Explore Jupiter's Family Secrets: JUMP TO JUPITER

OVERVIEW —

Participants jump through a course from the grapefruit-sized "Sun," past poppy-seed-sized "Earth," and on to marble-sized "Jupiter" — and beyond! By counting the jumps needed to reach each object, children experience first-hand the vast scale of our solar system.

WHAT'S THE POINT?

- The solar system is a family of eight planets, an asteroid belt, several dwarf planets, and numerous small bodies such as comets in orbit around the Sun.
- The four inner terrestrial planets are small compared to the four outer gas giants.
- The distance between planetary orbits is large compared to their sizes.
- Models can be used to answer questions about the solar system.

MATERIALS —

Facility needs:

- ☐ A large area, such as a long hallway, a sidewalk that extends for several blocks, or a football field (see Preparation section for setup options)

- ☐ A variety of *memorable* objects used to represent the Sun and planets, such as (use *Jump to Jupiter: Planet Sizes and Distances* to identify an appropriately-sized substitutes as needed):
  - ☐ 1 (4 inch) grapefruit
  - ☐ 2 (½ inch) marbles
  - ☐ 2 peppercorns
  - ☐ 2 poppy seeds
  - ☐ 3 pepper flakes
  - ☐ 1 pinch of fine sand or dust

Credit: Enid Costley, Library of Virginia

- ☐ 1 set of solar system object markers created (preferably in color) from:
  - 1 set of *Jump to Jupiter: Planet Information Sheets* OR
  - Posters created by the participants OR
  - Optional: 1 set of Our Solar System lithographs (NASA educational product number LS-2013-07-003-HQ): http://solarsystem.nasa.gov/docs/000-SolarSystemLithosCombined_Rev1_FC.pdf

- ☐ 12 (3') stakes or traffic cones or sign stands

For each child:

- ☐ 1 *Jump to Jupiter poem*
- ☐ 1 pencil or pen

For the facilitator:

- ☐ Measuring wheel
- ☐ 1 meter- or yard-stick

- ☐ Mallet or heavy object (for placing stakes in the ground)
- ☐ Tape
- ☐ Examples of the objects used in the solar system scale model course:
  - ☐ 1 (4 inch) grapefruit
  - ☐ 2 (½ inch) marbles
  - ☐ 2 peppercorns
  - ☐ 2 poppy seeds
  - ☐ 3 pepper flakes
  - ☐ 1 pinch of fine sand or dust
- ☐ *Jump to Jupiter: Planet Sizes and Distances*

Participants use one-meter jumps or very large steps to measure the distances between markers. Credit: Lunar and Planetary Institute

PREPARATION —

- Determine how many planets your space accommodates before you start.

- Set up a solar system course using *Jump to Jupiter: Planet Sizes and Distances*
  - It does not have to be in a straight line. The course may fold back on itself. (Uranus is half way between the Sun and Pluto, so have the participants turn back at the Uranus marker.)
  - *You do not have to use all the planets!* You can modify the course by using only the inner planets and Jupiter.
  - It is helpful to have the grapefruit "Sun" visible at the beginning of the course.
  - Mark each object's position with a stake, traffic cone, or sign stand.

- Alternatively, create your own larger or smaller course; use the Exploratorium museum's online calculator (http://www.exploratorium.edu/ronh/solar_system) to determine the scaled sizes and distances of the planets. A larger course will make the planets larger and easier to see; a smaller course may fit in tighter location.

- Another alternatively, invite the participants create their own course! Provide children ages seven and up with solar system information and materials to create the markers, and ask tweens and teens to determine the scaled sizes of the solar system objects, as well as their relative distance from the Sun.

- Attach the information sheet or lithograph for each solar system object to the appropriate stake, traffic cone, or sign stand.

ACTIVITY —

1. **Share ideas and knowledge.**
   - Frame the activity with the main message: Space is full of…SPACE!
   - Explain that the participants will use a scale model to explore the distances between solar system objects. Use open-ended questions and invite the participants to talk with you and each other about their prior experiences with scale models.

   - Invite the participants to offer questions to the group about planets, the dwarf planets Ceres and Pluto, and asteroids in our solar system. As the participants name the different objects, ask them to choose the best representative — based on size — from the beads, salt crystals, etc. that were used to construct the solar system course.

As much as possible, encourage the participants to offer information and questions. This model can be used to answer questions such as:

- How do the planets compare in size?
- How does big does the Sun appear to be from Earth? From Jupiter?
- How does the distance between the Sun and Pluto compare to the distance between the Sun and the next closest star system (Alpha Centauri)?
- Which destination is closer for a spacecraft: Venus or Mars?
- Are some planets closer together than others?
- Could an accurate model of the solar system fit on my bookshelf at home?

2. **Guide the participants as they explore the solar system scale model to answer their questions.** Optional: If the distances are large, have facilitators at each marker to guide the children with questions and information and keep them moving to other markers.
   a. Leave the "Sun" at the beginning of the course for their reference.
   b. Provide the meter- or yard-stick for the children to practice jumping that length.
   c. Offer the "Jump to Jupiter" poem and pencils or pens. Ask the children to count the total number of (one-meter) jumps from the Sun it takes to get to each marker. Explain that the poem has a place for them to enter each distance.
   d. Suggest that the participants find information about each solar system object by reading the signs.

Engage participants at the markers with questions such as:

- How many jumps did it take to arrive at this planet (or asteroid belt or Pluto)?
- How big does the grapefruit "Sun" look from here? Imagine what the real Sun would look like in the sky of this planet/dwarf planet!
- What do you think is happening to the temperature as you travel further away from the Sun?
- At the last marker of the course, compare the immense scale of our solar system to the even larger distances to other stars. At this scale, Alpha Centauri A would be slightly larger than a grapefruit and about 1,800 miles (3,000 kilometers) away — roughly the distance between Washington, D.C. and Mexico City!

3. **Have the participants describe what they discovered by exploring the model.**

4. **Remind the participants that the model isn't perfect.** In space, the planets are in motion as they orbit the Sun. Only rarely do four or more planets "line up." Have them imagine the circles that each planet would trace! Or, if desired, invite a few participants to carry a selection of planet models in large circles around the "Sun" to demonstrate their orbits.

5. **Conclude.** Draw on the participants' discoveries to summarize the experience, including:
   - Space is full of…SPACE! The planets are small compared to the Sun, and they are spread far, far apart.
   - Jupiter is the largest planet.
   - Ceres is the largest asteroid in the asteroid belt, but it is smaller than Pluto and much smaller than the planets.
   - The inner terrestrial planets — Earth, Mercury, Mars, and Venus — are relatively close together. Venus is Earth's closest neighbor (after the Moon). The giant planets (Jupiter, Saturn, Uranus, and Neptune) get farther and farther apart.
   - There is an enormous distance between the Sun and even the closest stars.
   - Temperatures can reach a scalding 800°F (425°C) on Mercury and even warmer on Venus (850°F!) due to its thick atmosphere. After Earth's balmy –125 to 130°F (-87 to 54°C), the

temperatures begin to plummet rapidly. It is –234°F (–145°C) at Jupiter's cloud tops, and a frigid –387°F (–233°C) on Pluto.

- From each marker, the grapefruit "Sun" will look just like it does in the sky of that object. From "Earth," *the real Sun appears to take up half a degree (or arc) in the sky. The grapefruit "Sun" appears to be the same size; it can be covered with a pinkie finger held at arm's length.*

CORRELATION TO STANDARDS

Next Generation Science Standards

Disciplinary Core Ideas:

ESS1.B: The solar system 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.

Science and Engineering Practices

- Developing and Using Models: Develop and/or use a model to represent amounts, relationships, relative scales (bigger, smaller), and/or patterns in the natural and designed world(s).
- Developing and Using Models: Identify limitations of models.
- Analyzing and Interpreting Data: Use observations (firsthand or from media) to describe patterns and/or relationships in the natural and designed world(s) in order to answer scientific questions and solve problems.
- Using Mathematics and Computational Thinking: Use counting and numbers to identify and describe patterns in the natural and designed world(s).

Crosscutting Concepts

- Patterns: Patterns in the natural and human designed world can be observed, used to describe phenomena, and used as evidence.
- Scale, Proportion, and Quantity: Natural objects exist from the very small to the immensely large.
- Scale, Proportion, and Quantity: Students observe time, space, and energy phenomena at various scales using models to study systems that are too large or too small. They understand phenomena observed at one scale may not be observable at another scale.

The Nature of Science

- Scientific Investigations Use a Variety of Methods: Science investigations use a variety of methods and tools to make measurements and observations.