky as children and dreaming of visiting the stars. Try going outside tonight and looking up at the sky. What do you see? Do the stars inspire you?

Image credit: Adil Boukind

How Do You Capture Space in VR?

Over the course of *ten years*, Felix & Paul Studios worked with technology developers to build cameras that were suitable for filming inside and outside the International Space Station. The camera inside the space station had to be specially built to function in the microgravity environment, operate remotely with little assistance from the astronauts, and move around in confined locations. The Outer Space Camera was attached to the outside of the ISS to film the astronauts' spacewalks. This meant that the camera had to be built for a variety of intense conditions, including extreme light, temperature variations, and the various hazards of outer space like flying bits of space rocks.

Additionally, it had to be able to operate *100% remotely*, as the astronauts had to focus on the work they were doing in outer space. Both the ISS-IVA (inter-vehicular activity) Camera and the Outer Space Camera capture images and video in **3D-360**, meaning that they can capture at every single angle and reproduce it to look as though you are there yourself, rather than looking at a video or picture on a screen. They film in **8K resolution**, which is the highest resolution TVs can reach today. 8K resolution makes images seem like they are real, and not a digital reproduction. Check out this video to see how different resolutions compare! Can you see how the image gets clearer and more detailed the higher the resolution?

How does this compare to a cell phone? Phone cameras are typically measured in **megapixels**, or MP, which is another form of image resolution. One megapixel is equal to **one million pixels** (*what are pixels?*). The average smartphone has a 12 MP camera resolution. Additionally, phone cameras can't take 360° photos on their own because the camera only faces one direction. The ISS-IVA and Outer Space Cameras, on the other hand, can document in **360°** with an equivalent of approximately **33 MP resolution**. That's quite the difference in image quality and size!

Here are the two cameras Felix & Paul Studios sent up to the ISS. Notice how there are multiple lenses on each of the cameras – those lenses help capture video and picture in 360°.

Gaia & Groundswell

Blumenthal is thrilled to offer two additional exhibits, Gaia and Groundswell, at Stage 1 at Blume Studios in tandem with THE INFINITE. Students will experience these exhibits during their field trips to our venue.

Gaia is a touring artwork by UK artist Luke Jerram. Measuring six meters in diameter, the mesmerizing Gaia features 120 dpi detailed NASA imagery of the Earth's surface. This beautiful artwork provides the opportunity to see our planet on this scale, floating in three dimensions. A fun fact is that the installation is 2.1 million times smaller than the real Earth and aims to create a sense of the *Overview Effect* (see page 26 for more information on this topic!), which was first described by author Frank White in 1987; experience what astronauts have described as a feeling of awe for the planet, a profound understanding of the interconnection of all life, and a renewed sense of responsibility for taking care of the environment.

Groundswell is an interactive sound art installation. It invites participants to move - individually or collaboratively - across a platform that tilts under their collective weight. This sets in motion thousands of metal balls that create oceanic waves of sound. The motion is disrupted by periodic swells of intense low vibration. Groundswell explores our individual and collective impact on the spaces we inhabit. As we move across the surface of the work, we are reminded how our actions are inextricably linked.

Click here to show your students Groundswell in action!

Pre-Show Discussion Questions

Utilize these questions to see how much your students know about space, gauge where they are curious to learn more, and build excitement to learn more about these topics.

1. What do you know about space and the ISS? See if you can make a list of 5 things on your own you know about the ISS. Use this activity as a starting point for the unit. Student answers can be reviewed later to see how much they retained during this unit.

2. Why is the ISS important? (See the “What We’ve Learned” activity on page 15 to dive deeper here)

3. What would you imagine life would be like on the ISS? Boring, fun, scary? Why?

4. Have you ever seen a rocket launch (even if just on YouTube – that is fine!)? What was going through your mind when you watched it take off into space?

5. Could you be an astronaut and leave everything behind on a journey to space?

6. What would be the three best and worst things about living in space?

7. How do you think this experience will be different from watching a movie or reading a book about space?

8. Have you ever utilized VR? What was the coolest (or scariest!) part once you put on the headset?

Section 2:

ISS 101

Diving into the Work on the International Space Station

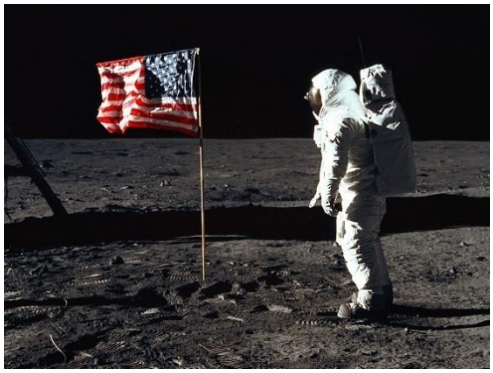
Vocab to Know Before Blast-Off

Throughout this study guide and while you're experiencing THE INFINITE, you may be introduced to some words that you've never heard before relating to space exploration. Below are some of the words you'll come across as you learn about space and travel through it virtually! You can click on the blue hyperlinks to watch a video and learn more about each term.

- **International Space Station (ISS)** - a spacecraft roughly the size of a football field that orbits the Earth. The ISS is an international research station where astronauts and cosmonauts from around the world live and work together. On the ISS, they conduct experiments and research in pursuit of knowledge for the betterment of humankind. You'll learn a lot more about the ISS in the coming pages and you'll get to explore it while experiencing THE INFINITE!

The ISS flying over Earth

- **Astronaut** - Someone who travels beyond the Earth's atmosphere. The word "astro" means "star," and "naut" means "sailor." To be an astronaut is to be a star sailor!
    - You may also see or hear the word cosmonaut while learning about space travel. Cosmonauts are the same as astronauts, except they were trained by Russia's space agency rather than one of the other major agencies such as NASA or the CSA. The only difference in the two titles is how they were trained. "Cosmo" means "universe," so a cosmonaut is a sailor of the universe!



Astronaut Neil Armstrong, the first person on the Moon, took this photo of his Apollo 11 crewmate Buzz Aldrin after planting the U.S. flag on the Moon's surface on July 20, 1969.

- **Expedition** - This is the term given to each new collection of astronauts that travels to the ISS and conducts work. Since the arrival of Expedition 1 at the newly completed ISS on November 2, 2000, there have been 71 Expeditions. Many astronauts participate in multiple Expeditions, like NASA astronaut Christina Koch, who participated in Expedition 59, 60, and 61! You'll learn more about Koch throughout this study guide and may even meet her in THE INFINITE!

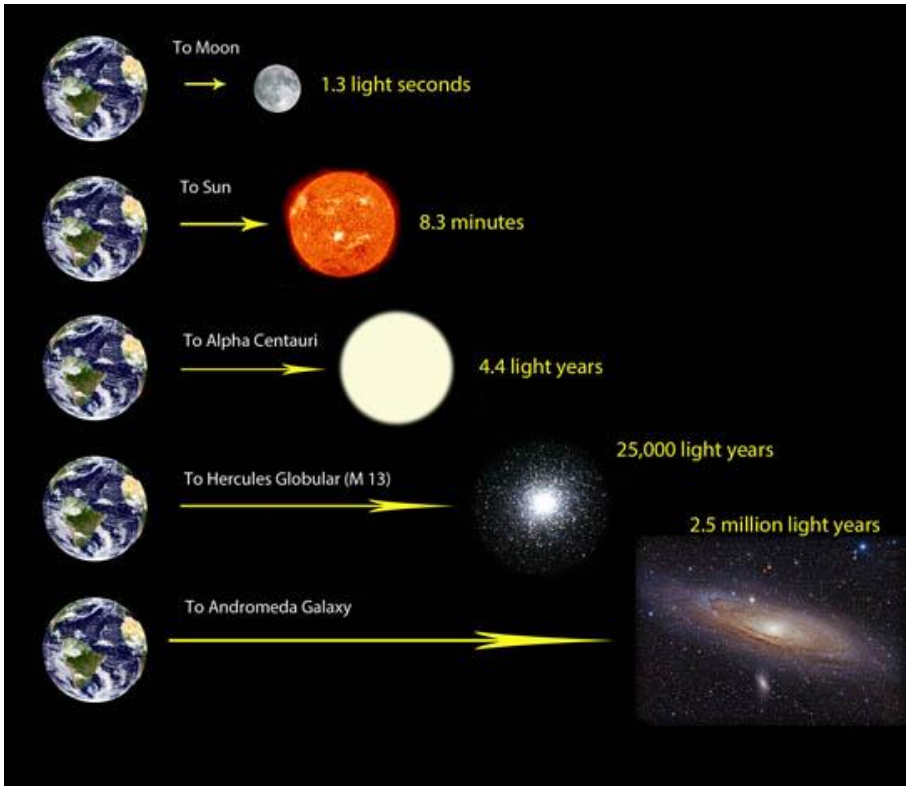
- **Spacewalk** - also called Extravehicular Activities (EVAs). Spacewalks are when astronauts conduct maintenance, research, or collect data outside of the ISS. On April 25, 2024, the 270th spacewalk for the ISS was completed, lasting just over 4.5 hours; the longest spacewalk ever recorded was nearly double that time, at 8 hours and 56 minutes!

A NASA astronaut waves at the camera while performing maintenance on the ISS during a spacewalk.

- **Microgravity** - This describes when objects seem weightless or are floating around, like how they do in space. "Micro" means "small" and "gravity" is the force that holds us in place on the ground (like how when you jump in the air, an invisible force pulls you back down to the ground). Microgravity environments have a very small amount of gravity.

NASA astronaut Christina Koch demonstrating how liquids take shape in microgravity – notice how the water and her hair seem to be floating!

- **Light-year** - This describes the *distance* light travels in one year and is used to calculate how far something travels through space. Because of how big space is, it's easier to use this unit of measurement rather than miles or kilometers. **1 light-year = 58,786,253,733,183 miles!** That's 58 TRILLION miles!



Fast Facts about the ISS

Over the span of two and a half years, pieces of the ISS were flown up into space and put together like a giant Lego set by astronauts and remotely controlled machines. Check out this video animation demonstrating how it was pieced together! The station officially went into operation with the arrival of the 3-man crew of Expedition 1 on November 2, 2000. Since then, over **250 people from more than 20 countries** have lived on the ISS, with anywhere from 3-13 people inhabiting it at any given time, though nowadays it **typically hosts a crew of 7**. The space station will continue to operate at least until 2030, but the ISS could be upgraded and maintained to last longer, as has been done numerous times since it was built.

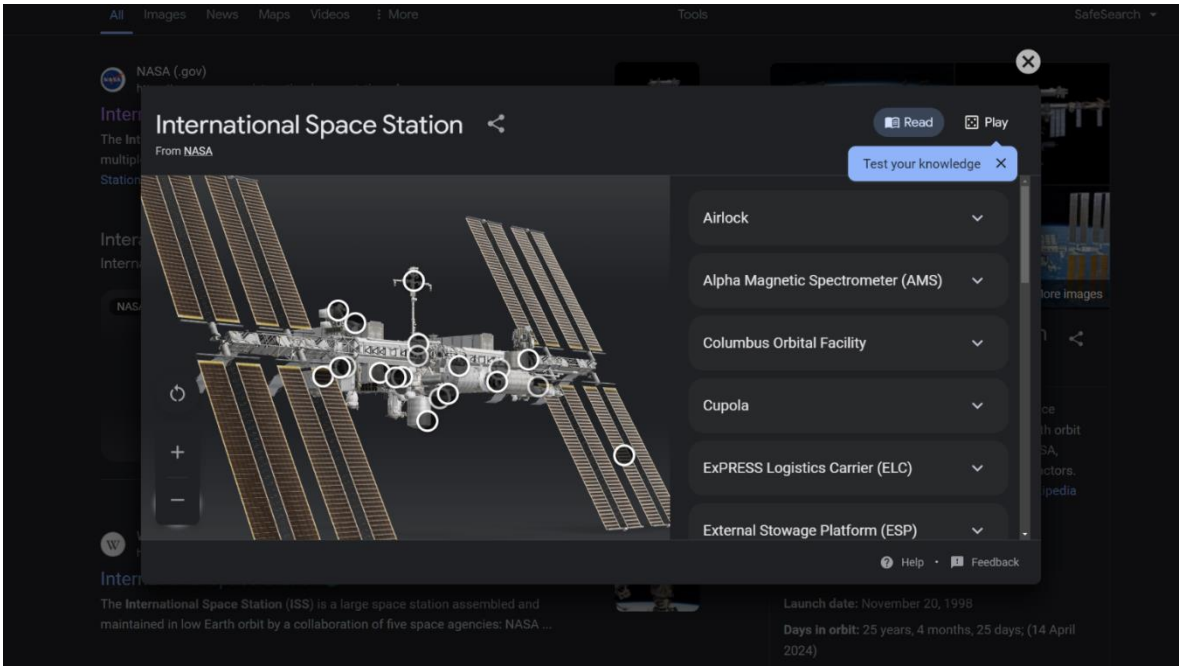
The International Space Station is a monument to human ingenuity, engineering development, and scientific research. According to NASA, the ISS was built with the shared aspiration across the world's space agencies to "lead to improvements in life on Earth for all people of all nations." These goals include inspiring kids to pursue careers in STEM (science, technology, engineering, and math); applying what has been learned from/on the ISS (regarding technology, physics, biology, engineering, etc.), and using the discoveries for the betterment of humanity.

By the numbers:

- The ISS took **9 years to design** (1984-1993), 5 years to plan out (1993-1998) and 13 years to build and assemble the main structure (1998-2011). The ISS is frequently upgraded and added to as new technology and research opportunities become available!
- **In the span of 1 day, the ISS will make 16 orbits around the Earth**. That means that astronauts aboard the ISS get to see 16 sunrises and sunsets every day!
- It takes more than **50 computers** to manage the various systems on the ISS.
- The ISS's **8 solar panels provide 75-90 kilowatts of power** - that's equivalent to powering 750-900 100-watt light bulbs!
- The ISS **flies over 90% of the Earth's population** in its orbit.

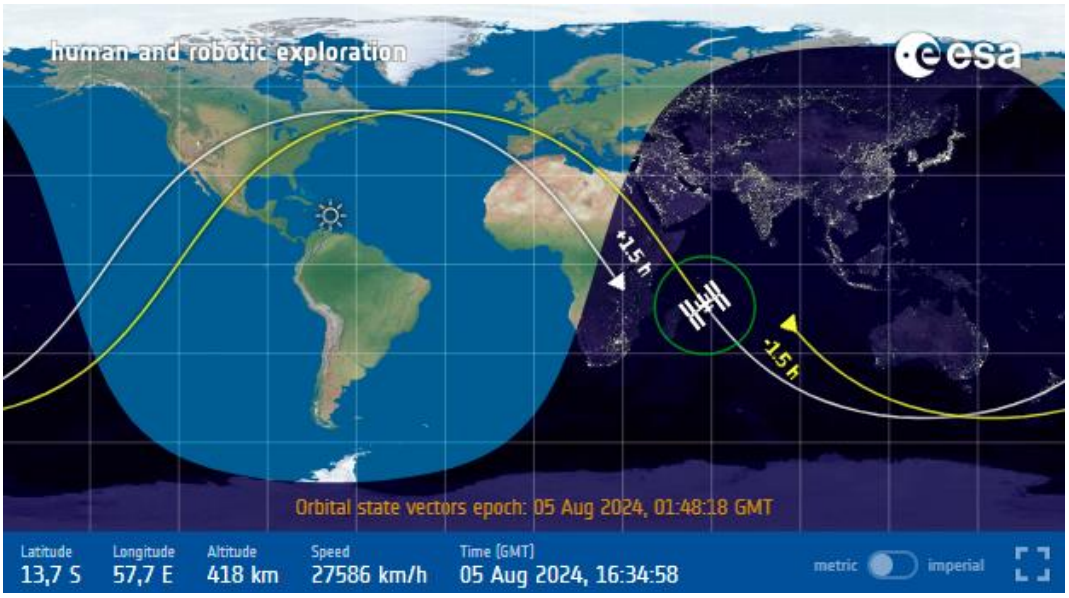
Explore the ISS

Google “International Space Station” and select the interactive diagram. Click on the diagram and explore the different components of the ISS! You can click on the word bank on the right to see what each piece does and where it is located on the station. Once you’ve spent some time learning about the station, try the “play” feature and see if you can match the words to their locations on the ISS!



And…Track the Station!

You can track where the ISS is at any time through NASA’s live tracker here! What day and time will it next be over Charlotte?!



ISS Impact: What We've Learned

In 1999, Expedition 1 landed at the International Space Station. Since then, over 3,000 experiments have been conducted on board, contributing to the betterment of life on Earth and the improvement of travel in space. Check out some of the experiments and discoveries below, and click on the hyperlinks to see more information about the research!

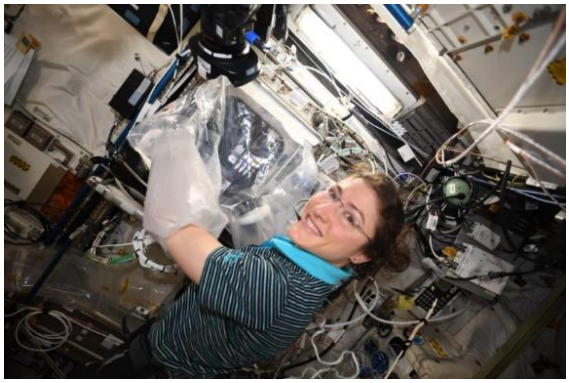
European Space Agency (ESA) astronaut Matthias Maurer cleaning out a part of the water filtration system

Water & Air Filtration Systems

Being up in space for so long, the astronauts on the ISS need to be able to clean and recycle the water they drink and the air they breathe. That way, they don't have to rely on constant supply deliveries. After researching, modifying, and experimenting on the station's life support system, the astronauts have found a way to recover, recycle, and reuse 98% of the water they started their mission with. Not only does this development help with life on the space station, but it also will help future missions as we begin traveling further and further out into space. Additionally, this can help us on Earth. Scientists and engineers can use the developments of the space station's water purification system to improve the systems down here, helping give clean water to communities who don't have access to it. Another essential life support system aboard the ISS is the air filtration system. Without a continuous supply of clean air, astronauts wouldn't be able to stay up in space. The improvements that have been made on the ISS's air filtration system helped further develop air purifiers here on Earth, which was really important when we were adapting indoor spaces during the COVID-19 pandemic!

Human Health

Much of the research done on the ISS is to help improve life down here on Earth. One project that is being developed on the ISS is bioprinting, which is like 3D printing but with living cells and other related elements instead of plastic or metal. This kind of research could pave the way for 3D printing human organs, which will help people in need of organ transplants. The first successful bioprinting experiment was completed last year –check out this video here to learn more about it!



NASA astronaut Christina Koch using the 3D Bio Fabrication Facility on the ISS.

Building in Space

One of the long-term goals of NASA is to set up a lunar base on the Moon for spacecraft landing/takeoff and long-term research of the Moon. Because the Moon is made up of different elements than the Earth, any building made for the Moon needs to be constructed with different materials than what we use down here. NASA researchers have been using mock lunar soil and mixing it on board the ISS to develop a cement that would be able to hold structures together more safely and securely. Not only is this research paving the way for structures on the Moon, but has potential for future structures on other planets as well – like Mars!

Astronaut Alexander Gerst experimenting with cement made with the mock lunar soil.

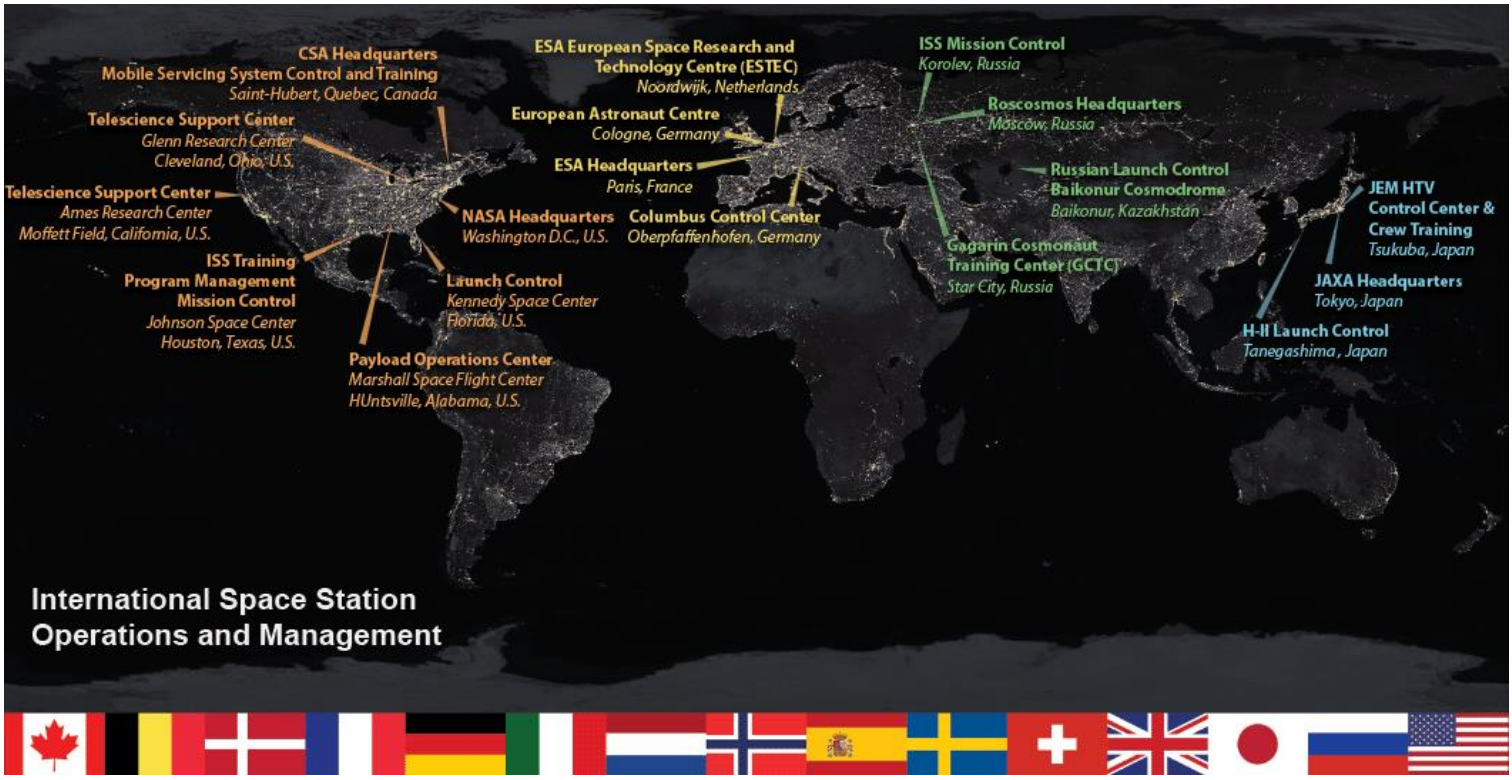
Earth Observation

- Climate Change: The ISS provides a unique vantage point to monitor Earth's climate, including changes in sea levels, ice caps, and vegetation.
- Natural Disasters: The ISS can help track and predict natural disasters like hurricanes (pictured below), floods, and wildfires.
- Air and Water Quality: Data collected from the ISS contributes to our understanding of air and water pollution.

The “International” of the ISS

Since its inception to today, the ISS has been a testament to international collaboration in the name of knowledge and discovery. Before being sent into space piece by piece, its components were designed and built primarily in the US and Russia, though other countries also helped build pieces of it. The ISS is operated and maintained by 15 different nations: Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Norway, Spain, Sweden, Switzerland, Russia, the United Kingdom, and the United States. The countries working together on Earth and in space make up five different space agencies, including the National Aeronautics and Space Administration (NASA) in the US, the Canadian Space Agency (CSA), the European Space Agency (ESA), the Japan Aerospace Exploration Agency (JAXA), and the Roscosmos State Corporation for Space Activities (Roscosmos) in Russia.

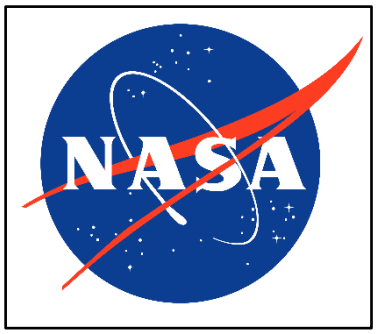
Each agency is responsible for the equipment they develop and build, but the space station as a whole is entirely reliant on collaboration, contributions, and cooperation from each agency. On board the ISS are astronauts from all over the world; some of the ones you may meet in THE INFINITE are from the United States, Canada, Russia, and Italy!



Above is a map showing the locations of the various facilities around the world that cooperate to manage the ISS. The flags below the map are the 15 nations that helped design and maintain the various parts of the space station. **Challenge students to match each flag with each country!**

Design Your Own Space Agency

Below are the different patches for each of the five space agencies working together on the ISS. Use the blank template to draw your own space agency patch! Give your space agency a name and think about its primary mission – are you trying to land on Pluto, travel at the speed of light, visit another galaxy, or something else?



National Aeronautics and Space Administration

Canadian Space Agency

European Space Agency

Japan Aerospace Exploration Agency

Roscosmos State Corporation for Space Activities (Russia)

Agency Name:

_____

Mission:

_____

Reality vs. Hollywood

The ISS hasn't made many appearances on the big screen just yet, but maybe you've come across space exploration in a movie like *Wall-E* or *Lightyear*. How do these film representations compare to real life? Click the blue hyperlink to watch the trailer for each movie!

***Wall-E* (2008)**

Wall-E deals with many important issues about taking care of our planet, which you'll read about more later on in this study guide. But a major part of the movie is the idea of living in space. The ISS proves that humans can live in space for extended periods of time, but it's not as easy as the movie makes it out to be and we still have a ways to go before we reach that point from a technological aspect. For example, astronauts must work hard and exercise every day to offset the effects of microgravity on the body. Additionally, if you watch this clip from *Wall-E*, you'll notice that nothing on the spaceship floats around like how it does on the ISS. Wall-E lands with a big thud when he's thrown forward! That's because the ship in the movie has something called "artificial gravity," which mimics the Earth's gravity. In real life, however, scientists haven't been able to make this kind of technology. While *Wall-E* depicts an exciting idea for long-term space travel, there is still a lot of work that needs to be done until we reach that point of scientific development.

Lightyear (2022)

Lightyear portrays the futuristic potential of space travel to new worlds. Though our technology is not quite ready for us to be able to walk on untouched planets, it is something that scientists are working towards; NASA is hoping to develop the technology necessary to put humans on Mars. Humanity may still be far off from doing so, but NASA's Artemis program (which you can read more about on page 48) will provide important steppingstones to have humans one day walk on the red planet.

Getting Dressed for Space

Extravehicular Mobility Units (EMUs) are special uniforms astronauts wear when they are moving around outside of a spacecraft – but you can just call them spacesuits! Without spacesuits, we wouldn't have been able to walk on the Moon or build and maintain the ISS. With NASA's long-term goals of setting up a permanent base on the Moon and sending the first humans to Mars, spacesuit development is more important than ever.

Spacesuits are designed to serve as a sort of "personal spaceship" for astronauts. The big backpacks on their backs hold their life support system, providing them with electricity, water, clean air, and a radio so that they can communicate with their crewmates back on the ISS. It also has something like a jetpack, which astronauts can turn on to propel them forward if they start to float away from the space station. The suit works as a sort of armor, protecting astronauts from space rocks that may be flying around and the radiation in space (what is space radiation?), while the visor protects their eyes from bright sunlight.

Neil Armstrong's spacesuit, which he wore when he became the first person to walk on the moon.

Build your own astronaut suit!

Something that all movies about space have in common, whether they take place in the past, present, or future, is space suits and a spaceship for the astronauts. Take some time to explore the Smithsonian's webpage dedicated to spacesuits – pay attention to how they look, why certain changes were made, and what the future of spacesuits might be. Think about the important features of spacesuits, like the gloves and the helmet.

Now it's your turn – grab some paper and colored pencils and design your own spacesuit! Think about what elements you might want to change or add to the spacesuit to make it your own. Would you make the helmet bigger to fit natural hair? Or make the gloves smaller so that you can grab things easier? Once you're done, reflect on your spacesuit and how it compares to NASA's. Why do you think NASA hasn't made the changes you've made?

Prototype spacesuit for the Artemis III Mission – the actual spacesuit will be white to better reflect heat and protect astronauts from extreme temperatures.

Meet Your Space Companions!

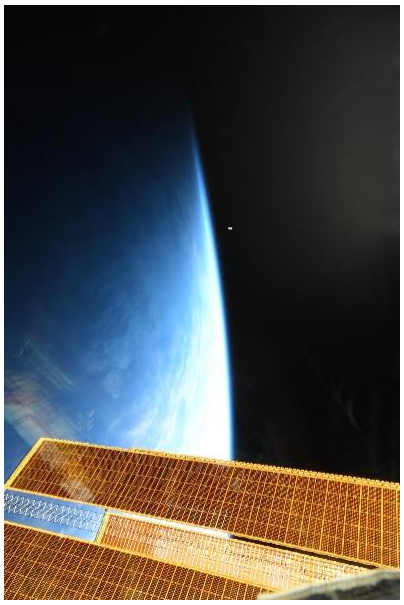
While you're experiencing THE INFINITE, you are going to meet several real-life astronauts who were on board the ISS when the creators of THE INFINITE sent their camera up to film. Here, you'll get to know some of them – where they're from, what their hobbies are, and what their role aboard the ISS is. **As you're going through each astronaut's biography, underline or highlight any similarities you find between them and yourself. Which astronaut do you have the most in common with?**

Christina Koch

Raised just an hour north of Wilmington in Jacksonville, Christina Koch is a North Carolina native! She graduated from NC State University in Raleigh, where she got a master's degree in electrical engineering. She served as a Flight Engineer on the ISS for Expedition 59, 60, and 61. During this time she also became the record holder for the longest single spaceflight by a woman, spending 328 consecutive days in space. Additionally, she participated in the first all-female spacewalk on October 18, 2019 alongside fellow NASA astronaut Jessica Meir. Her hobbies include community service, traveling, and photography – check out one of her awesome shots below!

Jessica Meir

Jessica Meir was born in Caribou, Maine and holds a doctorate in marine biology from the University of California at San Diego. With Expedition 60 and 61, she spent 205 consecutive days in space as a Flight Engineer on the ISS, where she partook in the first all-female spacewalk with Christina, as mentioned above. Jessica is trilingual: along with English, she also speaks Swedish and Russian. Though she is an American citizen, she holds dual Swedish citizenship, making her the first female Swedish citizen in space! Meir also knows how to play the flute, saxophone, and piccolo. Watch this video of her playing the Star Wars theme on the piccolo aboard the ISS!



Anne McClain

Anne McClain was born and raised in Spokane, Washington. She has earned three master's degrees, in aerospace engineering, international relations, and strategic studies. Not only does Anne hold the rank of colonel in the US army, but she has also served as the ISS Assistant to the Chief within NASA's astronaut office, among other jobs at NASA. Working on Expedition 58 and 59 as a Flight Engineer, she logged 204 consecutive days in space – making her one of only nine NASA astronauts to have reached this threshold. Before she became a colonel and an astronaut, Anne was a professional rugby player, and has played for the US women's national rugby team!

Andrew "Drew" Morgan

Drew Morgan was born in West Virginia to a military family; as such, he grew up all over the country and the world, including California, Texas, New York, Delaware, and Great Britain. Drew holds a Doctorate in Medicine at Uniformed Services University of the Health Sciences, as well as the rank of colonel in the US Army. He worked on Expedition 60, 61, and 62 on the ISS, conducting hundreds of experiments during his stay in a wide variety of fields, from biology to technology development. Morgan participated in seven spacewalks while staying on the ISS, totaling 45 hours and 48 minutes – an American record for a single spaceflight! When he's not in space, Drew enjoys swimming, family road trips, and reading about the history of space.

David Saint-Jacques

David Saint-Jacques, born in Quebec, Canada, is an astronaut with the Canadian Space Agency. He holds a Ph.D. in astrophysics from Cambridge University and an M.D. from the University of Montreal. David worked on Expedition 57, 58, and 59 as a Flight Engineer; during this time, he participated in one spacewalk, which was only the fourth spacewalk ever completed by a Canadian astronaut. In his free time, he enjoys skiing, cycling, and sailing. David can speak five languages: English, French, Russian, Spanish, and Japanese – all of which are particularly useful on the ISS!

Meet Joan Higginbotham

Joan Higginbotham, a retired astronaut, now calls Charlotte, North Carolina, home! Blumenthal will be engaging with Joan throughout the Fall of 2024, though she won't be present at every field trip morning. She does, however, fully support this project and is thrilled to see so many young people get the chance to experience space through immersive virtual reality. For students, this is a great reminder that astronauts are regular people too. Who knows – Joan could live right down the street from one of your students! We hope that engaging with a local astronaut, or simply learning a bit more about her story, will inspire your young learners to chase their dreams and if it is their life goal – to become an astronaut and travel to space!

Her NASA Timeline

August 1987 – First job at NASA's Kennedy Space Center (FL) - Payload Electrical Engineer (she started just two weeks after she graduated from college!)

April 1996 – Selected as an astronaut candidate and reported to NASA's Johnson Space Center (TX) in August 1996.

December 2006 – Her trip to space with the crew of STS-116!

- Her primary task was to operate the Space Station Remote Manipulator System (SSRMS), aka the robotic arm. She also served as the 'loadmaster', transferring more than two tons of equipment and supplies to the space station, and returning to Earth almost two tons of items no longer needed onboard the station.
- During these 13 days, she traveled 5.3 million miles, and logged over 308 hours in space. STS-116 landed on December 22, 2006.
- She took mementos from several organizations into space with her including Delta Sigma Theta Sorority, Incorporated, the Links, Incorporated and the Chicago White Sox, just to name a few. However, the most prized item she took was a t-shirt designed by her late father.

More about Joan: Her younger years were pretty normal by all accounts. Joan loved school (her favorite subjects were math and science), being smart, hanging out with friends and was incredibly fascinated with wires and electricity (she took apart her brother's transistor radio). It was through Inroads, a pre-engineering program, that she learned about the field of engineering and what engineers do (not conduct trains!). She decided that becoming an electrical engineer was the path for her, and the rest as they say, is history (or her-story).

Quote (about space travel): "On a personal level, flying in space was quite an achievement. On a more global level, I feel that this was the way that I got to contribute to my country."

With inspiration from Joan, ask your students: **how do YOU want to contribute to your country?**

Quotable Quotes

Below are quotes from several famous astronauts. Select 3 quotes below that stick out to you and write 2 to 3 sentences for each on why you relate to these reflections.

A. “We are united by the dream of exploration and accomplishment.” - Anne McClain
B. "We came, we saw, we collected rocks." - Neil Armstrong (a more lighthearted take on the Apollo 11 mission)
C. "The Earth is a beautiful blue marble in the vastness of space." - Frank Borman
D. "The risks are high, but the rewards are even higher. We must be bold and courageous in our exploration of the cosmos." - Sally Ride
E. "You develop an instant global consciousness, a people orientation, an intense dissatisfaction with the state of the world, and a compulsion to do something about it." - Edgar Mitchell
F. "To explore is human. Every generation has its explorers." - Michael Collins
G. "Space is a harsh and unforgiving environment. Every mission is a test of human ingenuity and resilience." - Michael Lopez-Alegria

Quote 1 (enter letter from above): ____
Why is it important:

_____

_____

_____

_____

_____

Quote 2 (enter letter from above): ____
Why is it important:

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Quote 3 (enter letter from above): ____
Why is it important:

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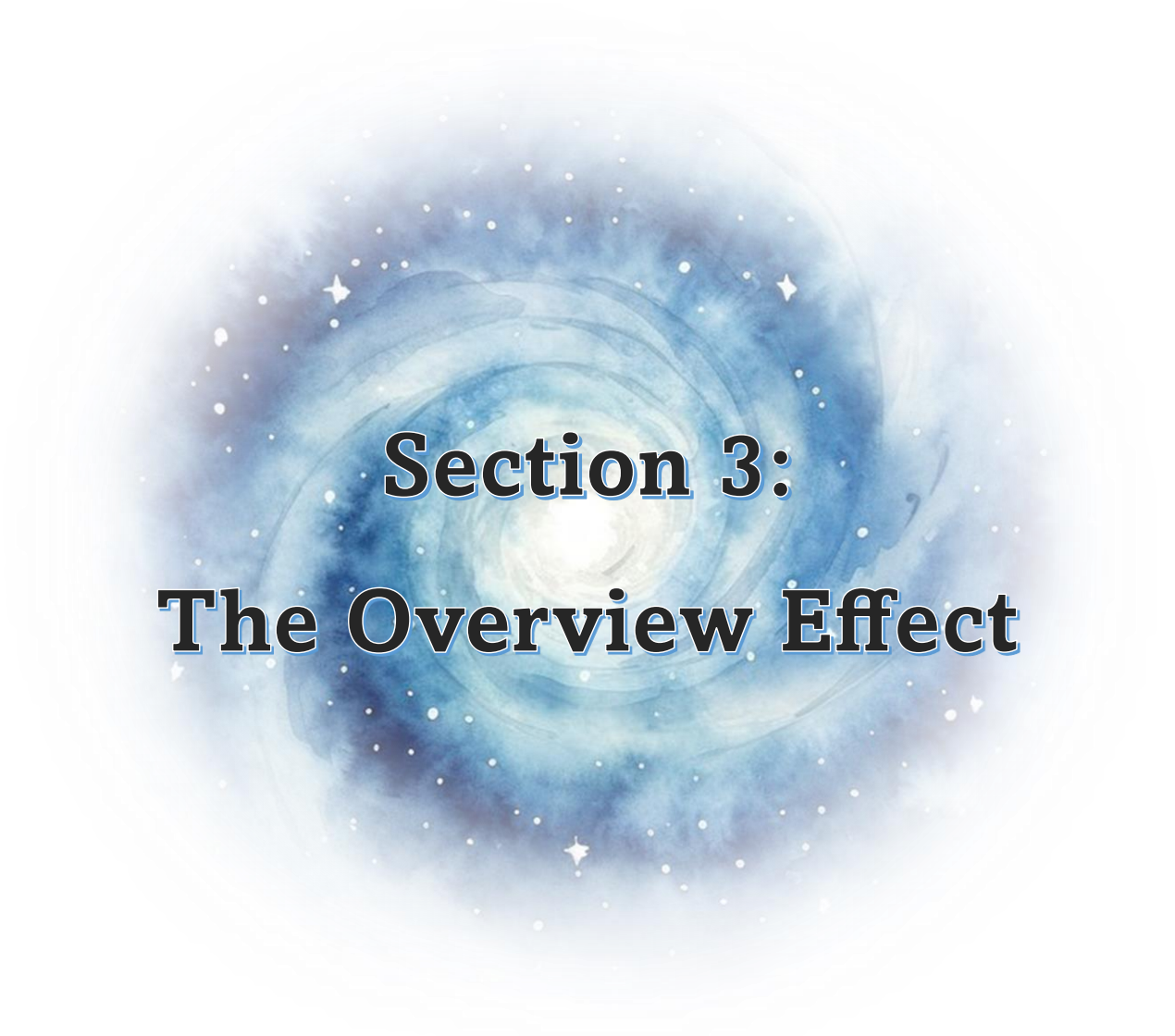


Section 3:
The Overview Effect

The Overview Effect

To set the tone for this activity, project an image of earth as seen from space on your whiteboard or smartboard and dim the classroom lights. Next, share this definition and relevant quotes with your students as you introduce this topic to them:

- The Overview Effect is a cognitive shift reported by some astronauts while viewing the Earth from Space. The most prominent common aspects of personally experiencing the Earth from space are appreciation and perception of beauty, unexpected and even overwhelming emotion, and an increased sense of connection to other people and the Earth as a whole.
- "In the long history of the world, only a tiny fraction of people have ever seen the Earth from space. But all of us, every one of us, live on it." - Carl Sagan
- "The overview effect - it's a profound experience that changes you." - Ron Garan

Initial discussion questions

1. Have you ever experienced a smaller version of the Overview Effect? Perhaps you were in a plane looking down on a city underneath you, took in a city skyline from far away, or looked at a map and realized just how far away you lived from some of your family?
2. Did you feel more connected to humanity in those moments or out of reach?
3. If you were to go up in space and look back at Earth, what emotions would you feel? What would you feel compelled to do?

Next, watch this video:
Pale Blue Dot – Carl Sagan

Follow-up discussion questions

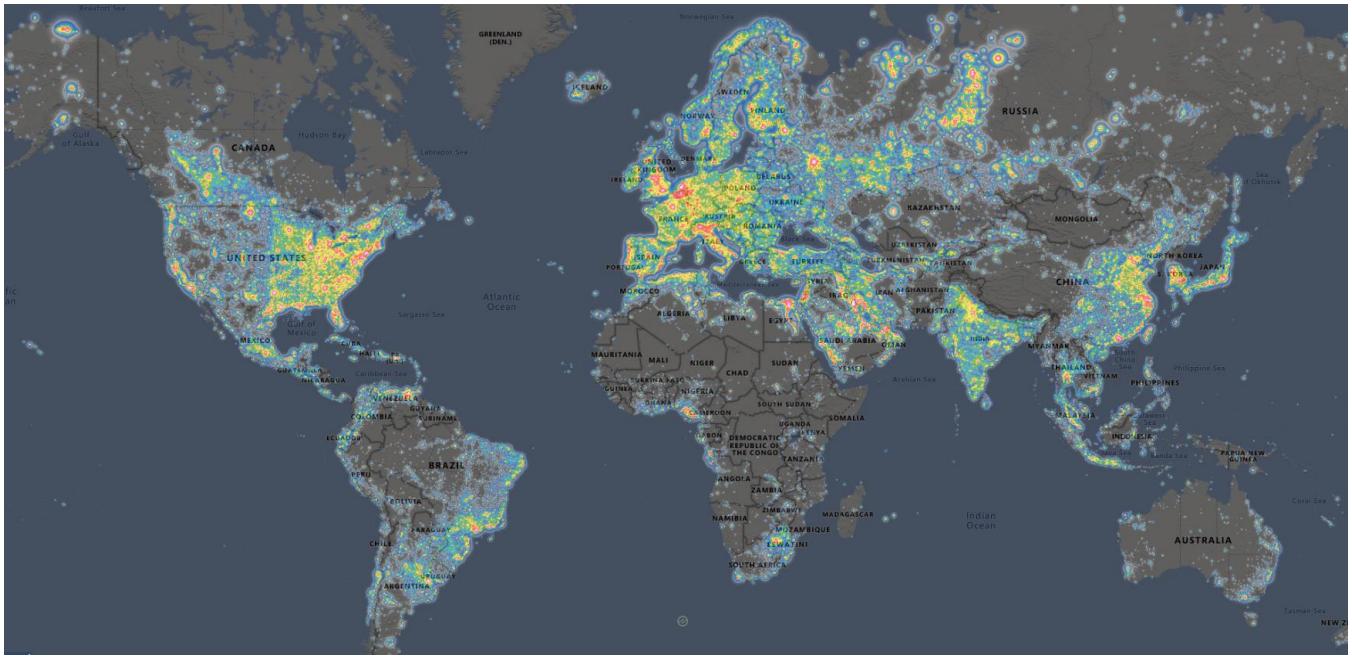
Feel free to have students write out answers so they can take more time for self-reflection.

1. How did watching the Pale Blue Dot image and Sagan's commentary make you feel?
2. How does the fragility of Earth, as seen from space, impact your view on environmental issues?
3. Does the idea of a shared humanity resonate with you? How can we foster a stronger sense of global community?
4. What role do you think science and technology play in shaping our future?
5. How does perspective change our views on the world around us?
6. How is this video related to the Overview Effect?
7. What does this activity inspire you to do or learn more about?

Want to dive even further? Here is a podcast produced by NASA on this topic or listen to *Star Trek* legend William Shatner talk about "the most profound experience" when he went to space.

Earth's Light in Space

This is an introductory activity to study light pollution. As a starting point, pull up this link (Light Pollution Map) and see if students know what it represents. Don't tell them at first. Ask students for a word to describe this image. They will most likely say cool, beautiful, etc. but what does it teach us?



Materials:

- Large, dark room or hallway
- Flashlights or other light sources
- Globe or world map

Lesson Plan:

1. **Create a Dark Environment:** Close all curtains/blinds, turn off lights, or blinds to create a dark room with minimal external light.
2. **Represent Earth:** Place a globe or world map in the center of the room to represent Earth.
3. **Introduce Light Sources:** Distribute flashlights or other light sources to students. These will simulate artificial lights from cities and towns.
4. **Simulate Light Pollution:** Ask students to shine their flashlights on different parts of the globe to represent urban areas. Encourage students to experiment with different angles and intensities of light to mimic various types of light pollution (ex. Pointing a light up = wasted electricity).
5. **Observe and Discuss:** As the room fills with light, discuss how the "night sky" becomes brighter and how it becomes harder to see the globe's details. Explain how this simulates the impact of light pollution on stargazing and wildlife. National Geographic has a fabulous article about the environmental effects of light pollution.
6. **Propose Solutions:** Divide into small groups and brainstorm 3 ways that humans can reduce light pollution. Write these down and prepare to present to the full class so the lesson remains hopeful and solutions-oriented.

Sustainable Earth Simulation

Astronauts who experience the Overview Effect closely connect it to the fragility of our planet, the only place known in the universe to support life. This activity will help students understand the interconnectedness of Earth's systems and the impact of human actions on the environment.

Materials:

- Large poster board or white board
- Markers
- Resource cards (with environmental challenges and solutions)

Setup:

1. Divide the class into groups of 4-5 students.
2. Create a large poster board or use a whiteboard to represent the Earth with different sections for land, water, air, and living things.
3. Prepare resource cards in advance with various environmental challenges (e.g., pollution, deforestation, climate change, overpopulation) and potential solutions (e.g., recycling, renewable energy, conservation). Give a score to each card (teachers can make this up on their own. Recycling = 5 solution points, Pollution = 25 challenge points, Natural Disaster = 100 challenge points, etc.)

Gameplay:

1. The class starts with a certain number of "Earth health points" in each category. A go-to is 100 points (400 points in total).
2. Groups take turns pulling a resource card and responding as a group (to encourage discussion and light debate).
3. If the card is a challenge, the group must decide which category to place the challenge (it must make sense for this placement). Their choices will impact that category's health points.
4. If the card is a solution, the group can implement it to improve their Earth health points.
5. Groups can collaborate and discuss their strategies in order to "survive" and keep at least 50 points or above in each category.
6. The game ends after "surviving" a predetermined number of rounds or when a group's Earth health points reach a critical level. This is flexible based on the points you allot to each resource card and how long you want to play the game.

Learning Outcomes:

- Students will understand the interdependence of Earth's systems.
- They will learn about various environmental issues and their consequences.
- Students will develop problem-solving and decision-making skills.
- They will appreciate the importance of sustainable practices.

Additional Tips:

- Incorporate real-world examples and data to make the simulation more engaging.
- As the teacher, play devil's advocate whenever possible to encourage critical thinking.
- Encourage students to reflect on their choices and the impact of their decisions.
- Discuss the results of the game as a class to reinforce key learning points.

Example Environmental Challenge Cards:

- **Pollution:** Air pollution, water pollution, land pollution, noise pollution, light pollution.
- **Resource Depletion:** Deforestation, overfishing, water scarcity, mineral depletion.
- **Climate Change:** Extreme weather events, rising sea levels, loss of biodiversity, ocean acidification.
- **Human Impact:** Overpopulation, urbanization, waste management, habitat destruction.

Example Environmental Solutions Cards:

- **Conservation:** Energy conservation, water conservation, land conservation, wildlife conservation.
- **Renewable Energy:** Solar power, wind power, hydro power, geothermal energy, biofuels.
- **Recycling and Waste Reduction:** Recycling programs, composting, reducing plastic use, waste-to-energy.
- **Sustainable Practices:** Organic farming, sustainable transportation, green buildings, eco-tourism.

Additional Game Elements for Added Fun:

- **Technology Cards:** Introduce cards representing technological advancements that can help or hinder Earth's health (e.g., electric cars, pollution-control devices, genetically modified organisms).
- **Natural Disasters:** Include cards for natural events like earthquakes, volcanic eruptions, and floods to add an element of unpredictability.
- **Global Collaboration Cards:** These cards can represent international agreements or initiatives to address environmental issues.

Bonus activity on this topic: Have students design a meme that would receive the most attention but also do the most good through motivating others to clean up our planet. Below is an example. Students can submit votes (or "likes") to select a class favorite and the winner could be posted on the classroom door.

Calculating the Cosmos

When you imagine space, do you think about the stars in the night sky? All of the stars you can see are a part of our galaxy, called the **Milky Way**. Below you can see a drawing of our Milky Way. Circled in black is our **Solar System**, which includes the Sun and all of the planets that orbit it, like the Earth. The Solar System is about 25,000 light-years away from the center of the galaxy. That means that if you traveled at the speed of light (*186,000 miles per second!*), it would take 25,000 years to reach the center! We don't have any pictures of the Milky Way Galaxy from space because intergalactic travel, or travel between galaxies, has not yet been achieved. Any "picture" that you see of the Milky Way is a drawing or painting based on what scientists know about galaxies. But if you go somewhere with a minimal amount of light pollution, like a desert or a mountaintop, you can get a glimpse of our galaxy.

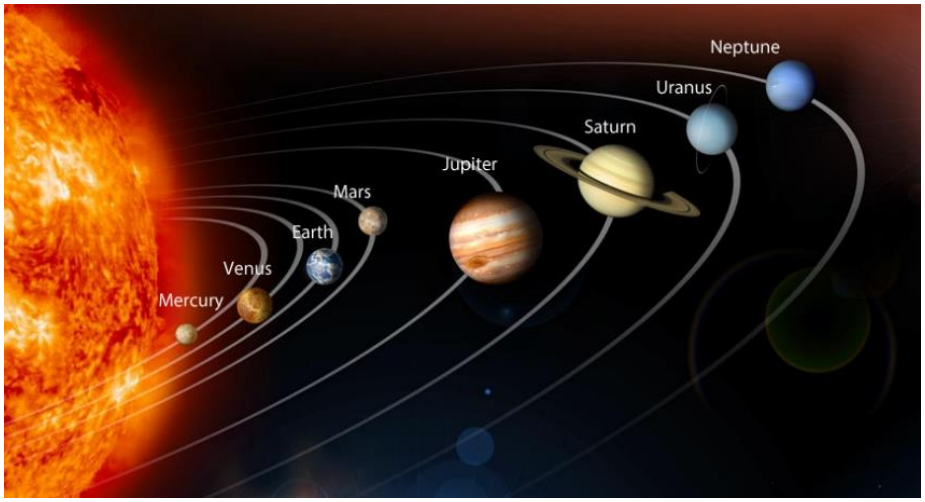
A drawing of the Milky Way Galaxy

The Milky Way Galaxy above the Lut Desert in Iran

Scientists estimate that there are anywhere from 100-400 billion stars in the Milky Way Galaxy – and our Sun is one of them! The Milky Way is just one galaxy in the universe; NASA believes that there are around **2 trillion** (that's 2 followed by *12 zeros*!) galaxies in the universe. And there are as many stars in the universe as there are grains of sand on the beach!

Here is a picture of the planets in our Solar System. This diagram can be misleading though, because it shows the planets as being very close together and close to the same size.

Check out this video to get a better understanding of the scale of the Solar System!



The Math of Space

1. NASA wants to set up a permanent lunar base on the Moon, which could help with long-distance space missions to other planets like Mars. The Moon is about **238,855 miles** away from the Earth. The average distance from Earth to Mars is about **140,000,000 miles**. On average, about how many miles away from Mars is the Moon?

2. The biggest planet in the Solar System is Jupiter, which has a diameter of about **86,881 miles**. The Earth has a diameter of **7,918 miles**. How many times larger is Jupiter than the Earth? *Hint: divide Jupiter's diameter by Earth's diameter*.

3. The furthest planet from the Sun is Neptune, which is **2.8 *billion* miles** away from the Sun on average. The speed of light, or how fast light travels from its source, is 186,000 miles per second, which is equal to **671 *million* miles per hour**. How many hours does it take for light traveling from the Sun to reach Neptune? *Hint: 671 million miles could also be written as 0.671 billion miles*.

4. Our Solar System only has one star, our shining Sun! The closest star to our Solar System is called Proxima Centauri. If you were to visit the star and then come back to Earth, you would travel **8.5 light-years**. How many light-years away is Proxima Centauri? *Hint: a roundtrip is double the distance to your first destination.*

5. The Milky Way is **100,000 light-years across**, and our Solar System is **25,000 light-years**, or ¼ of the way, from the center. Starting from our Solar System, if you wanted to travel across the Milky Way and pass over the center of the galaxy, how far will you have to travel?

6. The nearest galaxy to the Milky Way is the Andromeda Galaxy, about **2,500,000 light-years away**. If you wanted to do a roundtrip to the Andromeda Galaxy, meaning that you go there and then come back, how many light-years would you travel?

The Weight of Space

Because the strength of gravity on Earth is different from the strength of gravity on the moon and other planets, the weight of objects differs depending on where they are. This doesn't mean that objects lose or gain anything physically – mass always remains the same, no matter how strong the gravity is! Weight is determined by the amount of gravity that is pulling on an object, so the stronger the pull of gravity, the more an object will weigh. For example, because the pull of gravity on the moon is significantly less than on Earth, a 100-pound person on Earth would only weigh 16.53 pounds on the Moon! On Mars, the gravitational pull is slightly stronger than on the Moon – they would weigh 37.83 pounds.

Now you try! With the conversion formulas below, use a calculator to figure out how much these objects would weigh on the Moon and on Mars. Don't forget to include your unit of measurement!

$$\textbf{Weight On the Moon} = \frac{\textbf{Weight On Earth}}{9.81\ m/s^2} \times 1.622\ m/s^2 \qquad \textbf{Weight On Mars} = \frac{\textbf{Weight On Earth}}{9.81\ m/s^2} \times 3.711\ m/s^2$$

In these equations, m/s^2 means meters per second squared. This is the way that gravity is measured; On Earth, the average gravitational pull is 9.81 meters per second squared. You don't need to worry about this when typing your equations into your calculator, though!

Example:
A house cat weighs around **10 pounds** on Earth.

Moon weight: $\frac{10}{9.81}$ X 1.622 = **1.65 pounds** Mars weight: $\frac{10}{9.81}$ X 3.711 = **3.78 pounds**

Laika the space dog, the first living creature in orbit, weighed **13 pounds** on Earth.

Moon weight: _____ Mars weight: _____

The Curiosity rover weighs **2,000** pounds on Earth.

Moon weight: _____ Mars weight: _____

Apollo 11, the first space ship to land on the moon, weighed around **100,000 pounds** on Earth when it first launched.

Moon weight: _____ Mars weight: _____

Apollo 11 dropped about 90% of its mass at various points of its mission, making it weigh about **10,000 pounds** when it landed back on Earth.

Moon weight: _____ Mars weight: _____

The International Space Station weighs **900,000 pounds** on Earth.

Moon weight: _____ Mars weight: _____

Section 4:
Seeing Yourself on the International Space Station

Astronaut Checklist

So, what does it take to be an astronaut? Astronaut requirements have changed with NASA's goals and missions. To be considered for an astronaut position at NASA today, applicants must meet the following qualifications:

- ☐ Be a U.S. citizen
- ☐ Possess a master's degree* in a STEM field, including engineering, biological science, physical science, computer science or mathematics, from an accredited institution.
- ☐ Have at least two years of related professional experience obtained after degree completion or at least 1,000 hours pilot-in-command time on jet aircraft.
- ☐ Be able to pass the NASA long-duration flight astronaut physical.

Teachers - Take a bit of time to explain some of the degree categories, what fields they represent, some other potential jobs that can be obtained with that degree, and why undergraduate and graduate studies are so important when stepping into the workforce in those areas. Then….

Speaking of an astronaut physical, let's get on our feet!

Materials:

- Open space for physical activity
- Cones or markers
- Beanbags or balls
- Stopwatch (optional)
- Clipboards and pencils for recording data (optional)

Introduction (10 minutes)

- Explain that astronauts need to be in excellent physical condition to withstand the challenges of spaceflight.
- Discuss the different parts of the body astronauts need to keep strong and flexible, such as:
  - Cardiovascular endurance
  - Upper body strength
  - Balance and coordination
  - Core strength

Warm-up (5 minutes)

- Lead the students in some light stretches and jumping jacks to get their bodies warmed up.

Astronaut Physical Activities (25 minutes)

Activity	Description	Focus
Cardiovascular Endurance	Simulate a spacewalk by setting up a cone course. Students will jog or run around the cones for a set time (e.g., 2 minutes).	This activity tests students' ability to sustain moderate exercise for an extended period.
Upper Body Strength	Play a beanbag toss game where students throw beanbags or balls at targets while standing on one leg. This simulates the use of tools and equipment in space.	This activity tests students' upper body strength and coordination.
Balance and Coordination	Set up a balance beam or use a line on the floor. Students will walk across the beam or line while carrying a beanbag on their head.	This activity tests students' balance and coordination.
Core Strength	Have students perform some simple core exercises like sit-ups or planks. Astronauts need strong core muscles for stability in space.	This activity tests students' core strength.

Cool-down and Debrief (10 minutes)

- Lead the students in some gentle stretches to cool down.
- Discuss the activities and how they relate to the physical demands of space travel.
- Discuss what modifications would be needed to exercise in zero gravity.

Extension Activities (Optional)

- Have students research the specific physical tests astronauts undergo.
- Challenge students to design their own astronaut training program.

Want to learn more about becoming an astronaut?!

NASA has a straightforward FAQ page about becoming an astronaut that you can explore with students. One of the most frequently asked question is how much do astronauts make ($152,258.00/year) but there are other great ones in here about age restrictions, the best degree to choose in college, etc. Check it out!

ISS Daily Menu - Bon Appétit?

"No one goes to space for the food... but the views are amazing." - Astronaut Don Thomas

During the Apollo and Gemini missions, astronauts used to feed themselves by sucking out foods that were stored in tubes (like toothpaste tube). Since then, space food has come a long, long way. Today, some of these foods are dehydrated (this is similar to packaged dried noodles we find in stores). To make it edible, all astronauts need to do is add some water inside the package via a syringe.

Below is a sample menu aboard the ISS. For this activity:

1. Have students underline any foods they have tried before. Who has the most?!
2. Circle any food that you have no idea how they would make this in space and research this in small groups or as a class.
3. Finally on a separate sheet of paper, have students build their own menu for 3 days in space. There are some foods that astronauts can't eat in space! This resource answers all sorts of fun questions about space food. Leave time to discuss how proper nutrition is critical for astronauts, how NASA is researching sustainable food options for long flights, and if students would bravely try space food or if they'd steer clear and stick with food from the school cafeteria.

Day 1	Day 2	Day 3	Day 4
Meal A	**Meal A**	**Meal A**	**Meal A**
Eggs Scrambled	Cereal, cold	French Toast	Cereal, hot
w/Bacon, Hash	Yogurt, fruit	Canadian Bacon	Cinnamon Roll
Browns, Sausage	Biscuit	Margarine	Milk
Toast	Margarine	Syrup	Grape Juice
Margarine	Jelly, assorted	Orange Juice	Coffee/Tea/Cocoa
Jelly, Assorted	Milk	Coffee/Tea/Cocoa	
Apple Juice	Cranberry Juice		**Meal B**
Coffee/Tea/Cocoa	Coffee/Tea/Cocoa	**Meal B**	Quiche Lorraine
		Cheese Manicotti w/	Seasoned Rye Krisp
Meal B	**Meal B**	Tomato Sauce	Fresh Orange
Chicken, oven-fried	Soup, cream of broccoli	Garlic Bread	Cookies, Butter
Macaroni and Cheese	Beef Patty	Berry Medley	
Corn, whole kernel	Cheese Slice	Cookie, shortbread	**Meal C**
Peaches	Sandwich Bun	Lemonade	Soup, won ton
Almonds	Pretzels		Chicken Teriyaki
Pineapple-Grapefruit	Cried Apples	**Meal C**	Chinese Vegetables, stir-
Juice	Vanilla Pudding	Turkey Breast, sliced	fry
	Chocolate Instant	Mashed Sweet Potato	Egg Rolls
Meal C	Breakfast	Asparagus Tips	Hot Chinese Mustard
Beef Fajita		Cornbread	Sweet n Sour Sauce
Spanish Rice	**Meal C**	Margarine	Vanilla Ice Cream
Tortilla Chips	Fish, saut ed	Pumpkin Pie	Cookies, fortune
Picante Sauce	Tartar Sauce	Cherry Drink	Tea
Chili con Queso	Lemon Juice		
Tortilla	Pasta Salad		
Lemon Bar	Green Beans		

A Day in the Life: Astronaut vs. Student

Astronauts keep busy while they are up in space, but students may not know that they have down time too! Students will compare/contrast their daily routines to that of an astronaut to see the challenges of life in space (and may just learn some time management skills along the way!). Here is a great starter resource from Humans in Space that easily breaks down some differences among life in space vs. life on Earth. Students can use this as a springboard into deeper research on the daily schedule in space.

Materials:

- Large chart paper or whiteboard
- Markers
- Time management worksheets or planners

1. Introduction (10 minutes):

- Begin by asking students what they think a typical day in the life of an astronaut is like.
- Introduce the concept of time management and the importance of scheduling.
- Explain that astronauts have very specific schedules due to the nature of their work.

2. Creating a Student Schedule (20 minutes):

- Have students create a detailed schedule of their typical day, including wake-up time, school, meals, extracurricular activities, and bedtime.
- Discuss the importance of balancing different activities and responsibilities.

3. Researching an Astronaut's Schedule (20 minutes):

- Divide students into groups and assign each group a specific aspect of an astronaut's life (e.g., work, sleep, exercise, meals).
- Have groups research and present their findings to the class.

4. Comparing Schedules (20 minutes):

- Create a large chart or table on the board with columns for "Student Schedule" and "Astronaut Schedule."
- Fill in the chart together as a class, comparing and contrasting the two schedules.
- Discuss similarities and differences, focusing on time management, work-life balance, and physical activity.

5. Reflection and Extension (10 minutes):

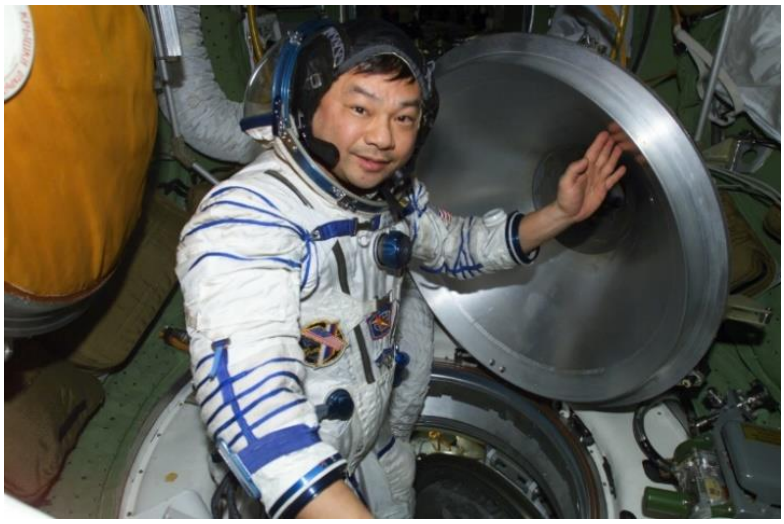
- Ask students to reflect on how their schedules compare to an astronaut's.
- Discuss the challenges and rewards of both lifestyles.
- When are there moments of isolation or connection during the day?
- Encourage students to consider how they could improve their time management skills based on what they learned about astronauts.

Seeing Yourself in Space

Every year, NASA's astronauts break down barriers and inspire a passion for space exploration in people all around the world. The astronauts highlighted below are just a few of many who are proving that anyone can go to the stars. Their tasks for the ISS vary widely, demonstrating the many different things you can do as an astronaut!

Nancy J, Currie-Gregg

Nancy participated in STS-88 ("space transport system"), which was the first assembly mission for the ISS. From December 4-15, 1998, Nancy, along with five other astronauts and cosmonauts, began piecing together the ISS, joining together a Russian-made module with a US-made module. Her work was an essential first step in making the ISS habitable full-time!



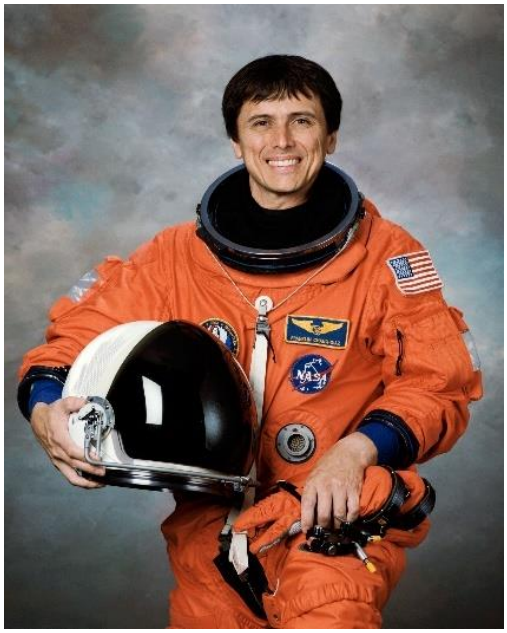
Leroy Chiao

Leroy has been to the ISS twice: once for a delivery and maintenance mission, and once on an Expedition. In October 2000, he participated in STS-92 to prepare the ISS for the arrival of Expedition 1 the following month. He later worked on Expedition 10 from October 2004-April 2005 as the Mission Commander, which made him the first Asian-American Mission Commander in NASA history!

Robert Curbeam. Jr.
Robert worked on STS-98 in February 2001 and STS-116 in December 2006. With STS-98, he helped deliver supplies to the crew of Expedition 1 on the ISS, as well as helped assemble a laboratory module to the ISS. With STS-116, Robert helped rewire the ISS's power station to make it stronger and delivered two tons of supplies and equipment to the station.

Peggy Whitson
Peggy has participated in Expedition 5, 16, 50, 51, and 52, totaling 665 days in space – more than any other American or woman! She served as Mission Commander for Expedition 16 from October 2007-April 2008, making her the first woman to command the ISS. Over the course of her five Expeditions, Peggy conducted hundreds of experiments, helped install new equipment onto the ISS, and completed 10 spacewalks to help upgrade the ISS.

Franklin Chang-Díaz
Franklin has participated in a total of seven space flights, making him tied with NASA astronaut Jerry Ross for the most trips to space. With his first mission STS-61-C in January 1986, Franklin became the first Hispanic American in space! His seventh and final mission with STS-111 in June 2002 took him to the ISS, where he helped repair a robotic arm for the space station as well as delivered new research equipment to the crew of Expedition 5, including Peggy Whitson!



Ellen Ochoa

Ellen became the first Hispanic woman in space in April 1993, when she flew as a mission specialist with STS-56. With STS-96 in May 1999, Ellen also became the first Hispanic woman to visit the ISS, where she helped install a crane on the outside of the station to aid with future assembly tasks. She broke through yet another glass ceiling in 2013, when she was appointed the director of NASA's Johnson Space Center in Houston, making her the first Hispanic director of the JSC.

Leland D. Melvin

Leland participated in two trips to the ISS with STS-122 in February 2008 and STS-129 in November 2009. On his first space flight, he helped deliver and install the ESA's new laboratory. With STS-129, he and his crewmates brought 30,000 pounds of equipment to replace and upgrade various essential functions of the ISS. Leland isn't just an astronaut though – he was also drafted by the NFL to play on the Detroit Lions in 1986 and the Dallas Cowboys in 1987! Unfortunately he never got to play a game due to injuries both times, but those injuries encouraged him to change his career, and he began working at NASA only two years later!

Victor Glover

From November 2020-May 2021 Victor served as Flight Engineer with Expedition 64 and 65, making him the first Black American to live on the ISS! He participated in four spacewalks to help upgrade the space station and fix broken equipment. Victor was selected by NASA to be a pilot on the Artemis II mission launching in late 2025, which will make him the first Black astronaut to participate in a lunar mission. You can read more about the Artemis missions on page 48.

Jessica Watkins

Jessica became the first Black woman to live on board the ISS when she worked on Expedition 67 and 68 from April-October 2022. While on board the space station, she researched and conducted experiments to learn more about the effects of long duration spaceflight on the human body. In understanding these effects, NASA scientists can better prepare for longer missions, such as sending humans to Mars! Jessica is no stranger to Mars – while she was still in college, she worked on the tactical and strategic planning for NASA's Curiosity Mission. The Curiosity rover has been exploring Mars for over a decade and counting!

Nicole Aunapu Mann

Nicole became the first Indigenous woman in space when she participated in Expedition 68 from September 2022-March 2023. She worked on hundreds of experiments, primarily relating to human biology to benefit humanity back on Earth. Nicole also conducted two spacewalks to upgrade the space station's solar arrays, helping prolong the life of the ISS for future Expeditions!

Who Inspires You?

Astronaut Mae Jemison was the first Black woman in space. She said that she was inspired to become an astronaut by the character Uhura from the TV/movie series *Star Trek*. All of these astronauts had someone that they looked up to and inspired them to become space travelers.

NASA astronaut Mae Jemison

Lt. Uhura, played by actor Nichelle Nichols, from Star Trek

Leia Organa, from Star Wars

Iron Man, from the Marvel movies & comics

Now think about yourself – who do you look up to and how do they inspire you? This person can be someone in your life, like a sibling or a teacher, or it can be a fictional character, like Princess Leia or Iron Man. Write out your answer in the space below!

_____

_____

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Section 5:
After the Experience

Sensing Space: Leaning into the Multisensory Experience

You understand now how the creative team behind THE INFINITE was able to capture space and bring it down to Earth, but what about the other elements of the experience? While you were going through THE INFINITE, what else did you notice? Close your eyes, reflect, and see if you can visualize the entire experience around you. Write out at least 2 descriptions of imagery for each question below:

1. What sounds did you hear?
2. What were the lights and projections like?
3. What did the physical space around you look like?
4. As you are immersed in this unknown world, how did all of it together make you feel, *particularly about space*?

Take a moment to reflect on the experience. What orb videos did you see? Did you get dizzy with the VR headset on? Did you keep your balance on Groundswell? Write down your 4 biggest takeaways from the field trip in paragraph form.

Post-Show Discussion Questions

We hope you enjoyed the show! Here are some questions you can talk through as a class so students can think critically about the experience.

1. What was most surprising to you about the experience? What was your favorite part?

2. Which orb/video that you watched was the most unique? Why did it stick out to you?

3. Which astronaut that you observed was your favorite and why?

4. How did the experience challenge your thinking about space travel and life on the ISS? Did it make it feel farther away or within your reach?

5. If you were to create a piece of art, writing, or music inspired by this experience, where would you start and tell us about the final product you have in mind.

6. What questions do you have after the experience about space travel? (and then write these down to talk through together as a class at a later date!)

7. How did the immersive experience enhance your understanding of life on the ISS?

8. What would you change about the experience to make it even better?

9. How would you share what you learned with someone who hasn't had this experience?

Creating the Next New Immersive Phenomenon

This footage from the ISS is incredible, especially in an immersive VR setting. Immersive is a new frontier for the digital arts world. What would your students select if they were to create the next great immersive experience? And most importantly, what would they hope that attending students learned from their experience?

Materials:

- Large sheets of paper or poster board
- Markers, crayons, or colored pencils
- Various art supplies (depending on the chosen theme)
- Chromebooks

Part 1: Brainstorming and Theme Selection

- Introduce the concept of immersive exhibits and provide examples (e.g., science museums, history centers, or your field trip to THE INFINITE!).
- Discuss the elements that make an exhibit engaging and memorable (storytelling, visuals, interactivity).
- Divide students into groups and ask them to brainstorm potential themes for their exhibit (ideas: Amazon rainforest, artic tundra, Mars, the Earth's core, etc.).
- Have each group present their ideas and select a final theme through a class vote.

Part 2: Research and Planning

- Guide students in conducting research on their chosen theme via their Chromebooks.
- Discuss the key elements and stories they want to convey in their exhibit.
- Introduce basic exhibit design principles (layout, flow, focal points).
- Have students create a storyboard or sketch to visualize their exhibit's layout.

Part 3: Creating Interactive Elements

- Explore different types of interactive elements (touch screens, games, puzzles, physical objects, VR, projections, etc.).
- Discuss how to align interactive elements with the exhibit's theme and storytelling.
- Divide students into groups to brainstorm and develop interactive ideas (or have them generate ideas together as a class).

Session 4: Building the Exhibit

- Provide students with materials to begin constructing their exhibit.
- Encourage collaboration and division of labor among group members.

Session 5: Final Touches and Presentation

- Help students refine their exhibit's design and add finishing touches.
- Encourage students to share their exhibit with classmates to gather feedback.
- Prepare for a class exhibit showcase where each group presents their work.

Newspaper Review

You are a journalist for the local newspaper. Starting with an engaging headline, write a review about Space Explorers: THE INFINITE and illustrate the press photo. Remember the headline should be crisp, concise, and catchy. See if you can fill the curiosity gap and connect with the reader in only a few words!

Headline:_____

Image caption:_____

Article body:_____

_____

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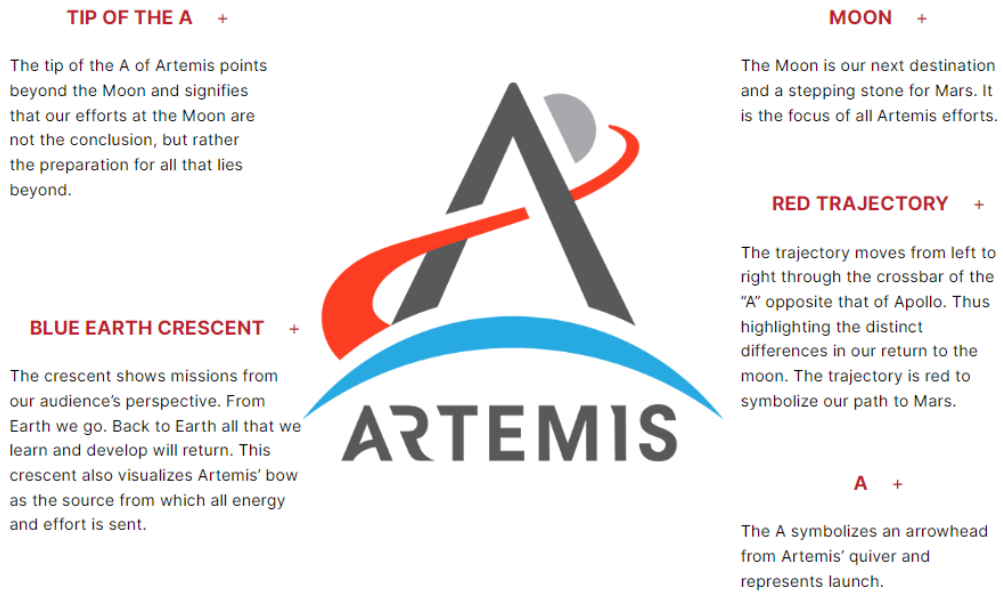
What's Next? The Moon, Mars, and Beyond

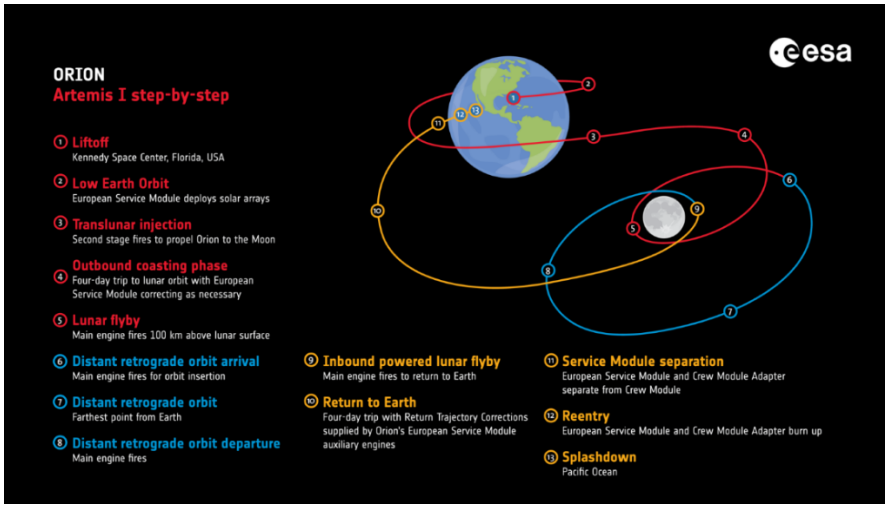
What does the future for space exploration hold? NASA is currently working on the Artemis missions to conduct more in-depth explorations of the Moon by humans and enable future missions to Mars. One Artemis mission has already taken place, and several more are planned. Read about the first three missions below!



Here is the patch for NASA's Artemis missions, designed to demonstrate the goals and aspirations of the program.

<u>Artemis I Mission</u>

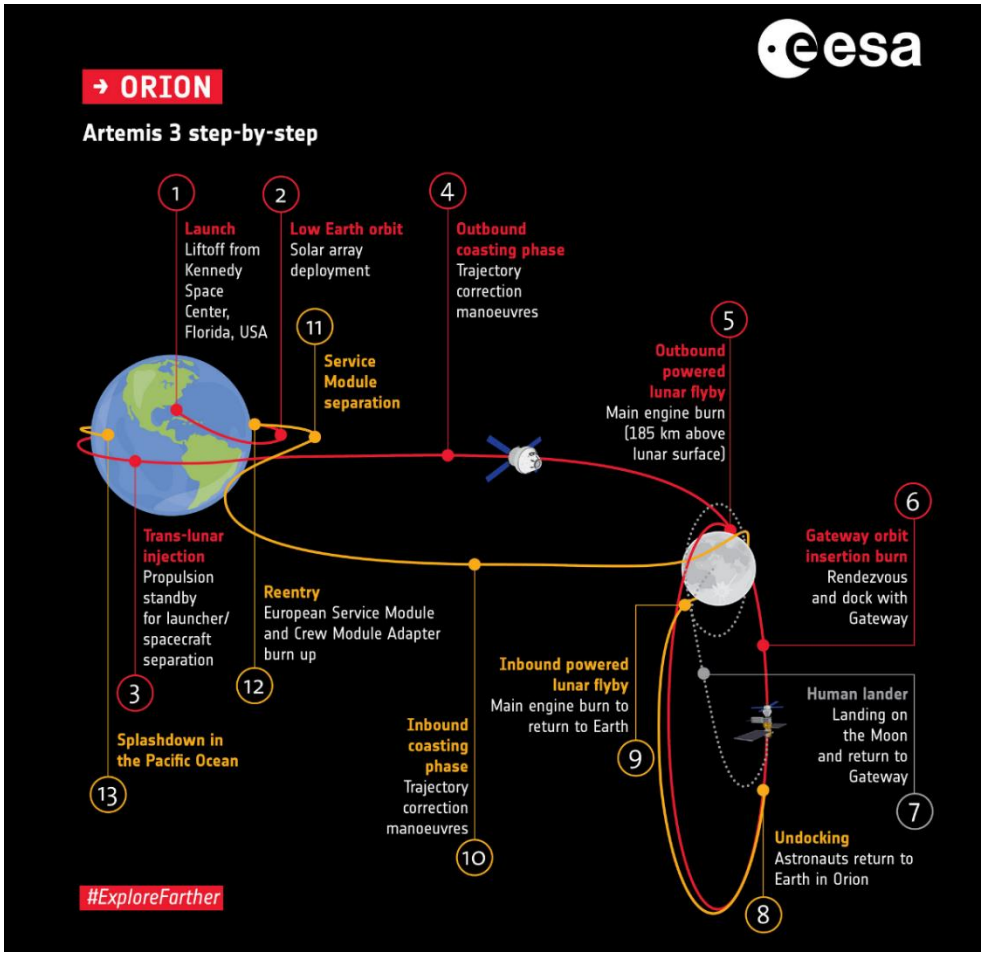
This mission took place from November 16–December 11, 2022. During the mission, the unmanned Orion spacecraft did two lunar flybys, in which it flew around the Moon without touching down on the surface. The Orion used the gravitational pull of the Moon to propel further out into space; the spacecraft traveled 270,000 miles from the Earth, more than 1,000 times farther than the ISS! This mission was an endurance test of the Orion, to make sure that the spacecraft could safely go out that far and return. The image on the right documents the path of Artemis I each step of the way. It was created by the ESA, which helped NASA develop some of the spacecraft's hardware.



Artemis II Mission

This 10-day mission is projected to launch in late 2025 with a crew of four. The astronauts on board will confirm that the Orion's life support, communication, and navigation systems operate as intended and could support a crew on longer duration missions. The Artemis II won't travel out as far as the Artemis I, but it will go out 46,000 miles above the Earth. It will do one lunar flyby, making it the first crewed test flight to the Moon since the Apollo missions of the 1960s-1970s. Additionally, the Artemis II's crew includes astronauts Christina Koch and Victor Glover; both will make history as the first woman and the first Black astronaut, respectively, to complete a lunar mission!

Artemis III Mission

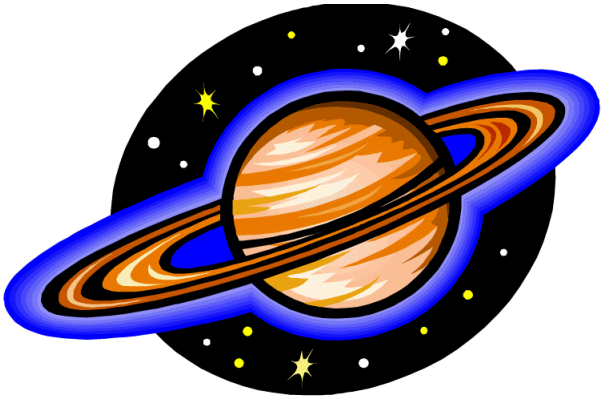


This mission is projected to launch in late 2026 with a crew of four astronauts and last around 30 days. Using what will be learned from the Artemis II flight test, the Artemis III mission will put humans back on the Moon's surface for the first time in over 50 years. The mission will send two astronauts in a landing ship called "Starship" to the lunar South Pole, while the other two astronauts remain on board the Orion. Though the crew has not been named yet, NASA has stated that this lunar landing will be the first time a woman and the first time a person of color steps foot on the Moon. During their week's stay on the Moon, the astronauts will take photos and videos, retrieve samples, and collect data for scientific analysis. According to NASA, the Artemis III mission will "usher in a future in which humans consistently access the Moon, and human planetary exploration missions are within reach. Each Artemis mission will increase our knowledge, refine our operations, and prove our technology as we prepare for the first human mission to Mars."

Bibliography/Additional Reading & Research

Have a student that just can't stop talking about the ISS or you'd like to go further into space travel with your class? Here are some resources to keep the conversation going:

The Earth & Space



- Light Pollution
- Space Food: What Do Astronauts Eat in Space?
- Everyday Life on the ISS
- Explorable 3D rendering of the Milky Way Galaxy
- Camera development for the Moon's surface

Representation in Space

- *First Woman* – Digital graphic novel about a young astronaut who becomes the first woman on the Moon
- *The Color of Space* – NASA documentary highlighting Black astronauts
- "Meet the Space Trailblazers of Color Who Empowered Others to Dream" – CNN Article
- "My NASA Story" – Article by NASA astronaut Joan Higginbotham

THE INFINITE

- Homepage
- Details for Charlotte residency
- News short highlighting features of THE INFINITE
- Interview with PHI Studio creative team

PHI Studio

Felix & Paul Studios

ISS National Laboratory entry for Felix & Paul Studios

NASA

ISS Homepage

Facts about the ISS

ISS Live Tracker

Research results from the ISS

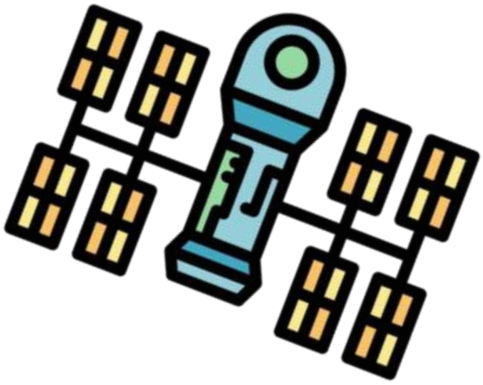
20 breakthroughs from 20 years of the ISS

NASA's plans for Mars

Becoming an Astronaut: Frequently Asked Questions - NASA

NASA's spacesuits through the years

NASA's official photographs from space



ISS Agencies

National Aeronautics and Space Administration (Check out the latest news!)

Canadian Space Agency

Japan Aerospace Exploration Agency

Roscosmos State Corporation or Space Activities (Russia)

European Space Agency

Student Ticket Sponsors

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GAIA Sponsor

Groundswell Sponsor – Judy and Derek Raghavan

And Finally…..Thank You!

We appreciate you organizing a field trip to bring a student group to attend Space Explorers: THE INFINITE at Stage 1 at Blume Studios. We hope to see you again soon!

Study Guide Courtesy of

BLUMENTHAL ARTS

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