Summer of Innovation

Solar System Adventures
4th – 9th grade

Introduction

The goal of the NASA Summer of Innovation Solar System Adventures camp is to excite young minds and inspire student trainees toward future science, technology, engineering, and mathematics (STEM) pursuits. Raising trainee achievement in STEM pursuits begins by leading trainees on a journey of understanding through these highly engaging activities. The activities and experiences in this guide come from across NASA's vast collection of educational materials.

This themed camp outline provides examples of one-day, two-day, and weeklong science and engineering programs. Each day contains 6-8 hours of activities totaling more than 35 hours of instructional time. The camp template will assist you in developing an appropriate learning progression focusing on the concepts necessary to engage in learning about the solar system. The Solar System Adventures camp provides an interactive set of learning experiences that center on the scale, exploration, and composition of the planets, moons, and other objects. The activities scaffold to include cooperative learning, problem solving, critical thinking, and hands-on experiences. As each activity progresses, the conceptual challenges increase, offering trainees full immersion in the topics.

Intended Learning Experiences

Through the participation in these camps future scientists and engineers will have the opportunity to explore the solar system. Student trainees gain learning experiences that help make scientific careers something they can envision in their lives. Trainees realize that they have the potential to make a contribution to this field and ignite their curiosity to see what they might create during the program. The learning experiences also anticipate that trainees will have the opportunity to:

- Create scale models of the solar system
- Investigate the rotation and revolution of objects within the solar system
- Describe basic characteristics of the planets and other minor bodies in the solar system
- Model the methods used by scientists to understand objects within the solar system
- Evaluate career options in space science
- Explore the electromagnetic spectrum and properties of light in the universe
- Investigate star structure and evolution

Professional Development

Educator Professional Development (PD) experiences are available. Webinars, NASA Digital Learning Network (DLN) programs, training videos, and online meeting spaces will help you implement the program. We hope that you and your trainees have a memorable and successful experience implementing these activities.

Professional Development Resources

- The NASA Educator Online Network is a great resource for STEM educators to share and learn about STEM topics. The Solar System Adventures camp hosts a group that will provide a place for sharing about the activities, additional resources, extension ideas, and support.
- Visit the Summer of Innovation homepage for an extensive catalog of news, media resources, and educational materials.

Format of the Guide

The Six E's
Each day or section of activities utilizes the 5-E Instructional Model. Included in this program guide is a sixth 'E' for Excite. This additional 'E' shows you how to incorporate NASA's unique information and resources to excite trainees with career connections, real world examples, spinoffs from NASA research, and more. Learn more about the 5-E Instructional Model.

$ Requires simple materials common in the classroom or relatively inexpensive to obtain.

$$ Requires purchasing unique materials such as poster board, duct tape, or hot glue guns.

$$$ Requires purchasing or building higher-cost items, though many are one-time purchases that may used for many trainees over several years.

Title	Overview	Time	Cost	Additional Resources
The title hyperlinks to the activity.	An overview describes the main concepts and strategies used in the lesson, activity, or demonstration.	The time listed includes time for an introduction, activity time, and conclusion time.	Please find this camp or the activity you are using in the Resource Repository for more information on costs and tips.	Suggested resources may include additional lesson plans, posters, images, or other learning support materials.

Engage: Question?

Icons may appear throughout the program


A computer symbol means you may need one or more computers or other technology, though alternatives are available.


The food icon indicates that the trainees will produce or use food in their learning.


The poster icon indicates that the projects the trainees produce make excellent station displays or decorations for a showcase event.

Journal

Journals are an optional element of your camp. Throughout the camp template, you will find reflective questions, ideas, and guidance in creating a journal. Journals also provide trainees with a unique souvenir of their experiences. Learn more about how scientists and engineers use journaling at NASA by watching this eClip video: Journaling in Space.

One-Day Camp: Solar System Adventure

The one-day camp gives trainees a broad understanding of the scale, structure, and exploration of the solar system. The camp is highly kinesthetic and includes several activities that may be combined to create one large project for display at the end of the day.

Title	Overview	Time	Cost	Additional Resources
Engage: What Planets and Dwarf Planets are in the Solar System?				
Modeling Planet Sizes with Food Page 6	Trainees choose from an array of fruits, vegetables, and foods to choose an item that represents the differences in the scaled sizes of the planets and other objects in the solar system.	0.5 hrs	$	Go to the Head of the Solar System: Online Game
Explore: How Has NASA Explored the Solar System?				
Voyager 1 and 2: Where Are You?	Trainees create a large-scale model of the solar system. Educators with space may choose to make a more permanent solar system distance exhibit in their neighborhood using activities in the resources column.	1.0 hrs	$	The Schoolyard Solar System Worlds Beyond Permanent Art Installations
Solar System Exploration Timeline Activity	Trainees investigate solar system exploration missions as they construct a timeline using NASA internet resources. The timeline display then serves as a visual reminder of coming events and makes a display for the day.	1.5 hrs	$ 	Solar System Lithograph Set Solar System Missions Reference Site
Explain: Why Is Our Sun Important?				
What Do We Know About the Sun: Our Sun as a Star Page 7	Trainees use brainstorming, discussion, and journaling to determine what they know about our sun and its importance to Earth.	0.5 hrs	None	Sunwatchers Through Time Interactive: Our Very Own Star
Elaborate: Can You Design or Build a Space Probe?				

NASA Spacecraft Paper Models	Trainees follow the plans to build one of several models of solar system exploration spacecraft. They could work to improve upon these models or modify them to meet new mission goals.	1.0 hrs	$$	Universe Spacecraft Paper Models
Evaluate: Where Do We Go Next?				
NASA Future Missions	This website highlights some of the future missions NASA has planned. Explore the site and offer trainees a chance to brainstorm about where they think we should go next and why. The activity may be completed at any point in the two-day program.	0.5 hrs	None 	NASA TV Be sure to check the various channels on NASA TV, especially the Education Channel
Excite: Can I Work at NASA Someday?				
NASA Careers Survey	Trainees explore career options for working at NASA. Educators can complete this activity at any point in the day.	0.5 hrs	None	NASA Career Corner for Trainees
Total		**6 hrs**		

Two-Day Camp – Day One: The Spirit of Exploration

The two-day camp explores the scale, structure, and exploration of the solar system with increasing depth and breadth. The camp is highly kinesthetic and includes several activities that may be combined together to create one large project for display at the end of the second day.

Title	Overview	Time	Cost	Additional Resources
Engage: Why Do We Explore?				
Why Do We Explore?	Trainees create a large poster of solar system exploration summarizing the reasons for space exploration. The lesson integrates reading skills, such as paraphrasing, into the trainee learning.	1.0 hrs	$	Planet Quest Historic Interactive Timeline Interactive: The Robotic Exploration of Space
Solar System Exploration Timeline Activity	Trainees investigate solar system exploration missions as they construct a timeline using NASA internet resources. The timeline display then serves as a visual reminder of coming events and makes a display for the day. Integration with the *Why Do We Explore?* lesson is a best practice for using this lesson.	1.5 hrs	$ 	Solar System Lithograph Set Solar System Missions Reference Site
Explore: What is the Scale and Structure of the Solar System?				
Modeling Planet Sizes with Food Page 6	Trainees choose from an array of fruits, vegetables, and foods to choose an item that represents the differences in the scaled sizes of the planets and other objects in the solar system.	1.0 hrs	$	Go to the Head of the Solar System: Online Game
Voyager 1 and 2: Where Are You?	Trainees create a large-scale model of the solar system. Educators with space may choose to make a more permanent solar system distance exhibit in their neighborhood using activities in the resources column.	1.0 hrs	$	The Schoolyard Solar System
Explain: What Have We Learned About the Solar System?				
Solar System Exploration Homepage	Trainees begin a research project on a planet of their choice. Working in teams, trainees go on a virtual scavenger hunt to find data about their planet. Trainees will use the information to create a travel brochure on day 2 of the program. If desired, trainees may also complete the activity in stations as they take an imaginary walk to another planet and gather details on that planet.	1.5 hrs	None 	The Solar System Simulator Interactive: Eyes on the Solar System
Total		**6 hrs**		

Two-Day Camp – Day Two: Solar System Adventure Travel

Title	Overview	Time	Cost	Additional Resources
Engage: What Is the Temperature of Space?				
What Is the Temperature of Space?	Trainees watch a short Brain Bites video clip and then participate in a panel discussion about the temperatures of space.	0.5 hrs	None 	Brain Bites Video: What Is the Temperature of Space? Brain Bites Video: What a vacuum looks like
Explore: How Do Scientists See the Solar System?				
Telescopes from the Ground Up	Trainees explore the various types of telescopes used to view the solar system and beyond.	0.5 hrs	None 	Scope It Out: An Educational Telescope Comparison Game
Explain: How Do Planets Move in the Solar System?				
The Dizzy Spinning Planet	This activity explains why planets and stars that spin rapidly flatten out on their tops and bottoms	0.5 hrs	$	Background: Early Solar System Rotation Planetary Motion and Modern Scientific Thought
Kinesthetic Astronomy Full Version Abbreviated Version	Through a series of simple body movements, trainees gain insight into the relationship between time and astronomical motions of Earth (rotation about its axis, and orbit around the Sun), and also about how these motions influence what we see in the sky at various times of the day and year.	1.0 hrs	$	Kinesthetic Astronomy Assessment Worksheets
Dancing with the Planets	Trainees explore the distance between Earth and Mars by making a human orbit. Trainees demonstrate dramatically, with music, costume, or dance, the movements of Earth and Mars around the sun and the trajectories of a spacecraft moving between them.	1.0 hrs	$	Interactive and Video: Eyes on the Solar System The Human Orrery
Elaborate: How Do the Movements of the Sun-Earth-System Cause Moon Phases?				
Cookie Moons	Trainees model the phases of the moon using cream-filled sandwich cookies.	1.0 hrs	$$	The Moons of Our Solar System

				6000 Year Moon Phase Catalog
Evaluate: What Would It Be Like to Travel to Another Planet?				
NASA Travel Agent	Trainees create a “travel brochure” about a planet. The travel brochure, though imaginary, should contain artistic thought on the necessary items and conditions needed for survival during a human exploration of another planet.	1.5 hrs	$	Solar System Exploration Homepage
Excite: What Is Next for NASA?				
NASA Future Missions	This website highlights some of the future missions NASA has planned. Explore the site and offer trainees a chance to brainstorm about where they think we should go next and why. The activity may be completed at any point in the two-day program.	0.5 hrs	None 	NASA TV
Total		**6 hrs**		

Weeklong - Day One: Solar System Introduction

In the weeklong Solar System Adventures camp, trainees work to understand basic solar system characteristics such as size, scale, revolution, and rotation. They progress towards understanding planetary data, comets, meteors, asteroids, moons, and structure of the universe, stars, and galaxies. Trainees continue on their adventures ultimately building a series of displays that showcase their learning. The trainee showcase may be held on the last day as a two-hour event, or as an optional star party night.

Trainees should be made aware of the culminating activities. As the week progresses, trainees will use a segment of their journal to plan for the showcase event. Educators should also keep in mind that several activities call for food to be used in the classroom. Be sure to survey all parents for food allergy information prior to beginning the program. The food list may also be a source of items you can have donated to your program by parents or the community.

While completing the weeklong program, many of the activities double as materials to use for the showcase.

The food icon indicates that the trainees will produce or use food in their learning. Trainees may offer their families the snacks during the showcase event or at the end of each day.

The poster icon indicates that the projects the trainees produce make excellent station displays or decorations for the showcase event.

Title	Overview	Time	Cost	Additional Resources
Engage: What Planets and Dwarf Planets are in the Solar System?				
Modeling Planet Sizes with Food Page 6	Trainees choose from an array of fruits, vegetables, and other foods to choose an item that represents the differences in the scaled sizes of the planets and other objects in the solar system. 	0.5 hrs	$	Go to the Head of the Solar System: Online Game
Explore: How far away are the planets?				
Edible Mars Spacecraft	Trainees use creative thinking and problem solving skills to design the FIDO or Athena Rover using a supply of different foods. The model will be used in conjunction with the Dancing with the Planets activity. 	0.5 hrs	$$	Other NASA Spacecraft Models Other Mars Spacecraft Models

Dancing with the Planets	Trainees explore the distance between Earth and Mars by making a human orbit. Trainees demonstrate dramatically, with music, costume, or dance, the movements of Earth and Mars around the sun and the trajectories of a spacecraft moving between them.	1.0 hrs	$	Interactive and Video: Eyes on the Solar System The Human Orrery
Voyager 1 and 2: Where Are You?	Trainees create a large-scale model of the solar system. Educators with space may choose to make a more permanent solar system distance exhibit in their neighborhood using activities in the resources column. 	1.0 hrs	$	The Schoolyard Solar System
Explain: What is rotation and revolution in the solar system and what does it mean to me?				
The Dizzy Spinning Planet	Explains why planets and stars that spin rapidly enough flatten out on their tops and bottoms	0.5 hrs	$	Background: Early Solar System Rotation Planetary Motion and Modern Scientific Thought
Kinesthetic Astronomy Full Version Abbreviated Version	Through a series of simple body movements, trainees gain insight into the relationship between time and astronomical motions of Earth (rotation about its axis, and orbit around the Sun), and also about how these motions influence what we see in the sky at various times of the day and year.	1.0 hrs	$	Kinesthetic Astronomy Assessment Worksheets
Elaborate: What Role do Mass and Gravity Have in the Solar System?				
Astro-Matic 3000	Trainees explore their weight on other planets using an online interactive. Educators may also expand this activity into stations, provide data, and require math calculations for individual trainee exploration	0.5 hrs	None 	Non-Flash Astro-matic 3000 Activity
Stretching Mass Activity	Trainees measure the amount of force gravity exerts on objects of different mass by suspending them on rubber bands then measuring the distance the rubber bands stretch. Trainees will collect and discuss their data and communicate the results.	1.5 hrs	$	Stretching Mass Video
Total		**6.5 hrs**		

Day two of the program moves outwards toward stars, galaxies, and the universe. Trainees gain a basic understanding of the properties of light, types of galaxies, and the vastness of space. Educators may optionally become certified to borrow the Meteorite Sample Disk to complete one of these activities.

Title	Overview	Time	Cost	Additional Resources
Engage: How Big Is the Universe?				
How Big Is the Universe? Page 24	Trainees use estimation, comparison, and math skills to understand the size of the universe. Educators may also perform this activity as a demonstration	0.5 hrs	$	Taking the Measure of the Universe Poster
Explore: What Is in the Universe?				
Make a Galactic Mobile	Trainees make their own mobile of different galaxy types. 	0.5 hrs	$	The Hidden Lives of Galaxies: Brochures, Presentations, and Posters
Classifying Galaxies Using Hubble's Fork Diagram Page 15	Educators should combine this activity with the Galactic Mobile activity to help trainees classify the different types of galaxies. In the activity, trainees use a diagram to label the galaxies on their mobile.	0.5 hrs	$	Galaxy Classification Transparencies Hubble Multimedia Resources
Explain: Does Space Have a Temperature?				
What Is the Temperature of Space?	Trainees watch a short Brain Bites video clip and then participate in a panel discussion about the temperatures of space.	0.5 hrs	None 	Brain Bites Video: What Is the Temperature of Space? Brain Bites Video: What a vacuum looks like
Explain: How Do We Get Information About Stars?				
Wavelength and Energy Activity	Trainees use a rope to explore frequency and wavelengths of light.	45 min	$	Imagine the Universe: What Is a Star Background Reading
What's the Frequency Roy G. Biv?	Trainees explore the properties of light and the colors in the visible spectrum.	0.5 hrs	$	The Spitzer Telescope Video Vault

Edible Model of the Sun	Trainees create an edible model of our star the sun. 	45 min	$$	Our Sun as a Star Lesson Guide
Planetary Nebula Lithograph Activity	Trainees use a NASA lithograph of a planetary nebula to kick off an internet research campaign to understand the birth, life and death of stars	0.5 hrs	$	The Life Cycle of Stars Presentations and Posters
Elaborate: How Do Stars Begin and End?				
These Stars are Classified	Trainees use real star data to plot a graph similar to the Hertzsprung-Russell Diagram.	0.5 hrs	None	Movie: The Big Bang
Hey Low Mass Star, This is Your Life! Page 11	Trainees make a model of a low mass star and its life cycle. Trainees then use a Hertzsprung-Russell diagram to make predictions about the life cycles of other stars. Trainees may optionally complete the Black Hole activity on page 12. 	1.0 hrs	$$	Stellar Evolution Background Reading
Total		**6 hrs**		

Weeklong - Day Three: Why Do We Explore and What Do We Know?

Day Three focuses on the spirit of exploration and our current understanding of the solar system. Trainees study planets, the exploration of the solar system, and careers in space science.

Title	Overview	Time	Cost	Additional Resources
Engage: Why Do We Explore?				
Why Do We Explore?	Trainees create a large poster of solar system exploration summarizing the reasons for space exploration. The lesson integrates reading skills, such as paraphrasing, into the trainee learning. 	1.0 hrs	$	Planet Quest Historic Interactive Timeline Interactive: The Robotic Exploration of Space
Excite: How Has NASA Explored the Solar System?				
Solar System Exploration Timeline Activity	Trainees investigate solar system exploration missions as they construct a timeline using NASA internet resources. The timeline display then serves as a visual reminder of coming events and makes a display for the day. Integration with the *Why Do We Explore?* activity is a best practice for using this lesson. 	1.5 hr	$ 	Solar System Lithograph Set Solar System Missions Reference Site
Explore: How Did the Planets Form?				
Building Blocks of Planets (Accretion) Activities B and C	Trainees explore the ways small particles in the early solar system accreted to form planets and other objects in the solar system. Educators may optionally become certified to borrow the Meteorite Sample Disk and complete Activity A as well.	1.5 hr	$	The Lunar and Meteorite Disk Program Active Accretion: A Learning Game
Looking Inside Planets Lesson 3, Page 13	Trainees make models of the interiors of planets and determine how the inner and outer planets differ. Done in cooperative groups for each planet or in stations, the results may be added to the exploration timeline created earlier in the day. 	1.0 hrs	$	Terrestrial Planet Interiors Gas Giant Planet Interiors
Elaborate: How Does NASA Learn About Planets Using Probes?				
Strange New Planet	Trainees create their own planets, and then they exchange them in order to learn more about each mystery planet. The trainees	1.0 hrs	$	Extreme Makeover: Planet Edition

	simulate earth-bound and space-bound observations. 			
Excite: Can I Work for NASA?				
NASA Careers Survey	Trainees explore career options for working at NASA. Educators can complete this activity at any point in the week.	0.5 hrs	None	NASA Career Corner for Trainees
Total		**6.5 hrs**		

Weeklong - Day Four: Comets, Asteroids, and Moons, Oh My!

Day Four gives trainees a basic understanding of comets, meteors, asteroids, and moons in the solar system. By studying these objects, they also gain understanding about the formation of the solar system.

Title	Overview	Time	Cost	Additional Resources
Engage: What Are Comets?				
Comet Mystery Boxes	Introduce trainees to the physical characteristics of comets by using a tactile learning experience. Using only their hands, trainees reach into a series of boxes and feel the variety of materials and structures within. Each box contains an object that represents a quality of comets. 	1.0 hrs	$	Comet Lithograph Comet Missions Summary
Comet on a Stick	Build a model of a comet to study the way the sun affects a comet. Simulate the sun's solar wind as it interacts with the comet. Evaluate the strengths and weaknesses of their comet model. 	1.0 hrs	$	Comet on a Stick Trainee Pages
Explore: What Are Meteors and Meteorites?				
Exploring Meteorite Mysteries: Edible Rocks Lesson 8	Trainees make edible rocks or use candy to represent meteorites. Educators may optionally end the activity by comparing models to the Meteorite Sample Disk. Trainees must use teamwork, observation skills, and field experiences to successfully complete the activity. 	1.0 hrs	$$	Mars Meteorite Photo Catalog
Exploring Meteorite Mysteries: Meteorite Sleuths Lesson 9	Trainees investigate the Meteorite Sample Disk in a series of stations. Educators should complete stations 1 and 3 with trainees. Stations 2 and 4 are optional.	0.5 hrs	$$	Meteor and Meteorite Photo Gallery NASA Skywatching Site
Explain: What Are Asteroids?				

Vegetable Light Curves	Trainees create models of asteroids and determine how scientists model their shapes using reflectivity.	1.5 hrs	$$	Video Training Modules for Building the Apparatus 2 videos available – see bottom of page
Explain: Why Does the Moon Have Phases?				
Cookie Moons	Trainees model the phases of the moon using cream-filled sandwich cookies. 	1.0 hrs	$$	The Moons of Our Solar System 6000 Year Moon Phase Catalog
Total		**6 hrs**		

Weeklong - Day Five: My Solar System Adventure!

There are two options for the final project day. Both options include the trainee showcase event. The option you choose depends on your specific site resources. Some locations may even have access to a planetarium as another alternative.

Option 1: Trainees and parents use a software program to investigate stars and planets. This is best for daytime activities.

Option 2: Trainees and parents complete several activities at night during a Star Party.

Planning
While paired in 10 groups as listed in the next section, trainees research and summarize their learning for the week by creating stations for display. The displays are intended to be showcase pieces that provide details about the week. Educators should direct trainees to use their journals to incorporate what they have learned into their displays. With prior planning, trainees can lead their parents on a journey throughout the solar system. A great idea may be to mark a pathway on the ground that parents can follow. This pathway can be made to scale or simply have data marked about the distances traveled on their solar system adventure walk. For some extra fun, if time permits, have trainees create a paper bag space helmet at http://lunar.arc.nasa.gov/education/activities/pdf/paperb.pdf. For both options, a series of sharing activities (below) give trainees and parents a chance to work together to understand what they are seeing, whether it be with the software program or the star party night. You may want to find a local astronomy club to bring their equipment for night viewing if you choose this option. Most astronomy clubs do this for free as part of their outreach programs. Here is a database to find an astronomy club near you. http://www.astronomyclubs.com/country/United%20States **Time Allotments** • Allow 2 hours for research, planning, and execution of the displays • Allow an additional 1.0 hrs for trainee preparation activities • Allow 1.0 hrs for touring the displays • Allow 2 hours for the parent sharing activities and the software or star party activities
Group Displays
The following are the suggested showcase displays. Trainees will use inquiry and teamwork to determine how and what they wish to

display about their particular assignment. Trainees may create a poster, make more models, design experiments, and more. Educators will act as facilitators as trainees design, discuss, and display their learning.

- **Mercury**
- **Venus**
- **Earth**
- **Mars**
- **Jupiter**
- **Saturn**
- **Uranus**
- **Neptune**
- **The Sun and Stars**
- **Other Objects in the Solar System**

Sharing Activities

Set up some or all of the activities below for trainees and parents to share regardless of the option chosen. After parents and trainees spend time enjoying the displays, work on these activities in conjunction with either the software program or star party.

Title	Overview	Time	Cost	Additional Resources
StarChild Star Life Level 1 - Page 2	Parents and trainees work together to assemble the order of the life, birth and death of a star on a large poster or strip of paper.	0.5 hrs	$	Life Cycle of Stars Presentations and Posters
StarChild Star Signs Level 2 - Page 13	Trainees and parents quiz each other about the constellations. They then look for those constellations in the sky either in the software or live in the night sky.	0.5 hrs	$	The Constellation Catalog
StarChild Those Amazing Stars - Page 15	Trainees and parents work their way through a maze about stellar evolution. The maze is on paper but can be expanded into a scavenger hunt type of activity suitable for a larger area.	0.5 hrs	$	Kepler Planetarium Shows
Make a Star Finder	Trainees and parents make a star finder and use it to locate objects in the night sky or on the software program. Use telescopes if they are available,	0.5 hrs	$	Virtual Planisphere Sky Spy

Option 1: Software

Download and display the Stellarium software program. Stellarium is a free, open-source planetarium for your computer. You may use

a computer projector to explore the program. If computer stations are available, parents and trainees can work together at their own station while trainees navigate through the program. This option requires about 1.0 hrs of training during the day. The software is easy to use, but will still require trainees to become familiar with its use so they can show it to their parents.
The software is available at http://www.stellarium.org/

Option 2: Star Party Night

Holding a star party is a great way for family to be involved with their children. The event can be dramatic and very exciting as trainees share what they have learned. You may wish to have telescopes available for viewing the sky. You can find hints and tips for conducting a star party online at http://www.jsc.nasa.gov/sightings/planningguide.html