

Scale in the Solar System Unit Plan

Grade Level: 8th Grade

Topic or Content Area: Scale in the Solar System

Time: 5-7 45 minute class periods

Please list the Big Idea or Ideas:

- Size and distance of objects in space
- Recent advances in technology, engineering, and science have propelled space science forward

Unit Overview: In this unit students use a variety of NASA/JPL resources, activities, and problem sets to understand scale and size in space as well as surface features of planets, moons, and asteroids. Students begin the unit by drawing a model of the solar system, calculating distances and travel time of various planetary objects, and then the second half focuses on the surface features and core structures of objects in space and the scientific tools used to study them. The unit concludes with a performance task where students create a travel brochure for a location within our solar system.

Stage 1 Desired Results	
<p>Standards</p> <p>New York State Science Learning Standards (NYSSLS) (Next Generation Science Standards)</p> <p>MS-ESS1-3 Analyze and interpret data to determine scale properties of objects in the solar system.</p> <p>Science and Engineering Practice</p> <ul style="list-style-type: none"> • Analyzing and interpreting data <p>Disciplinary Core Idea</p> <ul style="list-style-type: none"> • ESS1.B Earth and the Solar System: The solar system 	<p>Prior Knowledge</p> <ul style="list-style-type: none"> • 3-ESS2-2 Earth's Systems - Obtain and combine information to describe climates in different regions of the world. • 3-ESS2-1 Earth's Systems - Represent data in tables and graphical displays to describe typical weather conditions expected during a particular season. • 4-ESS1-1 Earth's Place in the Universe - Identify evidence from patterns in rock formations and fossils in rock layers to support an explanation for changes in a landscape over time. • 4-ESS2-1 Earth's Systems - Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation. • 5-ESS1-1 Earth's Place in the Universe - Support an argument that the apparent brightness of the sun and stars is due to their relative distances from the Earth.
	<p>Transfer</p>
	<p>T1 Transfer Goal 1 - Students will be able to independently organize and analyze data about size, distance, and surface features of objects in the solar system including planets, moons, and asteroids.</p>

consists of the sun and a collection of objects including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.

Crosscutting Concepts

- Scale, Proportion, and Quantity
 - Time, space, and energy phenomena can be observed at various scales using models to study system that are too large or too small
- Interdependence of Science, Engineering, and Technology
 - Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

T2 Transfer Goal 2 - Students will be able to use their learning to describe similarities and differences among solar system objects by identifying patterns of features of those objects including scale, distance from the sun, diameter, surface features, structure, and composition.

Meaning

UNDERSTANDINGS

- **U1** The solar system is made up of a variety of objects including planets, moons, and asteroids that orbit the sun because of its gravitational pull
- **U2** Advancements in science, technology, and engineering, have led to our ability to collect and analyze data from our solar system.

ESSENTIAL QUESTIONS

- **Q1** How do objects in space compare in scale and features?
- **Q2** How has recent technology, engineering, and science advancements benefited scientific knowledge of space?

Acquisition

Students will know...

- **K1** *The sun's gravitational pull hold planets, moons, and asteroids in orbit*
- **K2** Scale
- **K3** Trajectory
- **K4** False color imaging
- **K5** Light years
- **K6** The Cassini Mission
- **K7** The Artemis Mission Series

Students will be skilled at...

- **S1** Organizing data
- **S2** Identifying relationships
- **S3** Analyzing data
- **S4** Drawing conclusions from data

Stage 2 - Evidence

Evaluative Criteria	Assessment Evidence
<ul style="list-style-type: none">• Demonstrates understanding of the objects size and distance in relation to both the sun and Earth• Claims about the scale of surface features and weather are formed based on well analyzed and interpreted data• Calculations are accurate and include units <p>OTHER EVIDENCE:</p> <ul style="list-style-type: none">• Student Self Reflection• Exit Tickets• Teacher Observation• Conferencing	<p>PERFORMANCE TASK:</p> <p>Planetary Travel Brochure</p> <p>You have been hired by the "Need More Space? Space Travel Agency" to design a travel brochure to one of the objects in our Solar System. Using your knowledge from this unit and additional research design a brochure that includes the following elements:</p> <ul style="list-style-type: none">- Title- Images- Description of at least three main attractions/features on the surface (i.e. oceans, volcanoes etc.)- Distance from the sun and Earth- Diameter- Structure and Composition (i.e. gas, rock, liquid)- Weather/weather related events- Estimated travel time from Earth (using currently available technology) <p>Bonus: Create an advertisement of your choosing (Instagram ad, youtube ad, print ad, billboard etc) for your space travel destination.</p> <p>Reference NASA Education. (2009, April 10.). <i>Educator feature travel agent</i>. National Aeronautics and Space Administration. Retrieved April 2, 2022, from https://www.nasa.gov/audience/foreducators/k-4/features/A_Travel_Agent.html</p>

Stage 3 – Learning Plan

Summary of Key Learning Events and Instruction

Lesson 1: Modeling the Solar System

- *Engage*: Ask students - What units of measurement can we use to describe distance? Expected student responses - feet, meters, inches, centimeters etc. Ask students how can we measure distance in space? Expected responses include kilometers, miles, and light years. Share [light-years video](#) with students.
- *Explore*: Instruct table groups to draw a rough model of the distance of the planets on a piece of receipt paper with the sun on one end and Pluto on the opposite end. Once students finish, have each table hang their models and note similarities and differences.
- *Explain*: Explain that distance in space is a common misconception, that the planets are not equally distant from one another. Also clarify that although we're making models that put the planets in a linear order, the planets are not aligned in a linear manner. Share and discuss this [video](#) with students about planetary distance in space.
- *Extend*: Students complete the solar system scroll activity on the same receipt paper they used to make their initial predictions. Students carefully follow the [procedure](#) from JPL on folding and marking their model up.
- *Evaluate*: Discuss with students how their predictions compare to the end result. Students complete an exit ticket noting their most surprising take away from this activity. Students should also tape their scrolls into their notebooks so they may continue to reference their model throughout the unit.

Modifications

- Teacher conferencing
- Translations when needed
- Teacher modeling

Materials

- receipt paper
- rulers
- colored pencils

References

JPL/NASA Education. (n.d.). *Classroom activity solar system scroll*. Jet Propulsion Laboratory National Aeronautics and Space Administration. Retrieved April 2, 2022, from

<https://www.jpl.nasa.gov/edu/teach/activity/solar-system-scroll/>

NASAJPL Edu. (2020, May 20). Solar System Size and Distance. [Video]. YouTube.

<https://www.youtube.com/watch?v=DMZ5WFRbSTc&t=75s>

NASASolarSystem. (2019, April 2). Our milky way galaxy: How big is space? [Video]. YouTube.

<https://www.youtube.com/watch?v=MX3PIkbTQwQ&t=101s>

Lesson 2: Distance and Time in Space

- *Engage*: Ask students how long it took them to get to school today. Create a dot plot using students' travel time data. Discuss the patterns and trends with the students, also point out the Y axis represents number of students and the X axis represents time in minutes it took them to get to school. Then create a bar graph representing the different ways students got to school (walking, biking, scooting, subway, car etc.). Compare the two graphs and discuss. If students do not bring up that we did not collect data on how far everyone lives from school, teacher should add this layer into the class discussion asking students to consider how they would represent that data and how it might change their understanding of the data we already collected. Conclude this section by Then asking how long they think it would take to reach the moon.
- *Explore*: Unpack calculating how long it would take to get to the moon. Break students up into small groups and ask them what information they would need to know in order to calculate how long it would take to get to the moon using the same methods it took them to get to school this morning (walking, biking etc.). When groups are ready, tell them the moon is 238,900 miles from Earth and have them begin calculating the time it would take to travel there given the methods previously discussed. Compare the travel times of biking, walking, etc.
- *Explain*: Teacher reviews the formula for calculating distance. Review methods of space travel and provide a little background on the newest Artemis mission. Explain that a *trajectory* is used rather than a direct line from point a to point b when calculating space travel because of the sun's gravitational pull - be transparent with students that in our next activity for simplicity we will consider direct distance from point A to point B and not calculate trajectories today.

- *Extend*: Provide visuals of each planet using the [lithograph](#) poster set from NASA. Students complete the [Planetary Travel Time student handout](#) from NASA/JPL to calculate planetary distance from Earth and travel time from Earth using different methods of transportation. Teacher conferences with table groups, providing assistance where needed. Extension - early finishers may create a graph of their choice to represent the data visually or convert travel time into days/weeks/months.
- *Evaluate*: Teacher leads class discussion analyzing, reviewing, and summarizing the results students calculated.
 - What patterns or trends do we notice?
 - Which planet takes the longest to travel to from Earth?
 - Which planet has the shortest travel time from Earth?
 - How could we visually represent this data to make it easier to interpret?
 - Invite students up to share their graphs
 - Students submit worksheet as exit ticket

Modifications

- Teacher conferencing
- Calculators provided
- Translations when needed
- Teacher modeling how to complete calculations if needed by individuals or groups

Materials

- Chart paper (Engage graphs)
- Calculators
- Rulers
- Copy of Planetary Travel Time student worksheet
- lithograph poster set print outs

References

JPL/NASA Education. (n.d.). *Planetary travel time*. Jet Propulsion Laboratory National Aeronautics and Space Administration. Retrieved April 2, 2022, from <https://www.jpl.nasa.gov/edu/teach/activity/planetary-travel-time/>

NASA Education. (n.d.). *Our solar system lithograph set*. National Aeronautics and Space Administration. Retrieved April 2, 2022, from https://www.nasa.gov/stem-ed-resources/Our_Solar_System_Lithograph_Set.html

Lesson 3: Describing Surface Features and Core Structures

- *Engage*: Ask students - What do you know about moons? Our moon? Invite students to share out. Expected responses - our moon orbits Earth, affects our tides, it's moving farther away from Earth a little bit each year, it has craters, some planets have more moons than Earth. *Transition*: Today we're going to take a deep dive into Saturn's moon Enceladus.
- *Explore*: Display a diagram of Earth and its core, call on students to identify the different layers. Tell students that we're going to begin making a model of Saturn's moon Enceladus noting some of its exterior features and making predictions about its core. Lead students through model making activity of drawing Enceladus as described in the NASA/JPL [Flying through the plume on Saturn's Moon Enceladus](#) problem set. The model drawing steps include:
 - Tell students to draw a moon - any shape, full, half, or quarter. Remind students to leave room for labels.
 - Tell students the moon is covered in ice and allow time for students to add this to their diagram visually.
 - Share the temperature data with students that shows the south pole of Enceladus is warmer than other parts of this particular moon. Students should brainstorm possible reasons why and draw them.
 - After a few minutes add on that there are large cracks in the ice at the southpole and share images of the jets shooting out particles from the cracks. Tell students to include this in their drawing.
 - Provide the final piece of information - that scientists believe there is an entire ocean underneath the ice covered surface of Enceladus. Tell students that this is the last addition to their drawing.
 - Finally, share the [Cassini mission video](#) from National Geographic to provide context on how scientists receive data about far away places in space.
- *Explain*: Students compare and contrast the two labeled diagrams of Enceladus and Earth using a Venn Diagram. Students should explain the similarities and differences and begin to discuss why this might be the case. Teacher encourages students to analyze and interpret the models.
- *Extend*: As students finish their comparison of Enceladus and Earth the teacher can also add in additional diagrams of planetary objects such as the moon, Mars, the Sun etc.. On top of identifying and analyzing features of space objects this activity can be extended by using the problem set from [Flying through the plume on Saturn's Moon Enceladus](#) problem set.

- *Evaluate*: Assess students' Venn diagrams and one math problem of their choice.

Modifications

- If needed, model the model making (drawing) process using a document camera in the explore phase.
- Provide students with a word bank for their Enceladus diagram and Venn diagram.
- Provide a pre-labeled graphic organizer for the Venn diagram.

Materials

- Paper
- Colored pencils
- Calculators

References

JPL/NASA Education. (n.d.). *Problem Set Flying through the plume on saturn's moon enceladus*. Jet Propulsion Laboratory National Aeronautics and Space Administration. Retrieved April 2, 2022, from <https://www.jpl.nasa.gov/edu/teach/activity/teachable-moment-flying-by-saturns-moon-enceladus/>

National Geographic. (2017, May 4). *Crashing into saturn: This cassini mission is the most epic yet short film showcase*. [Video]. YouTube. <https://www.youtube.com/watch?v=68vxYRAony8>

Lesson 4: Analyzing Images through Art

- *Engage*: Ask students - does science inspire art or does art inspire science? Engage in a class discussion and encourage students to use examples of art and science when possible.
- *Explore*: Walk students through a few of the slides in the slideshow of [NASA images](#) (available in a variety of formats and found in the materials section of the link provided). Point out how some of the images were enhanced with false color. Explain that false color is a tool scientists use to enhance images so they can better interpret them. Invite students to describe what they see in each image, really focusing on shapes, the textures, and the patterns. Ask students to consider what they notice when color is applied or removed from certain images. Students may complete a self guided tour of the slides or at the teachers discretion continue to move through the slides as a teacher led activity while students continue to note shapes, patterns, and textures.

- *Explain*: After sharing the slideshow with students OR having students independently review the slideshow via google classroom at table groups should compile a list of shapes, patterns, and textures they observed. Teacher pushes into groups and prompts students to consider what the shapes, patterns, or textures represent - volcanoes, valleys, storms etc. Tables share their lists to then generate a class list of shapes, patterns, and textures and what they represent in the images in terms of surface features.
- *Extend*: Students select one of the NASA images of an object in space to inspire an art piece. Students may choose to work with a variety of materials to create their work including watercolor, colored pencils, and oil pastels.
- *Evaluate*: Display student artwork to facilitate a gallery walk where students engage in TAG feedback (Tell, Ask, Give - Tell them something you appreciate, ask a question, and give a suggestion). Students conclude the lesson with an exit ticket answering the following: 1 - Why do scientists use false-color imaging? 2 - What were you able to notice when studying false-color images?

Modifications

- Option to continue exploring images as a self paced activity or teacher led
- Option to create digital artwork for student with dysgraphia
- Student choice in inspiring image and media

Materials

- Slideshow of NASA images
- variety of paper colors including black
- markers, oil pastels, colored pencils, watercolor
- printed out color images from the slideshow of NASA images
- Google classroom (to share NASA image slideshow)

Reference

JPL/NASA Education. (n.d.). *Classroom activity art and the cosmic connection*. Jet Propulsion Laboratory National Aeronautics and Space Administration. Retrieved April 2, 2022, from <https://www.jpl.nasa.gov/edu/teach/activity/art-the-cosmic-connection/>

Lesson 5: Travel Brochure Performance Task

- *Engage*: Introduce students to the Travel Brochure performance task. Be sure to note the criteria and that the information in the brochure should be factual not fictitious.
- *Explore/Explain*: Students should be given time to determine which object in the space they want to design their travel brochure for. Teachers should help guide students with this choice to ensure that it is an object within our solar system and that students will be able to find the required information given their object. Once students have their object decided, students conduct research, review their work within this unit, and begin collecting and organizing information about their space location. Once students have sufficiently researched and compiled information they can begin working on designing their brochure.
- *Extend*: If time allows, provide space for peer review. Students should give feedback on whether or not the required criteria is present in their brochure.
- *Evaluate*: Students present their final travel brochures to the class. Lesson concludes with student self reflection on their learning and understanding.

Modifications

- Graphic organizers for collecting information and research
- Template for creating a brochure
- Checklist of steps for completing the task
- Student choice

Materials

- Laptops
- Art materials

Reference

NASA Education. (2009, April 10.). *Educator feature travel agent*. National Aeronautics and Space Administration. Retrieved April 2, 2022, from

https://www.nasa.gov/audience/foreducators/k-4/features/A_Travel_Agent.html

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NASA Education. (2009, April 10.). *Educator feature travel agent*. National Aeronautics and Space Administration. Retrieved April 2, 2022, from https://www.nasa.gov/audience/foreducators/k-4/features/A_Travel_Agent.html

NASA Education. (n.d.). *Our solar system lithograph set*. National Aeronautics and Space Administration. Retrieved April 2, 2022, from https://www.nasa.gov/stem-ed-resources/Our_Solar_System_Lithograph_Set.html

NASAJPL Edu. (2020, May 20). *Solar System Size and Distance*. [Video]. YouTube. <https://www.youtube.com/watch?v=DMZ5WFRbSTc&t=75s>

NASASolarSystem. (2019, April 2). *Our milky way galaxy: How big is space?* [Video]. YouTube. <https://www.youtube.com/watch?v=MX3PIkbTQwQ&t=101s>

National Geographic. (2017, May 4). Crashing into saturn: This cassini mission is the most epic yet short film showcase. [Video]. YouTube. <https://www.youtube.com/watch?v=68vxYRAony8>

NGSS Lead States (2013). Next Generation Science Standards: For States, By States.