Make a Scale Solar System

In this session, you will learn about our solar system and create your very own scale model of the planets.

The distance between planets can be gigantic, with the distance from the Sun to Earth being approximately 149.60 million km or 0.00001581 light-years away. The planets are also large – Earth has a radius of 6,378 km - and several other planets are much bigger!

But what exactly does this mean?

By creating your model, you will have the opportunity to learn how to calculate the relative sizes of the planets and the distances between them.

By the end of the task, you will know which planet is the largest, the smallest, and each one in between!

I wonder which planets are bigger than Earth?

Time required
45-60 minutes

Materials required:

- Chalk and distance markers e.g., lollipop sticks or cones (for outdoor activity) OR
- Ruler OR measuring tape (with centimeter markings)
- Calculator
- Paper
- Pen/pencil

Activities

01 Decide what activity you would like to do

Either, you can create a model of the distances between the planets or create a model of planetary sizes. You can do both if you are keen, but we would suggest starting with a model of distance between the planets.

02 To create a model of distances between the planets

When discussing the large distances between the Sun and the planets, it's not very convenient to use kilometers (the numbers become too big!) or light years (the numbers become too small!)

Instead, scientists define the Sun to Earth distance as "one Astronomical Unit" (or 1 AU for short), and use this as their ruler for measuring the distances between the Sun and the planets.

Having planet distances in AU is handy for us to make a model solar system. To make sure this is a convenient size, we'll use a "scaling factor" to convert the massive distances in AU (in the real solar system) to much smaller distances in centimeters (in our model solar system).

Here we'll use a distance scaling factor of 20 cm/AU - so 1 astronomical unit in the real solar system is 20 centimetres in our model solar system.

To calculate distances in the model you need to multiply the distance in astronomical units by this scaling factor. For example, we can apply our scaling factor of 20 cm/AU to Earth, which is 1 AU from the sun in the real solar system. So you would need to multiply 1 AU x 20 cm/AU to get 20 cm - so in your model, Earth would be 20 cm away from the Sun.

	Sun to planet distance in the...	
Planet	**real solar system (AU)**	**model solar system (cm)**
Mercury	0.39	7.8
Venus	0.72	14.4
Earth	1	20
Mars	1.52	30.4
Jupiter	5.2	104
Saturn	9.54	190.8
Uranus	19.2	384
Neptune	30.1	601

Sources

https://www.jpl.nasa.gov/_edu/pdfs/scaless_reference.pdf

https://www.jpl.nasa.gov/edu/resources/project/make-a-scale-solar-system/

03 To calculate the size of the planets

Similarly to distances between the planets, it's often easier to consider planets' sizes not in kilometers (or light years!), but in terms of how big one planet is compared to another. For example, using the size of Earth as our ruler - Earth's diameter is 12,756 km.

If we have the planets' sizes (diameters) in Earth diameters (in the real solar system), we can use another scaling factor to convert these to diameters in centimeters (in our model solar system).

Here we'll use a size scaling factor of 2 cm/Earth diameter - so 1 Earth diameter in the real solar system is 2 centimetres in our model solar system.

To calculate sizes in the model, as before you need to multiply the size in Earth diameters by this size scaling factor. For example, we can apply our size scaling factor of 2 cm/Earth diameter to Mercury, which has a diameter of 0.38 Earth diameters in the real solar system. So you would need to multiply 0.38 Earth diameters x 2 cm/Earth diameter to get 0.76 cm - so in your model, Mercury would have a diameter of 0.76 cm.

This means Neptune would have a diameter of 7.8 cm in our size model.

You can adjust the size scaling factor to a larger or smaller value, to make your planets larger or smaller, but make sure they are all multiplied by the same amount.

	Diameter of planet in the...	
Planet	**real solar system (Earth diameters)**	**model solar system (cm)**
Mercury	0.38	0.76
Venus	0.95	1.9
Earth	1	2
Mars	0.53	1.06
Jupiter	11.2	22.4
Saturn	9.4	18.9
Uranus	4.0	8.0
Neptune	3.9	7.8

Sources

https://www.jpl.nasa.gov/_edu/pdfs/scaless_reference.pdf

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Now it's time to create your very own solar system model.

Using chalk outside.

If you are using chalk outside, first draw the Sun on the ground using your chalk. The planets will be drawn in comparison to the Sun so make sure you draw it nice and big, and larger than the planets.

Measure the distance you calculated to each planet and draw them at their scale distances.

If you also calculated the planet sizes compared with each other, measure those sizes as you draw them, giving your planets the correct diameter.

You can draw your planets all along a single straight line from the Sun, but if you have enough space, consider drawing circles to represent the planets' orbits, using the distance you calculated as the radius of the circle, centred on the Sun. And putting the planets at different spots along their orbits around the Sun.

Optional extension activity

Size and distance model, with optional orbital periods. In this model, both the sizes and the distances of the Sun and planets in the model solar system have the same relative size as in the real solar system. If you make this, you'll get a good idea of how big the Sun is relative to the planets. And what people mean when they say "space is big" - the distances between the planets are much bigger than the planets themselves!

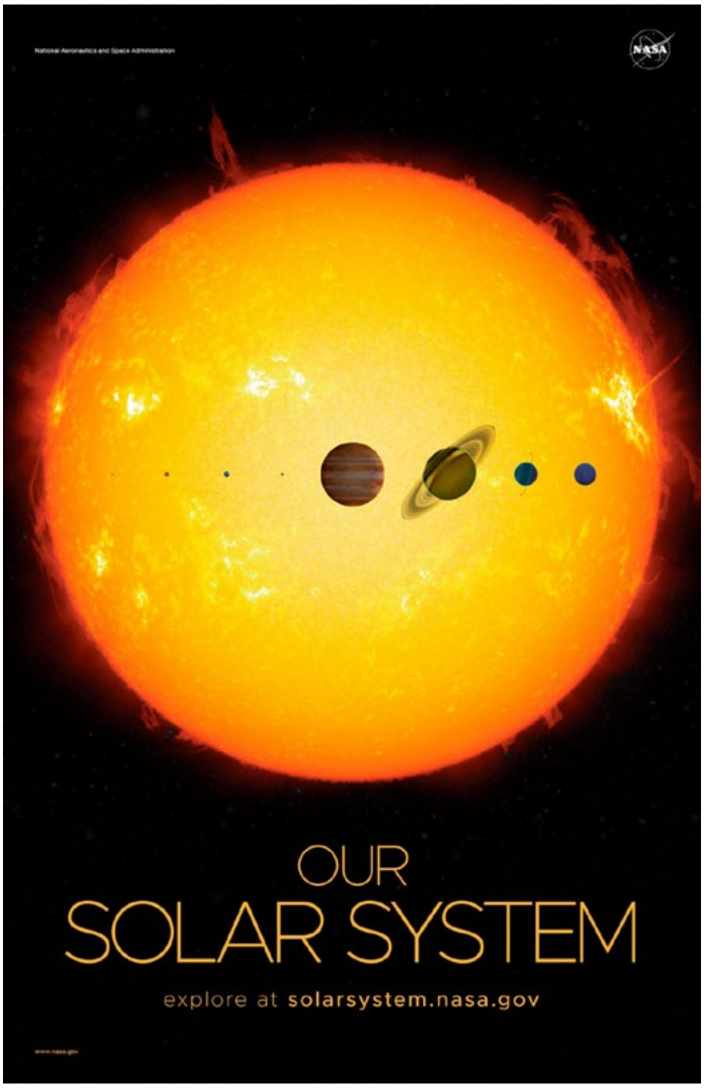
If you use the length scale factor we've suggested, you should be able to have Jupiter make a full orbit on a typical football pitch.

If you trace out the orbit (e.g. with markers), you can use the orbit time to run or walk around the orbit, and get insights into how fast the planets move relative to each other.

	Diameter of body in the...		Sun to planet distance in the...		Time for planet to make 1 orbit in the...	
Solar system body	**real solar system (Earth diameters)**	**model solar system (mm)**	**real solar system (Earth diameters)**	**model solar system (m)**	**real solar system (years)**	**model solar system (mins)**
Sun	109	109	-	-	-	-
Mercury	0.38	3.8	4,574	4.6	0.24	0.12
Venus	0.95	9.5	8,444	8.4	0.62	0.31
Earth	1	10	11,728	11.7	1	0.5
Mars	0.53	5.3	17,826	17.8	1.9	0.94
Jupiter	11.2	112	60,984	61.0	11.9	5.9
Saturn	9.4	94	111,882	111.9	29.5	14.7
Uranus	4	40	225,171	225.2	84.0	42.0
Neptune	3.9	39	352,533	352.5	164.8	82.4

Common length scale factor (distance and size)	0.1 cm/Earth diameter
Time scale factor	0.5 minute/year

Please note this isn't linking time and space via scaled speed of light in the model.



This image shows the planets of our solar system lined up as if they were transiting the Sun. Although such a view would not be possible in reality, this graphic is intended to show the accurate scale of the planets, relative to each other and the Sun.

Source: NASA

Student Project: Make a Scale Solar System | NASA/JPL Edu

Sources

https://www.jpl.nasa.gov/_edu/pdfs/scaless_reference.pdf

https://www.jpl.nasa.gov/edu/resources/project/make-a-scale-solar-system/

https://www.rmg.co.uk/stories/space-astronomy/solar-system-data

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