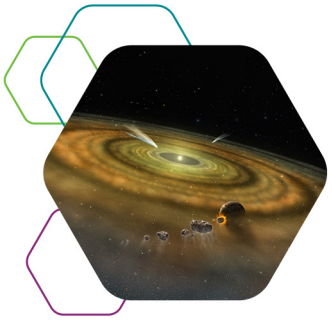

FACILITATOR GUIDE

Pocket Solar System

Learning objectives

This activity explores the following ideas:

- There's a lot of empty space in our solar system—distances between planets are vast!
- The solar system is made up of eight planets and many other objects orbiting the Sun.
- NASA's science missions are exploring our solar system, and beyond.

Materials

- 3 foot long paper or 3, 8.5 x 11 sheets taped together
- Scissors
- Tape
- Solar system "stickers" - print out planet images and cut each one out
- Markers
- *Exploring the Solar System* information sheet
- Illustrated facilitator folding guide
- Activity and facilitator guides

Advance preparation

It might take a little practice to figure out just how to fold the paper and place the stickers. If you have time, before doing this with your learners, try following each step and use the illustrated facilitator folding guide if you need help. (You can also watch the activity training video: vimeo.com/191168509.) Not only will this allow you to practice the steps, but it will also provide an example visual model for your learners.

Pre-cut the paper into 3 foot lengths in advance of doing this activity with learners. You will need one 3 foot-long strip of paper per learner. If you're unable to cut the paper in advance, you can make assembling the paper part of the activity.

Print and cut out the planet images or if you happen to have planet stickers, have those ready.

Notes to caregivers and teachers

Making the Pocket Solar System model

Refer to the illustrated instruction sheet to guide participants through the following steps:

1. Put the Sun at one end of the paper and the Kuiper belt at the other end.
2. Fold the paper in half and make sure you crease it firmly. Unfold the paper, draw a line in the crease to mark the orbit, and place the Uranus sticker somewhere on this crease.
3. Refold the paper in half and fold it in half again (you should now have fourths). At the halfway point between Uranus and the Kuiper belt, draw an orbit line and place the Neptune sticker. At the halfway point between Uranus and the Sun, draw an orbit line and place Saturn.
4. Now, fold the Sun up to Saturn. Unfold the paper and place Jupiter at the halfway point between Saturn and the Sun. Be sure to add a line representing the orbit.
5. Fold the Sun to meet Jupiter. Unfold the paper and place the asteroid belt sticker at the halfway point between Jupiter and the Sun.
6. Fold the Sun to the asteroid belt. Unfold the paper and place Mars, and its orbit line, at the halfway point between the Sun and the asteroid belt.
7. Fold the Sun to Mars. Leave it folded and fold that section in half again. Unfold the paper and you should have three creases: Mercury and its orbit go on the crease closest to the Sun, Venus goes on the next crease, and Earth goes on the final crease.

Learners, especially younger ones, may need close supervision and help to follow each step of making the scale model. As you go through each step of folding and placing stickers, you may like to invite your learners to make a prediction about which planet will go on that crease.

Optional: Some learners may want to try predicting where they think the planets will fall in a scale model of the solar system. This works especially well for older learners who are familiar with the planets and have learned their order. Before they start folding, encourage these learners to draw in all the planets and other objects in the solar system. Work together to remember all the planets. Then, have them flip the paper over for the activity. When they're done, they can compare their prediction to the model. How close was their prediction? What was correct? What was different? Are they surprised?

Conversational prompts

After learners have made their scale models of the solar system, encourage them to look at some of the mission spacecraft images. Humans have sent many satellites into space to study the planets and other objects. Do they want to add in some of the human-made objects traveling through the solar system?

Encourage learners to think about planning their own NASA mission.

- Where would they want to send a space craft?
- What instruments would their spacecraft have? A camera for capturing pictures? A microphone for measuring sound? A thermometer for taking temperature readings? A chemistry kit for testing for different minerals?
- Who would they need on their spacecraft team? What role would each person play?
- How much would their mission cost, and who would pay?
- What would they do with their spacecraft once the mission was over?
- What are the risks and benefits of sending a spacecraft to explore rather than humans?

Important note: The pocket solar system model shows the relative **distance** between objects in the solar system. It doesn't show the relative **size** of the Sun and the planets. If we were to also take into account the size of the Sun and planets on this same scale, the Sun would be smaller than a grain of sand, and you would need a strong magnifying glass to see any of the planets!

Difficult concepts

This activity (or other educational activities learners may have experienced) can give the impression that all the planets in the solar system are lined up in a row. To avoid this misconception, encourage learners to think about the lines they draw on the creases as parts of the full circular orbits of planets around the Sun. Remind them that the planets could be anywhere on those circular orbits, but we're just placing them here because of the constraints of our model.

Many people imagine the solar system as being "clean" or empty aside from the objects they know. While it is true that the space in between the planets is fairly empty, many planets are "messy" with moons, bits of debris, and retired spacecraft. To address this fact, you might say something like, "Yes, space sometimes seems 'empty' to us, because the distances are so vast. But there are actually lots of things in space—they're just really far apart or too tiny to see!"

Some learners may have learned that there were nine planets: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, and Pluto. Pluto is no longer considered a true planet, but researchers think they may have found evidence for a different, still-undiscovered "Planet Nine." If learners suggest there are actually nine planets, or ask about Pluto, you can say something like, "Yes, for a long time we thought there were nine planets in the solar system. As we learn more and more about our universe, we sometimes revise our models based on new evidence. That's what happened as we learned more about our solar system. Right now scientists think Pluto is too small to be a true planet—but there is some evidence that there may be a different ninth planet!"

Scale in the solar system can be a tricky concept. Listen to responses or watch for interactions with learners that might indicate they are struggling to understand. Remember:

- The Sun is the only star in our solar system (there are no other stars sprinkled throughout.)
- The solar system is inside the Milky Way Galaxy (not in the center), which is part of the universe (but also not "in the center"). Learners may confuse these vocabulary words and use them interchangeably.
- The large amount of space between planets still contains things like dust, plasma, and light, so it isn't truly "empty."
- The Sun, not the Earth, is the center of the solar system.

Training resources

Refer to the *Tips for Leading Hands-on Activities* sheet in your activity materials.

- An activity training video is available at vimeo.com/191168509.
- A content training video is available at vimeo.com/191172070.

The NISE Network has a curated list of programs, media, and professional development resources in the NASA Wavelength Digital Library that directly relate to the toolkit. These resources can be viewed and downloaded from nasawavelength.org/users/nisenet.

Credits and rights

This activity is a classic that exists in many versions. NISE Net's adaptation was inspired by the Night Sky Network's Pocket Solar System (retrieved from: https://nightsky.jpl.nasa.gov/download-view.cfm?Doc_ID=392) and by Sciencenter's version, Solar System in Your Pocket.

Illustration of Juno orbiting Jupiter courtesy NASA/ JPL-Caltech.

Photograph of NASA crew building the Juno spacecraft courtesy NASA/ JPL-Caltech.

Close up of Jupiter courtesy NASA/ JPL-Caltech.

Photograph of Juno Lego® Crew courtesy NASA/JPL-Caltech/KSC.

Planets in orbit illustration by Emily Maletz for the NISE Network.

Developed and distributed by the National Informal STEM Education Network.

This material is based upon work supported by NASA under cooperative agreement award number NNX16AC67A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).

Original materials edited for at-home use by Bishop Museum Education Staff, Honolulu, HI April 2020