EDUCATOR'S GUIDE

Space Refuse

Preparation

Overview and Objectives
This lesson is geared toward students in grades 6-8.

Participants will learn about the space refuse and the types of debris that have been left in space by past missions. Exploding rockets, colliding satellites, and natural decay of old spacecraft have caused a buildup of unusable small and large particles in space. Participants will reflect on the management of garbage on Earth versus in space and then track their garbage production over a week to understand the ways that humans impact Earth and space environments.

Standards

New Generation Science Standards

MS-ESS1-3
MS-ESS3-3
MS-ESS3-4

This lesson includes a slideshow in which an instructor can lead participants through types of common space refuse and ways that space agencies are attempting to limit the debris today.

Instructional Modalities

This activity was designed for both synchronous or asynchronous instruction.

For **synchronous instruction**, we recommend a platform that allows both for whole class discussion and for students to interact in small groups.

For **asynchronous adaptations**, we provide suggestions for teachers to provide additional support for the activities and for students to share their work with each other.

Materials

- **Space Refuse slideshow**
- **Space Refuse: Track My Trash worksheet**
- **Space Refuse: Mess on the Moon worksheet**

Lesson

1. **Introductory Activity**
    - Before beginning the slideshow, define “refuse” for students and discuss:
        - **What kinds of objects might make up the debris in space?**
        - **How does space refuse become space refuse?**
    - Students will watch a 12 minute video about the equipment, waste, and other items left on the Moon during the Apollo missions, particularly the Apollo 11 mission. They will use the Mess on the Moon worksheet to answer questions about the video. Discuss the worksheet questions. The following questions expand on those ideas:
        - **Why did NASA order Neil Armstrong and Buzz Aldrin to leave so many things on the Moon at the last minute?**
        - **Are you surprised by any of the things Armstrong and Aldrin left behind?**
        - **What items left behind had sentimental value? What was the significance of leaving behind meaningful items like these?**
        - **How might the trash and waste left on the moon affect its environment?**
    - Discuss the types of space refuse and the differences between debris left behind on purpose and that which was never supposed to stay in space.
    - Many satellites and rocket pieces were sent to space with no intention of bringing them back down. Some of those have been sent to the “graveyard orbit” and many will eventually decay after decades or centuries and fall back down to Earth. Some will burn up in Earth’s atmosphere. Some will fall apart or explode in space and become many small pieces of orbiting space junk.
    - Other space refuse pieces were sent to space with the intention of bringing them back to Earth at some point. These include satellites and rockets that were orbiting the Earth when they crashed into other spacecraft, breaking into pieces and causing them to become part of the mass of space junk. Tiny pieces of metal and paint flakes also can come off of any spacecraft and become space refuse.
        - **How does this build up of space refuse compare to the buildup of garbage on Earth?**
        - **How might space refuse impact the experience of astronauts and the planning of future space missions?**

2. **Core Activity**
    - Ask students to reflect on why space refuse might be a problem for space travel and space organizations.
        - **Why don't we allow trash to pile up around us on Earth?**
        - **What methods do we use on Earth to limit our refuse production?**
    - Discuss the ways that space refuse threatens the safety of current spacecraft, including satellites. Small particles like paint do not harm spacecraft when they come into contact. But it is the large pieces of rocket, probes, and satellites that can damage spacecraft while they are in orbit.
        - **How does trash on Earth threaten our safety?**
        - **What might NASA do to limit the threat of space refuse harming future spacecraft?**
    - Space refuse also impacts the environment here on Earth. Discuss the Point Nemo spacecraft cemetery, light pollution, and falling space debris.
        - **How does the management of fallen space debris compare to the management of trash produced on Earth?**
            - ex. the Great Pacific Garbage Patch
    - There are many ways that NASA and other space agencies are attempting to curb the expansion of space refuse. While it is more difficult to bring space debris back down to Earth, it is possible to prevent spacecraft from exploding and creating more pieces as well as from crashing into each other. Discuss the use of elliptical orbits, the graveyard orbit, and passivation to limit the impact of satellites and defunct rockets.
        - **Why do you think there isn't an international policy regulating space refuse?**
        - **Why is it helpful to move unusable spacecraft into the "graveyard orbit"?**
        - **A lot of space refuse simply falls down on its own, about one piece a day. What complications might this process cause?**

3. **Wrap-Up**
    - Much of the space refuse left on the Moon, and some in orbit by itself, is made of food and human waste. Students will use the Track My Trash worksheet to spend one week tracking all of the trash and recyclable waste they produce each day, item by item. At the end of the week they will reflect on the types of waste they produce, any changes they

noticed in their waste production, and how they might limit their waste in the future.

- **What practices for limiting waste on Earth might work in space?**

Asynchronous Adaptation

Have participants go through the slideshow on their own and track their waste for one week. Have them post their trash tracking online and reflections on how they can limit waste in the future.

Extension Activities

To deepen student engagement with this content, you may choose to add the following activities :

Design a Space Refuse Removal Device

Ask students to design a tool to remove space debris. They should consider the size of the debris they are trying to remove and where the debris is located. They may want to research additional information about current proposed ideas for inspiration.

- **How is your tool equipped to remove debris from space?**
- **What materials is your tool made of?**
- **Does your tool require human control?**

This may be a sketch or a model built from household materials.

Additional Resources/ References

NASA FAQ on orbital debris

An example of waste tracking

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