

Kinesthetic Solar System Demonstration

Materials

- Students
- Pictures or signs representing each body in the solar system, including comets, and asteroids.
- Large outside open area, such as a football field, soccer field, or school playground

Notes

- Best done outside in a large open area, such as a football field or school playground.
- Works well with 24-30 students.
- For this demonstration, Pluto is still a planet, and has its own moon, Charon.

Procedure

1. Assign each student to be a member of the solar system, including the sun, asteroids, Earth's Moon, Jupiter's 4 largest moons, and 1-2 comets, so all students will be part of the model.
2. Students can hold images or drawn signs for each solar system object they are representing.
3. Begin by placing the sun at the center of the open area. This student can spin slowly on their axis, if desired.
4. Place Mercury a few paces away from the sun, and have this student circle the sun.
5. Next place Venus a few more paces from Mercury, and have this student circle the sun as well. Venus should go slower than Mercury.
6. A few paces further out, have the Moon begin orbiting the Earth; then have that pair of students begin to circle the sun. Again, Earth and Moon should go slower now than Venus.
7. Several paces further out, place the student who are the asteroids in a ragged line. This group will also circle the sun, slower than Earth.
8. Place Mars next a few paces further.
9. For Jupiter, move out several more paces from Mars, and have its four moons begin to orbit the planet. Then have this group of 5 students begin to go around the sun like the rest of the solar system.
10. Continue placing Saturn, Uranus, Neptune, and Pluto and its moon Charon, moving further from the sun, and having all "planets" continuing to orbit.
11. Remember to have the further away planets orbit slower than the inner planets, so the by the time Pluto and Charon are placed, they are moving at a snail's pace.
12. Have 1-2 students representing the comets move carefully through the solar system, orbiting the sun in highly elongated orbits. Remind them to move slowly when they are far from the sun, and to move quicker when they are closer. These students might carry

a streamer that they should stretch behind them when they are closer to the sun, and hold hidden when they are further from the sun. This represents the tail of the comet that is only visible when they are close to the warming light of the sun.

Possible Discussion Topics

- Kepler's Three Laws of Planetary Motion:
 - Planets closer to the sun orbit faster than those further away.
 - The nearly circular orbits of the planets, and highly elliptical orbits of comets.
 - Advanced students - The relationship between a planet's orbital period to its distance from the Sun determines the mass of the sun.
- The inner planets are warmer, and rockier. The outer planets are cooler and gaseous. Discuss this reason being because of distance to the Sun.
- Jupiter's moons mimic the rest of the solar system, with inner moons orbiting faster, and inner moons being warmer than outer moons.
- The asteroid belt is thought to be the remains of a planet that never formed in the early solar system.
- Development of a comet's tail.
- Mythology of the planet names.
- Solar system spacecraft missions to each of the planets, past, present and future.
- How humans might travel one day to other planets beyond the Moon.
- Why humans send robots to explore the solar system before sending humans.

Solar System in Your Pocket Activity Guide

Type of Activity: Quick demo / make-and-take

Set up Time: 5 minutes to pre-cut register tape

Time to Do: 10 minutes

Audience age: 8 years and older

Group size: any number

What's This Activity About?

You will build a quick model of the Solar System by folding a piece of register tape. The relative distances between the orbits of the planets will be illustrated. Images in textbooks often depict the planets squeezed together, but this model shows how far apart they are, especially beyond Mars. This is a quick activity that can be done as a transition in a longer program or as a demonstration to entertain people waiting in a line. It's especially useful if planets are visible.

Materials for each model:

- 1 meter length of cash register tape
- 10 round stickers: five large and five small (optional)
- pencil or marker

Setting Up the Activity

If you are doing this activity with a large group, you can pre-cut 1m strips of register tape and divide out groups of stickers for each participant. If you wish, practice the steps a few times so you don't have to refer to your notes.

Suggestions for Introducing the Activity

For any of these scale model activities, it is useful to start by exploring the notion of models. Referring to playthings, such as dolls or toy cars, can be a useful reference for talking about scale models. For a more thorough exploration of this concept with ideas of how to introduce and discuss it, see the introduction to the Saturn Project.

Pull out a folded completed sample of the model from your pocket. Point out that the planets never appear in a straight line like this in order out from the Sun, but this is just a reminder of the radius of the orbits. The planets would be found somewhere along a circle this far from the Sun.

If you have a board with a thumbtack, you can tack it to the board at the Sun and show or draw out the orbits.

Doing the Activity

Now have the participants create their own Pocket Solar System models. Lead them through the following steps:

1. Place a sticker on each end of the tape, one large and one small, right at the edge. Label the large one Sun and the small one Pluto.
2. Fold the tape in half, crease it, unfold and lay flat. Place a large sticker at the half-way point. You can ask for guesses as to which of the remaining 8 planets might be at this half-way point. Label the sticker Uranus.
3. Fold the tape back in half, then in half again. If there are mixed ages, give those with some knowledge of fractions the opportunity to show off by asking "What is half of a half?" Unfold and lay flat. Place large stickers at the quarter mark and $3/4$ marks and label as Saturn (closer to the Sun) and Neptune (closer to Pluto).
4. Fold back into quarters, then in half one more time. This will give you eighths. Unfold and lay flat again. Place a large sticker for Jupiter at the $1/8$ mark (between the Sun and Saturn), and label.
5. No need to fold the whole thing up again. If you take a look, you've got the 4 gas giants and Pluto all on there. For the remaining terrestrial planets, you'll only need $1/2$ of the first $1/8$ th! That's the inner $1/16$ th of your meter. Fold the Sun out to meet Jupiter to mark the $1/16$ th spot. A planet does not go here, but the Asteroid Belt does.
6. At this point, things start getting a little crowded and folding is tough to get precise distances, so fold the remaining $1/16$ th in half and crease at the $1/32$ nd spot. Place a small sticker for the Earth just inside this fold (between the Sun and Asteroid Belt) and a small sticker for Mars just outside the fold (closer to the Asteroid Belt) and label them.
7. Place small stickers for Mercury and then Venus, between the Earth and Sun, pretty much dividing the space into $1/3$ rds and label them as Mercury closest to the Sun and Venus closest to the Earth.

Wrap-up

At the end of the discussion, be sure to have everyone put their names on their tapes and fold them up to put it in their pockets. But before you put them away, here are some questions you might ask to get participants thinking about insights they can get from building this model.

1. Are there any surprises? Look how empty the outer solar system is: there is a reason they call it space! And how crowded the inner solar system is (relatively speaking).
2. Do you know anything about the physical properties of the ones that are spread out versus the ones that are crowded in close to the Sun? All the inner ones are small and rocky and the outer ones are gassy giants (except small icy Pluto).

3. Given this spacing, why do you think little rocky Venus can outshine giant Jupiter in the night sky? Both are covered with highly reflective clouds and although it is much smaller Venus is also much, much closer.
4. Does anyone know where the 10th planet, 2003UB313, will go? At 97 A.U., it would more than double the size of the model. Pluto is on average 40 A.U. (A.U. stands for Astronomical Unit, roughly the mean distance from the Earth to the Sun. 1 AU = 149,597,870.691 kilometers, or about 93 million miles.)
5. On this scale (1m = 40AU) where would the nearest star be? After some guesses you could bring out your pocket calculator to use in getting how far away the star would be. This allows you to talk about how far is a light year and do the calculations to find that the next nearest star is about 7km (4.2miles) away. They could then take out a local map to see what is that far away from where the presentation is happening. [Calculations: A light year, the distance light travels in one year, is about 63,240 A.U. (about 9,460,000,000,000 km). The nearest star is Proxima Centauri (visible from the Southern Hemisphere), at 4.2 light years. So, $4.2 \text{ ly} \times 63,240 \text{ A.U./ly} \times 1 \text{ m} / 40 \text{ A.U.} = 6640.2 \text{ m} = \text{about } 7 \text{ km.}$]

Complimentary Activities:

- Worlds in Comparison (scale model of the sizes of the planets)
- Earth as a Peppercorn (scale model of the sizes and distance of the planets)