LESSON PLAN: Downlink Educator Guide
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### HOW TO WATCH ON FEBRUARY 10, 2023

Tune in from 9:30 - 11:30 AM EST (NASA will give us the official start time for the downlink on February 2, 2023). We'll be broadcasting the live event in the Bausch Auditorium at the RMSC Museum & Science Center, and you can watch online via the links below:

- [NASA TV](#)
- [NASA Live](#)
The NASA In-Flight Education Downlink program connects K-12 students with astronauts aboard the International Space Station for live question-and-answer sessions about living and working in space.

On February 10, 2023, fourth grade students from Dr. Martin Luther King Jr. School No. 9 in Rochester, NY will visit the RMSC to witness the astronauts of Expedition 68 respond to their questions! You’ll be able to watch the astronauts live online too - get ready with us beforehand by researching the expedition and learning about human space exploration through the activities in this lesson plan.

Start by watching this YouTube video from RMSC Strasenburgh Planetarium Director Steve Fentress to learn more about the International Space Station and the downlink program.

What do you notice? What do you wonder?

Suggested downlink clips:

- JPL/Caltech and Van Buren Elementary
- Orville Wright STEM Magnet
- Glenn Research Center
- Full playlist of NASA In-Flight Education Downlinks

ABOVE: International Space Station Expedition 33 flight engineer Kevin Ford (on screen) answers questions from students during a downlink event held in honor of International Education Week at the Smithsonian National Air and Space Museum, Thursday, November 15, 2012 in Washington (NASA).
DESIGNING DOWNLINK QUESTIONS  
estimated time: 60 minutes

Downlinks are quick! Our question-and-answer session is 20 minutes long - we’ll give NASA a list of 18-20 questions, but the astronauts might not have time to get to all of them. How can we make the most of our questions? What would you ask if you were to host a downlink? Here, you’ll design our own downlink questions, starting by setting up some guidelines for “good” questions. We’ve added a couple suggestions to get you started. Come up with some more rules together (or feel free to move on with these two basic guidelines).

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<th>RULE</th>
<th>REASONING</th>
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<td>Questions must be in compliance with NASA’s no-go question list – linked here.</td>
<td>Questions have to be approved by NASA’s Public Affairs Office. If we submit questions from the no-go list, NASA simply won’t answer them!</td>
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<tr>
<td>Questions must be open-ended.</td>
<td>We recommend keeping things open-ended to get the best explanations - in past downlinks, astronauts have even done science demonstrations to explain their answers!</td>
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1. Next, take a look at the sample questions below. Do they fit the rubric? Why/why not? How can you change them into downlink-worthy inquiries? Revise, and share out your edits!

   - Does water boil in space? [closed-ended question; consider rephrasing with “why” or “how”]
   - Why does everything float on the ISS? [use “International Space Station” or “space station”]
   - Do you ever get bored on the space station? [too personal; consider asking about hobbies]

2. We’ll be working in small groups for this part. Research the International Space Station (including Expedition 68 and its crew) using resources from the Research Bank to determine primary areas of inquiry. Consider what you already know and what you want to learn more about. Generate a list of first draft questions based on your research. Evaluate questions against the rubric determined in Part 1, and revise as needed. Write each question on a post-it, and start organizing and forming categories/connections. What are your favorite questions?

3. Once the groups have finished brainstorming, get back together as a whole group to review and prioritize them. Remember, we only get to ask so many questions! Anything to share before we get started? How did the research and brainstorming process go? What categories did you come up with earlier? Put them on a whiteboard or large piece of chart/butcher paper. Take turns sharing questions. Add post-its to your classroom mind map, forming categories to help group together common questions and themes. Label post-its with students’ names. Survey the other groups – did you have the same question? Group together any duplicates! Finally, evaluate the class’s questions - choose group favorites and eliminate others (making sure to discuss the reasoning for each decision). Edit the list until you have your final group of questions.
OREO MOON PHASES
estimated time: 30 minutes

The amount of moon we see changes over the month — lunar phases — because the moon orbits Earth and Earth orbits the Sun. Earth’s shadow can cover all or part of the lunar surface.

What else orbits Earth? The International Space Station! The space station takes only a few minutes to cross the sky, orbiting Earth approx. every 90 minutes.

Materials:

- Oreo Moon Phases worksheet
- Pen or pencil
- 1 individual package of Oreos
- Andes Chocolate Mints (optional)

Instructions:

1. Using your worksheet, draw each lunar phase in its corresponding circle.
2. The moon orbits the Earth — add in the missing arrow!
3. Eat your Oreos — in the shape of each moon phase!
4. Use an Andes mint to represent the International Space Station (optional).
On April 8, 2024, we’ll experience a total solar eclipse in Rochester. In a solar eclipse, the moon gets between the sun and Earth. In a total solar eclipse, people who are in the path of totality see the sun’s bright disk totally covered by the moon for a short time. Learn more at [https://rochestereclipse2024.org/](https://rochestereclipse2024.org/).

### Sun, Moon, and Earth Models

**Materials:**
- Model [template](#)
- Brass fasteners
- Scissors

**Instructions:**
1. Cut out your sun, Earth, moon, and connector pieces.
2. Use brass fasteners to connect the sun to Earth and Earth to the moon.
3. How can you model a solar eclipse? A lunar eclipse?

### Earth-Moon Scale

**Materials (example):**
- Yardstick
- 1-inch foam ball (Earth)
- ¼-inch foam ball (moon)
- Toothpicks
- Binder clips
- Lamp with 1 bulb

**Instructions:**
1. Recreate eclipses using a scale model of the Earth and moon. Attach each foam ball to a toothpick.
2. Using a binder clip, attach one of the balls on the 3-inch mark and the other on the 33-inch mark on the yardstick. This demonstrates how the size and distance of the Earth and moon are in relation to each other.
3. Try to replicate a solar eclipse and a lunar eclipse by casting shadows with the lamp.
BINARY BRACELETS
estimated time: 30-45 minutes

More than 50 computers control the systems on the space station, and more than 3 million lines of software code on the ground support more than 1.5 million lines of flight software code.

Typically, we use ten digits — 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 — to represent numbers when counting, calculating, or communicating values. Computers, on the other hand, operate differently. They use "binary code" that uses only zeros and ones in a sequence of eight spots. Each pattern of ones and zeros over eight spaces represents a different letter, number, or other symbol. Binary code is the "language" used to communicate information between computers, communication devices, and many more modern technologies.

Materials:

- Binary code alphabet
- Beads (3 colors)
- String
- Scissors
- Paper
- Pen or pencil

Instructions:

1. Write your name (or other word).
2. Use the key to translate each letter into binary code.
3. Make your bracelet or necklace! Transform each letter to a colored bead.
   a. Choose one color bead to represent 1 and another color to represent 0.
   b. Between each letter, you can add an extra bead in a color of your choice as a divider. In computer science, separating markers like this are called "delimiters."
4. Make a key for your code!
LOLLIPOP SEASONS  
estimated time: 15-20 minutes

The Earth is tilted 23.5 degrees on its axis. As the Earth revolves around the sun, this tilt means that sunlight does not shine evenly on Earth's surface. This is why we have seasons! When a hemisphere is tilted towards the sun, it receives more sunlight and is warmer. When a hemisphere is tilted away from the sun, it receives less sunlight and is cooler.

Materials:
- Lollipops
- Markers
- Small cups
- Playdough, sand, marbles, or other small weighted objects
- Small flashlights

Instructions:
1. Draw a horizontal line around the middle of the wrapped lollipop to represent the Earth's equator.
2. Put some playdough or small weights in the cup, and then place the lollipop inside the cup at an angle to represent the Earth's tilt.
   a. Make sure the lollipop stays at the same angle. Find a landmark in the room, such as a window, projector, or poster, and make sure the lollipop is always pointing the same way as it moves.
3. Turn on the flashlight to represent the Sun and place the lollipop setup near it so that the lollipop is pointing towards the flashlight. Observe the lollipop. Is there more light at the top or bottom of the lollipop? If the lollipop represents Earth, which hemisphere would be in summer?
4. Move the lollipop to the other side of the flashlight, but make sure it's still pointing in the same direction! Where is there more light now? Which part of the Earth is in summer now?
5. Experiment with the model. Can you use it to represent spring and fall?
**Expedition 68**

- **Mission summary**
- Astronaut crew profiles
  - Frank Rubio
  - Dmitri Petelin
  - Koichi Wakata
  - Josh Cassada
  - Nicole Mann
  - Sergey Prokopyev
  - Anna Kikina
- Expedition 68 photo gallery

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<tr>
<td>- <strong>Introduction video from Steve Fentress.</strong> A good place to start learning about the International Space Station (12 minutes).</td>
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<td>- Josh Cassada videos. Watch “Astronaut at a Glance: Josh Cassada” (4 minutes) to hear Dr. Cassada talk about working through difficult problems.</td>
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<td>- Watch astronauts take care of their hair, eat, and move equipment. Go to <a href="https://www.nasa.gov/mission_pages/iss/main/iss_b_roll.html">https://www.nasa.gov/mission_pages/iss/main/iss_b_roll.html</a> and select “Life on Station” (5 minutes).</td>
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<td>- <strong>How does the toilet work on the International Space Station?</strong> It’s no joke. In space and on Earth, toilets that work properly are necessary to protect everyone’s health. European Space Agency astronaut Samantha Cristoforetti gives you a tour (3 minutes).</td>
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<td>- <strong>Full playlist of NASA In-Flight Education Downlinks.</strong> Astronauts answer questions from other students around the country.</td>
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<td>- JPL coding activities</td>
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<td>- Learning Space</td>
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<td>- <strong>ISS Diagram</strong></td>
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<td>- 2022 calendar: On the International Space Station</td>
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<td>- <strong>International Space Station</strong></td>
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<td>- Exoplanet Travel Bureau coloring book</td>
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<td>- Space Place coloring pages</td>
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<td>- Send a postcard to space with <a href="http://blueorigin.com">Blue origin Club</a></td>
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<td>- Galaxy Zoo on Zooniverse</td>
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CONNECTIONS TO STANDARDS

- **Science and Engineering Practice 1: Asking Questions and Defining Problems**
  - Identify scientific (testable) and non-scientific (non-testable) questions.
  - Ask questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships.

- **Science and Engineering Practice 8: Obtaining, Evaluating, and Communicating Information**
  - Compare and/or combine across complex texts and/or other reliable media to support the engagement in other scientific and/or engineering practices.

- **Disciplinary Core Idea ESS1.A: The Universe and Its Stars**
  - The Sun is a star that appears larger and brighter than other stars because it is closer. Stars range greatly in their distance from Earth.

- **Disciplinary Core Idea ESS1.B: Earth and the Solar System**
  - The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the Sun, moon, and stars at different times of the day, month, and year.

- **Nature of Science: Science is a Human Endeavor**
  - People from all cultures and backgrounds choose careers as scientists and engineers.
  - Most scientists and engineers work in teams.
  - Creativity and imagination are important to science.

- The highlighted experiments on the mission summary connect to many fourth-grade NYSSLS performance expectations, such as:
  - **Plant Habitat - 03**
    - 4-LS1-1. Construct an argument that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction.
  - **Catastrophic Post-Wildfire Mudflows**
    - 4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.
    - 4-ESS3-2. Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.
**Field Trips:** Continue your exploration at the RMSC! We offer a variety of guided and self-guided experiences that connect to your classroom content and provide hands-on discovery. Can't come to us? RMSC educators can visit your classroom, and virtual trips are available for many of our programs! Some of our programs include:

**RMSC Museum & Science Center**
- Light Up the Martian City: Alternative Energy Challenge (Grades 2-8) - Become part of an elite team of astronauts as you construct an energy grid for the first human settlement on Mars.
- Live Science: Solids, Liquids & Gases (Grades 2-12) - Our coolest demonstrations, literally! This program explores temperature’s effect on solids, liquids and gasses using liquid nitrogen.
- Roving Robots (Grades 1-5) - Discover how robots are programmed to perform tasks. Program a robot to complete a mission in space. Build a robot to communicate with extraterrestrial life!

**RMSC Strasenburgh Planetarium**
- Planet Spectacular (Grades 1-2): Depart Earth, and visit Pluto and all the planets in our solar system!
- Rotation and Revolution (Grades 3-6): Take a virtual trip from Earth’s surface into the solar system to see vividly how rotation and revolution produce the cyclical sky changes we see.
- Solar System Science (Grades 3-8): Surrounded by the best images from recent space missions such as the New Horizons Pluto flyby projected at giant scale, students encounter the majesty, mystery, and wonder of our solar system.

Visit [rmsc.org/museum-science-center/field-trips/](https://rmsc.org/museum-science-center/field-trips/) to learn more about program offerings and book your field trip today! Thanks to generous contributions from the community, the RMSC has limited scholarship opportunities available to fund educational experiences. Check availability and submit your application at [rmsc.org/learning/school-scholarships/](https://rmsc.org/learning/school-scholarships/).

**Youth Volunteer Opportunities:** Do you work with teenage learners? We welcome youth (ages 15-17) to volunteer in a variety of roles with us! Visit [rmsc.galaxydigital.com](https://rmsc.galaxydigital.com) for more information and to submit an application.

- **Curiosity Camps:** Curiosity Camps Volunteers help provide a fun and safe camp experience while sharing in the exploration of science!
- **Ask-It:** Ask-It Volunteers spend time interacting with visitors in museum exhibits. If you enjoy connecting with people and are passionate about science, technology, cultural heritage, the environment, and hands-on experiences, then the Ask-It Volunteer team is for you!