



Jupiter's Relative Size

Elementary grades

Lesson Summary

Students use jellybeans to visualize the size of the Earth compared to that of Jupiter.

Prior Knowledge & Skills

- Numbers and counting
- Volume

AAAS Science Benchmarks

The Physical Setting

The Universe

Common Themes

Scale

NSES Science Standards

- **Physical science:** Properties of objects and materials
- **Earth and space science:** Objects in the sky
- **Science and technology:** Understandings about science and technology

NCTM Mathematics Standards

- **Measurement:** Apply appropriate techniques, tools and formulas to determine measurements
- **Numbers and operations:** Understand numbers, ways of representing numbers, relationships among numbers, and number systems

Teaching Time: One 45-minute period

Materials

To share with the whole class:

- About 1,400 small jellybeans
- Fishbowl to hold at least 1000 beans
- Small Dixie cup

Advanced Planning

Preparation Time: 20 minutes

1. Gather materials
2. Review lesson plan

Why Do We Care?

This activity gives students some physical intuition about size scales in the solar system.

Suggested Background Reading

Planetary Physical Data

Jupiter fact sheet

Source: Galileo K-12 Educator's Resources, Project Galileo, NASA/JPL

Jupiter's Relative Size

Materials used: About 1400 small jellybeans (or pinto beans/other kind of beans)

Fishbowl to hold at least 1000 beans

Small Dixie cup

Grade level: Lower Elementary (upper elementary for advanced discussion)

Background information: Jupiter is about 1,400 times the size of Earth (by volume), but that's difficult to believe, since it appears so small in the sky. It's also difficult to visualize just how big something 1,400 times bigger than Earth would be.

Equally hard to believe is that 1,000 Earths would fit inside the planet Jupiter. Since the Earths can't fit exactly side-by-side, there is space remaining in-between -- space the volume of 400 Earths!

We can illustrate these points with the following exercise, approximating (roughly!) the Earth's size and shape by a bean.

Activity description: After talking about the planets and explaining that they are of different sizes, impress students by telling them that about 1,000 Earths would fit inside Jupiter. Show the students 1 jelly bean and ask them: if this were the size of Earth, how big would Jupiter be? Show them the fishbowl and mention that it would be about the size of Jupiter, if Earth were the size of a jelly bean.

How could you prove this? Ask them for ideas. They might suggest that you put the jelly beans in and count. But it might take awhile to count 1000 jelly beans. If you count how many beans will fit into a small Dixie cup, can you figure it out faster? Try estimating the size of Jupiter by counting how many beans fit into a small Dixie cup, then measure them in scoops. (E.g., If 50 beans fit into each Dixie cup, then it will take 20 cups of jelly beans.)

To illustrate that Jupiter is 1400 times bigger than Earth (by volume), then you'd have to squish the beans and add about 400 more. Alternatively, you can fill those Dixie cups with water and estimate how many more Earths would have fit in-between the cracks.

You can do different variations on this exercise based on what information you give the students and what you ask them to figure out.

For reference, by the way, Jupiter's volume is roughly $1.53 \times 10^{15} \text{ km}^3$; Earth's is about $1.09 \times 10^{12} \text{ km}^3$. (Their equatorial radii are 71,492 km and 6,378 km, respectively.)

More advanced discussion: This discussion warns students that the scales of diagrams they see may *not* always represent a true scale. It also illustrates some reasons why it might be useful to present this kind of "false advertising."

When making solar system models, sometimes the planets and their moons are not quite to scale. For example, Jupiter should be about 11 times bigger by diameter (1400 times bigger by volume) than Earth, but in diagrams, the two planets often appear to be closer in size. More dramatically, Jupiter is about 46 times bigger by diameter (396,000 times bigger by volume) than its moon Europa. Take a look at the diagram below, in which the relative sizes of the moons are exaggerated. Why would we want to do this, since it's inaccurate?



Some possible answers: In the most convenient model for the information we want to show, it might be impractical to make Jupiter 1400 times bigger than the size of Earth or 396,000 times bigger than Europa. Even in a 2-dimensional diagram, if we choose Europa to be the size of a dime, then Jupiter would take up 12 pages. (The area of a 2-dimensional outline of Jupiter would be 2,000 times bigger than one of Europa.) But even if we shrink Jupiter down to fit on a page, we can still show some basic relationships, such as (in a solar system model) which moons go with which planets and what order they're in. Or, perhaps the purpose of the diagram is to show the differences in surface features