Scale Models of the Solar System

Subjects: Our Solar System

Texas Essential Knowledge and Skills

Science

§112.14. grade 3 (b)-3(C) represent the natural world using models such as volcanoes or Sun, Earth, and Moon system and identify their limitations, including size, properties, and materials
§112.14. grade 3 (b)- 8(C) construct models that demonstrate the relationship of the Sun, Earth, and Moon, including orbits and positions.
§112.14. grade 3 (b)- 8(D) identify the planets in Earth's solar system and their position in relation to the Sun.
§112.18. grade 6 (b)-3(C) identify advantages and limitations of models such as size, scale, properties, and materials.
§112.18. grade 6 (b)-11(A) describe the physical properties, locations, and movements of the Sun, planets, Galilean moons, meteors, asteroids, and comets.

Astronomy

§112.33(c)-6(B) compare and contrast the scale, size, and distance of objects in the solar system such as the Sun and planets through the use of data and modeling.

Introduction

This data will allow you to make a scale model of the solar system. For younger students, do a distance-only model. For older students, you might want to scale the size of the planets to the same scale as for the distances.
Distance and sizes in the solar system are difficult to visualize because the numbers are so large. In making a scale model, you need to divide the actual figure by any standard number to make a scaling factor. For example, if the wheels of a model car are 9 cm in diameter, and the wheels of a real car are 72 cm in diameter, then the scaling factor is 72 divided by 9 or 8. The model car is a 1/8-scale model of a real car. Looking at the model, measuring the part, and multiplying by 8 can determine the true size of any other part of the car.

Object	Distance from Sun (AU*)	Distance (kilometers)	Diameter (kilometers)
Sun	--	--	1,391,980
Mercury	0.39	58,000,000	4,880
Venus	0.72	108,000,000	12,000
Earth	1.00*	150,000,000	12,800
Mars	1.52	228,000,000	6,800
Jupiter	5.20	778,000,000	142,000
Saturn	9.54	1,430,000,000	120,000
Uranus	19.2	2,870,000,000	51,800
Neptune	30.1	4,500,000,000	49,500
Pluto	39.4	5,900,000,000	2,300

(*) Note that 1 AU (astronomical unit) is 150,000,000 km (about 93,000,000 miles). It is the average distance from Sun to Earth.

Engage

Show several items, such as toys, of various scales and ask students to describe them. Ask the students to write down or draw a picture of what they think the solar system looks like.

Explore

Use the data table to measure out a scale model of the solar system. [If you don't have space to use one meter = 1 AU in your model, you or your students may wish to calculate a new scale for the class, or to do only part of the solar system.] One way to make a model is to measure out pieces of string of the proper lengths and put a piece of masking tape at each end. All the pieces begin at the position of the Sun. The strings can be attached to a ring in the center and go out in all directions. (For lower elementary grades, don't worry about the exact positions of the planets in relation to each other. They change every day!)

Explain

Ask the students to compare their initial description from the model they made. Since the planets orbit the Sun in almost the same plane, it is correct for you to make a model on a flat surface, like a floor.

Extend

The nearest star to the Sun is Alpha Centauri, at 274,332 AU. Where would this star be in the model you have made? Another extension might be to add drawings or three dimensional models of the planets. How big are the sun and planets if you make them to the same scale you used for distance? (Answer: The diameters are much smaller than the distances and unless your model is very large it will be difficult to do.)

Evaluate

What are the advantages and disadvantages of making a scale model? (Answer: The advantage is that it is small enough to see all at once and that it may fit into the space available. It is like the real solar system because it shows the distances of the planets relative to the sun. A disadvantage is that most students make a model in which all the planets are in a straight line, which is not their usual arrangement. Another disadvantage is that it is very difficult to do both distances and diameters to the same scale.)

Solar System Scale Model Demonstration

Ratio of this scale model to actual sizes: (~560 million : 1)

Solar System Object	Representative Sphere	Diameter (centimeters)	Diameter (inches)	Actual Diameter (km) (Equatorial)	Actual Distance from Sun (km) (Semimajor Axis)	Scale Model Distance from Sun
Mercury	Steel Shot (Silver Ball)	0.8 cm	0.31 in	4,878 km	57.9×10^6 km	100 meters
Venus	Big Marble (Dark)	2.2 cm	0.85 in	12,104 km	108.2×10^6 km	193 meters
Earth	Big Marble (Clear)	2.3 cm	0.9 in	12,756 km	149.6×10^6 km	267 meters (~3 football fields)
Moon	Airsoft BB (Yellow Plastic)	0.6 cm	0.24 in	3,476 km	0.384×10^6 km (from Earth)	60 centimeters (from Earth)
Mars	Small Marble (White Swirl)	1.3 cm	0.5 in	6,792 km	227.9×10^6 km	407 meters
Jupiter	Basketball	25 cm	9.55 in	142,988 km	778.3×10^6 km	1.39 kilometers
Saturn	Volleyball	21 cm	8.25 in	120,660 km	$1{,}427.0 \times 10^6$ km	2.55 kilometers
Uranus	Softball (Large Yellow)	9.5 cm	3.75 in	51,118 km	$2{,}869.0 \times 10^6$ km	5.12 kilometers
Neptune	Softball (Small White)	9 cm	3.5 in	49,500 km	$4{,}497.1 \times 10^6$ km	8.03 kilometers (about 5 miles)
Pluto	Brass BB (Smallest BB)	0.45 cm	0.18 in	2,370 km	$5{,}900 \times 10^6$ km	10.53 kilometers
Sun	*Would be an 8 ft diameter ball*	245 cm	96.5 in (~8 ft)	1,377,648 km	4.04×10^{13} km (to nearest star)	71,137 km (to nearest star, roughly twice as far as the moon)

Other interesting distances and speeds at this scale…

Light

Quantity	Scaled (English)	Scaled (Metric)	Actual Speed
Speed of Light	21 in/sec	53 cm/sec	3×10^{8} m/sec
Light Year	10,352 mi	16,660 km	9.46×10^{12} km

Distances to Stars and Center of Milky Way

Object	Scaled Distance (English)	Scaled Distance (Metric)	Actual Distance
To Alpha Centauri (nearest star)	44,202 mi	71,137 km	4.04×10^{13} km
To Sirius (brightest star in night sky)	89,440 mi	143,940 km	8.17×10^{13} km
To Deneb (one of the most luminous stars known)	14,513,278 mi	23,356,857 km	1.33×10^{16} km
To Center of Milky Way	286,850,511 mi	461,641,149 km	42.62×10^{17} km

Sizes of Stars (diameters)

Type of Star	Scaled Size (English)	Scaled Size (Metric)	Actual Size
Hot Star (Type O5)	144.74 ft	44.1 m	25,054,200 km
Cool Star (Type M5)	30.88 in	78.42 cm	445,408 km
Red Giant (Betelgeuse)	6031 ft	1838 m	1,043,925,000 km
White Dwarf (Sirius B)	0.82 in (close to Earth's size)	2.1 cm	11,700 km
Neutron Star	0.0014 in	0.035 mm	20 km