



Planetary Distances on the Playground

Elementary/middle grades

Lesson Summary

In this activity, each student or small group of students represents a planet in order to illustrate the spacing of the planets. The Planetary Data Table at the beginning of these activities lists the distance of each planet from the Sun (in astronomical units). By translating these numbers into paces, the students can pace off the distances to the planets.

Prior Knowledge & Skills

- Characteristics of the planets
- Creating scale models

AAAS Science Benchmarks

The Physical Setting

The Universe

NSES Science Standards

- **Earth and space science:** Objects in the sky, Earth in the Solar System

NCTM Mathematics Standards

- **Number and Operations:** Compute fluently and make reasonable estimates

Suggested background reading

Bode's Law

Planetary Physical Data

Teaching Time: One 45-minute period

Materials

Each group needs:

- Posterboard
- Markers
- Copy of Planetary Physical Data table
- Worksheet

Advanced Planning

Preparation Time: 20 minutes

1. Gather materials
2. Review lesson plan

Why Do We Care?

Through this activity, students can observe “Bode’s Law,” the general rule describing the spacing of the planets. According to Bode’s Law, the distance between planets approximately doubles as you move from one planet to the next away from the sun. For instance, Jupiter is about 4.3 AU (an astronomical unit is a unit of distance that is approximately equal to the average distance between Earth and Sun) from Saturn, and Saturn is about 9.7 AU from Uranus. This could be an opportunity to talk about the difference between empirical laws and other physical laws. (Empirical laws, like Bode’s law, are devised to match observations and have no physical explanation. Other laws are predicted by fundamental physics and then tested against observations.)

Source: adapted from The Great Learning Spot, High Energy Astrophysics Division, Harvard-Smithsonian Center for Astrophysics

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MATERIALS: Playground or field; letter-sized sheet of paper for each planet; markers.

1. Calculate the number of paces for each planet's orbit, based on the data in as constrained by the size of the area available. (Just find a number by which to multiply the Average Distance from Sun (Semi-Major Axis in A.U.) column such that even Pluto's orbit will fit on the field.)
2. Split the class into 9 groups, and assign each group to represent one planet. Find one volunteer to be the Sun. Have each group make a sign with the name, picture and any other information it likes about its planet.
3. Take the class to a field or playground. Have the Sun stand near the edge of the field or playground; each orbit is measured from the Sun.
4. Pace off the orbit of each planet as calculated in step 1. Have each group mark the planet's position by standing there.
5. Be sure to stress that this is only an illustration of the relative distances of the planets from the Sun; since each planet orbits the Sun with a different velocity, the planets spend most of their time somewhere along their near-circular orbit around the Sun, rarely along a straight line with the other planets.

DISCUSSION:

Are the planets evenly spaced? Is there some pattern you can find which seems to fit what is seen? Could you find some mathematical equation which would fit the pattern? How does a planet's distance from the Sun relate to its temperature? Should planets nearer the Sun be hotter or cooler than those farther away?

Planetary Distances on the Playground Worksheet

Part 1: Setting the Scale

Let's figure out how much we'll have to scale down the solar system to get it to fit in the playground.

Distance across the playground: _____ paces

Distance to Pluto: _____ AU

If Pluto will be at the far edge of the playground, how many paces should equal 1 AU?

1 AU = _____ paces

Part 2: Scaling the Solar System

Now that you have a scale factor, fill out the table below to calculate how many paces from the sun each planet should be.

Planet	Distance in AU	Distance in paces
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		
Pluto		