

National Aeronautics and Space Administration



NASA Helio Club

Capstone Project: Mission Proposal

NASA Heliophysics Education Activation Team



Overview (20 Minutes)

Now that learners have explored some of NASA's missions, including missions that study the Sun, the solar system, and distant stars and galaxies, it is time for them to propose their own mission.

The introduction to the project takes approximately 20 minutes, but it is recommended to give learners at least 60 minutes to design their mission.

Ask learners:

- What questions do you still have?
- What places or phenomena would you like to learn more about?

Use the slide deck to give learners a deeper background in types of NASA missions before they embark on designing their own.

Use the rubric to measure learner success.

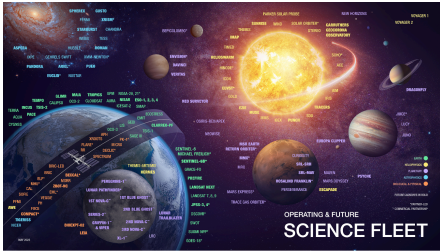
Materials

- [Handout Directions Capstone Project](#)
- [Handout Mission Proposal Letter](#)
- [Handout Criteria for Success Capstone Project](#)
- Educator Resource: [Slides Capstone Project](#)
- Digital Resource: [NASA Science Missions](#)

Instructions

- A. **Provide Context:** Throughout the club sessions learners explored a variety of heliophysics and related topics: [Slide 2]
- **Session 1: Heliophysics 101** - This session explored the structure of the heliosphere and how the Sun influences the space around it.
 - **Session 2: Observing the Sun** - This session included several different options for safely observing the Sun, including solar eclipse glasses and pinhole projectors.
 - **Session 3: Parker Solar Probe Engineering Challenge** - This session included two engineering challenges based on the engineering challenges of NASA's Parker Solar Probe Mission to the Sun.
 - **Session 4: Predicting Space Weather** - This session explored the properties of magnetism and how the magnetic fields of the Sun and Earth interact through a phenomena called space weather.
 - **Session 5: Aurora: The Beauty of Space Weather** - This session continued to explore space weather by examining the phenomena of aurora.





NASA's Science Fleet
Credit: NASA

- **Session 6: Beyond the Heliosphere** - This session explored the life cycle of stars and examined other stars in the Milky Way Galaxy and the planets that orbit them.

In **Session 6** learners viewed a graphic showing **NASA's Science Fleet**, on page 77 of the [NASA Helio Club Youth Guide](#), which includes missions that study the Sun, the solar system, and distant stars and galaxies. These missions, collectively, help NASA create a more comprehensive understanding of the universe. [Slide 3]

- **Earth Science** – missions that study Earth
- **Heliophysics** – missions that study the Sun and the heliosphere
- **Planetary Science** – missions that study objects in the solar system
- **Astrophysics**- missions that study objects outside the solar system
- **Biological and Physical Science** – missions that use the spaceflight environment to study phenomena in ways that can't be studied on Earth

The missions we learned about throughout the club include: [Slide 4]

- **Session 1:** IBEX (H), Voyager (H)
- **Session 2:** SDO (H), STEREO (H), Hubble (A)
- **Session 3:** Parker Solar Probe (H)
- **Session 4:** Solar Orbiter, SOHO (H), MMS (H), Artemis (H)
- **Session 5:** ICON (H), International Space Station (BPS)
- **Session 6:** Chandra (A), TESS (A), Kepler (A), Spitzer (A), JWST (A)

B. There are a variety of different kinds of missions, depending on the destination and what scientists are

interested in learning about. Here are the different types of missions, with examples of each type: [Slide 5-7]

- **MISSIONS with PHYSICAL SAMPLES**

We have collected physical samples from **the Moon**, and even an **Asteroid (Bennu)** from the [OSIRIS-REx Mission](#), from which samples are returning to Earth in 2023. The [Stardust Mission](#) was the first mission to return samples from a **comet** to Earth. We even have samples of the solar wind from NASA's [Genesis Mission](#). Physical samples give scientists a lot of information about the object they are studying. [Slide 5]

- **MISSIONS with SURFACE EXPLORATION**

We currently have several missions studying the surface of **Mars**, including rovers like [Curiosity](#) and [Perseverance](#). The [Huygens Mission](#) landed on Saturn's largest moon, Titan. Rovers and other probes that land on the surface of an object have instruments that can be used to conduct experiments and collect valuable data, even if they don't return samples to Earth. The [Apollo 11 Mission](#) was the first mission to send humans to the Moon. [NASA's Artemis Mission](#) is an exciting upcoming mission, which will send the next generation of astronauts to the Moon. [Slide 5]

- **ORBITING MISSIONS**

[Solar Orbiter](#) completes one revolution of the Sun every 168 days. As you can see from the NASA Fleet graphic there are many Earth orbiting missions collecting data about Earth, [Landsat](#) is one example. There are also satellites orbiting the Moon and other planets, taking pictures and collecting data. The [Reconnaissance Orbiter \(MRO\)](#) is just one of many missions orbiting **Mars**. The [Juno Mission](#) orbits around **Jupiter**.



The [Messenger Mission](#) orbited **Mercury** for 4 years. [Cassini](#) orbited **Saturn** for 13 years. The [Galileo Mission](#) orbited Jupiter for 8 years. The [Magellan Mission](#) orbited around **Venus**. Orbiting an object many times allows scientists to collect lots of information about the planet. [Slide 6]

- **FLYBY MISSIONS**

We have more limited data collected from missions that just had a flyby of a planet, dwarf planet, or a moon, such as [New Horizons](#) passing by **Pluto** and its moons in 2015. A flyby gives scientists less time to gather data than the missions that orbit an object for many years. The [Voyager Missions](#), launched in 1977, have gone farther than any other mission ever has, leaving our Solar System in 2012, gathering data from its flybys of the **Jupiter** and **Saturn** systems, discovering new moons in both systems. Launched in 1973, the [Mariner 10 Mission](#) had the first flybys of **Mercury** and **Venus**. [Slide 6]

- **OTHER MISSIONS**

There are lots of other missions. Some missions orbit Earth, but look out into the universe, like the [NASA Hubble Space Telescope](#), the [Kepler and K2 Missions](#), the [TESS Mission](#), as well as others. The new space telescope, the [James Webb Space Telescope](#), doesn't orbit Earth, but orbits a point out in space that experiences a gravitational equilibrium, about 1 million miles from Earth. The [International Space Station](#) is a unique international mission that studies multiple disciplines of science to demonstrate new technologies and makes research breakthroughs not possible on Earth. [Slide 7]



Mission Proposal Letter

Mission Name: _____

Mission Destination: _____

Lead Investigator: _____ (your name)

Credit: NASA

Mission Question: _____

Mission Concept: _____

Dear NASA:

Our team of scientists and engineers is very excited about the study of the Sun and the heliosphere. We have examined the data gathered from previous and existing missions to the Sun, missions that study magnetic fields around Earth, missions to the edge of the heliosphere, and missions that search for planets around other stars. But we believe that there is more to discover!

Mission Justification
We think this would be a good mission because...

Phase A: Project Plan:
The type of data that we will collect on this mission includes...

Mission Proposal Letter

C. **Direct learners to page 82 of the [NASA Helio Club Youth Guide](#) or use the [Handout Directions Capstone Project](#) for an overview of the project. [Slide 8]**

Use the Parker Solar Probe Mission to show learners an example of how to design a mission. [Slides 9-10]

Allow learners sufficient time to research what kind of mission they want to plan, create their design, write the **Mission Proposal Letter**, and to draw their spacecraft. **Direct learners to page 84 of the [NASA Helio Club Youth Guide](#), or use the [Handout Mission Proposal Letter](#).** This could take several class periods or can be done as homework.

[Optional] Have learners create a model of their spacecraft using simple crafts and household items.

D. **Assess: Direct learners to page 83 of the [NASA Helio Club Youth Guide](#) or use the [Handout Criteria for Success Capstone Project](#) to view the criteria for success, see below. Applying points for a grade is optional. [Slides 11&12]**



Criteria for Success

	Expert Design (2)	Intermediate Design (1)	Beginner Design (0)	
Mission Destination	Mission destination is unique and innovative with a strong science focus. Destination shows thoughtful consideration to current and past missions.	Mission destination is a popular hotspot for scientific exploration. However, this location has already been heavily explored.	Mission destination is not necessarily of scientific interest.	
Phase A: Mission Science	Mission has a strong science goal and a clear plan for collecting data.	Mission has a valuable science goal.	Mission's science goal is unclear.	
Phase B: Mission Design (Engineering)	Mission has an efficient design that matches the challenges of the destination. Design provides details about how the spacecraft and its instruments will be protected from the challenges of the specific space environment of the destination.	Mission has a thoughtful design that takes into consideration the general challenges of exploring the space environment.	Mission design doesn't directly address the challenges of exploring the general space environment.	
Points [optional]	A = 6 – 5	B= 4 – 3	C= 2 – 1	Resubmit = 0

