

# Relative Size of the Planets

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This is an activity or display that shows the relative sizes of the planets using round objects that everyone is familiar with: Balls used for various sports. It costs under \$20.00 to put together.

For this display, a basketball is chosen to represent Jupiter. A basketball is the largest ball most people are readily familiar with. Jupiter is also the largest planet. Objects used to represent the other planets are scaled to the Jupiter = basketball scale. The table below gives the objects used and their relevant measurements

<u>Planet</u>	<u>Radius</u>	<u>Radius</u> (Jupiter=1)	<u>Object</u>	<u>ideal</u> <u>circumference</u>	<u>ideal</u> <u>diameter</u>
Jupiter	68,700 km	1.000	basketball	73.5 cm	23.4 cm
Saturn	57,550 km	0.838	soccer ball	61.5 cm	19.6 cm
Uranus	25,050 km	0.365	softball	26.8 cm	8.52 cm
Neptune	24,700 km	0.360	softball	26.4 cm	8.40 cm
Earth	6,378 km	0.093	large marble	6.81 cm	2.17 cm
Moon	1,738 km	0.025	tiny bead	1.86 cm	5.91 mm
Venus	6,050 km	0.088	large marble	6.47 cm	2.06 cm
Mars	3,394 km	0.049	small marble	3.61 cm	1.15 cm
Mercury	2,440 km	0.036	small bead	2.60 cm	8.30 mm
Pluto	1,700 km	0.025	tiny bead	1.81 cm	5.78 mm
Charon	750 km	0.011	tiny bead	0.80 cm	2.55 mm

The chart is arranged in order of decreasing size, with the only exception being the moon given right after the Earth.

It is impossible to find familiar balls to represent all the different planets in exact scale. The ones I found are all accurate to within 10% (not bad for astronomy in general). You could possibly find a manufacturer who could custom make balls of the exact needed size, but that would spoil much of the effect. It is better to use familiar objects so that people will remember them and their relative sizes more easily.

## Some additional details are in order:

The numbers in the table above are the ideals. Get them as close as you can but don't worry too much. Within 10% is fine, but 20% error is probably too much.

For Saturn, I used a size 4 soccer ball (a standard, size 5 is too large). Also, within the 10% error I allowed myself, Uranus and Neptune are the same size. thus, they are both represented by softballs (softballs, not baseballs). To measure the larger planets, I just used a seamstress' tape measure and looked at their circumference, then divided by 2Pi to find the radius (there I was in Toys-R-U's, carefully measuring all their sports balls, taking notes, consulting my calculator, getting funny stares...).

The moons of the gas giant planets are not included to simplify things, even though some of them are bigger than the Earth's moon, Mercury, and Pluto. The smaller ones, however, would be microscopic.

For the Earth and smaller planets, I used calipers and measured diameters. You may need to go to several toy stores to find just what you need. Although Earth and Venus are about the same size within 10%, if you can find a slightly smaller marble for Venus, that would be good. I was lucky and found a blue marble

for the Earth, a white one for Venus, and a red one for Mars. When you get down to Mercury and smaller, just measure to the nearest millimeter. If you can, find a bead store that has a large selection of individual beads you can browse through and select for yourself (there I was in the bead store, carefully measuring all their beads with calipers, taking notes, consulting my calculator, getting funny stares...). All of the beads together cost about 8 cents.

If you want to represent the asteroids, three or four grains of salt can stand for the very largest ones. You can put them on a small card so you don't lose them. Anything smaller than this is completely invisible at the scale we're using. That's why the moons of Mars are not given. They would be microscopic.

At this scale, the Sun is 2.4 meters in diameter. If you have space for a permanent display, you could paint the Sun on the wall.

The distance from the 2.4 meter diameter Sun to the tiny bead Pluto, in the scale of our model, is about 6.3 miles. In between is a whole lot of nothing. Just a basketball, soccer ball, two softballs, and assorted bits of dust. The distance from the big blue marble Earth to the small bead Moon is about 65 centimeters.

If you want to know other distances (like the Sun-Jupiter distance, for example), the scale of the model is 0.0017 mm per km. Just look up the distance you want to scale and multiply it by 0.0017. This will give you the scale distance in millimeters. Turn that number into meters by dividing by 1000, or turn it into kilometers by dividing by 1,000,000. Turn kilometers into miles by dividing by 1.6 (these are standard conversions).

For example: The Sun-Jupiter distance is 778,000,000 km (from the back of any astronomy text book). In the scale of our model, that is  $778,000,000 \times 0.0017 = 1,322,600$  mm. That is equivalent to 1,320 meters, 1.32 kilometers, or 0.82 miles. Have someone else check your figures... it's easy to make mistakes.

If you get really ambitious, you could find a long country road (6.3 miles long or so) and make a model you can drive through. Start with a 2.4 meter Sun at one end, and place the other planets beside the road at appropriate distances (calculated using the method above). If you make a "model" solar system this way, everything will be in the same scale (sizes of the planets and distances between them). Then load the students on a bus or in a van and take a drive. Call it the "Drive-by Solar System."

Another variation that could be used is to show distances between some of the objects and their moons. The four largest moons of Jupiter (called the "Galilean Moons") and Titan, largest moon of Saturn, could be represented by beads the same size as the one used for the Earth's Moon. Some examples are given below, but feel free to expand this list using the scale factor given above.

Jupiter - Io distance:	0.71 meter
Jupiter - Europa distance:	1.14 meter
Jupiter - Ganymede distance:	1.82 meter
Jupiter - Callisto distance:	3.20 meter
Jupiter - Sinope distance:	40.3 meter (outermost moon of Jupiter)
Mars - Phobos distance:	1.6 cm
Mars - Deimos distance:	4.0 cm
Earth - Moon distance:	65 cm
Saturn - Titan distance:	2.08 meter
Pluto - Charon distance:	3.3 cm