SOLAR SYSTEM: Model of the planets’ relative sizes

This activity gives students an idea of the relative sizes of the planets. They will see how much larger the gas giants are to the terrestrial planets and will be able to compare all the planets to the Sun.

Supplies needed:

Construction paper

Rulers

Compasses to draw circles

(one for each student or group if possible)

Scissors

Tape, and possibly string

Directions:

Students should work in groups. Measure, draw, and cut construction paper circles of appropriate diameters to demonstrate the general appearances and relative sizes of each planet. Display the model planets in the classroom. They may be able to be hung from the ceiling or taped to the walls. Be sure students understand that, while the relative sizes of the planets are to scale, the distances between the planets will not be. To demonstrate the relative distances between the planets, see the next two activities.

Below are color suggestions and the appropriate sizes for each planet:

Sun: yellow – 109 1/8”

Mercury: gray – 3/8”

Venus: yellow –15/16”

Earth: blue – 1” Moon: white – ¼”

Mars: red – 17/32”

Jupiter: tan – 11 3/16”

Saturn & Rings: tan – 21 5/8”, Saturn only: 9 13/32”

Uranus: green –4”

Neptune: blue – 3 13/16”

Pluto: gray – 15/64”

This activity can be expanded for older students to include the moons of the planets. Have the students determine the scaling factor for the model by finding the actual diameters of the planets and comparing that with the diameters in the model. After looking up the actual diameters for the moons of the other planets, they can calculate the model size for each moon using the equation below and add the moons to the model.

(planet’s model size) (moon’s model size)

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(planet’s actual size) (moon’s actual size)

Students often think of the solar system as being composed of huge bodies without much space between them. The following two activities are designed to correct this view and to demonstrate the enormous size of our solar system, in which empty space, not planets, dominates.

The “Scaling the Solar System with Toilet Paper,” has the advantage of requiring less room. On its scale, however, the planets would be tiny. This means that this activity doesn’t allow students to easily visualize the sizes of the planets relative to each other or to the space between them. It has been included as a second-choice activity in case the amount of space needed for “The Thousand and Thirty-Yard Solar System” is impossible to find.

For this activity you need a distance of about 37 meters, which is about the length

of 4 football fields.

Supplies:

10 Index cards

2 rolls of 500 sheet toilet paper

Write the name of the Sun and the nine planets on the index cards (one object per card). Spread the index cards out on the table and have students arrange them in the correct order. If they need help, the saying, “My Very Educated Mother Just Showed Us Nine Planets” can help them remember the planets’ order out from the Sun. (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto).

If you want to include learning about each planet in this lesson, see if students can tell you something about each one. If they can’t, help them out. Here are examples of the things you might tell them:

Mercury is a barren rock. It orbits the Sun in just 88 days. The side facing the Sun can reach temperatures around 700 degrees Fahrenheit, while the side away from the Sun has temperatures of about -330 degrees Fahrenheit.

Venus has thick clouds of sulfur that trap the Sun’s heat and make it the hottest planet in the solar system. It also rotates in the opposite direction as most of the other planets. Of all the planets only Mercury and Venus do not have moons.

Earth is our home and is the only planet we know of (so far) in the whole universe that has life. About 70 percent of Earth is covered in oceans. Mars is a red planet with very little atmosphere. It is a cold desert with a volcano the size of Utah and a canyon that would stretch across the entire United States. It has ice caps at its poles.

Jupiter is the largest planet and the first of the Gas Giants. It is home to the Great Red Spot, a storm that is so large that the four terrestrial planets could fit inside. Jupiter also has the most moons of any planet. (We know of sixty moons that orbit Jupiter.)

Saturn is the second largest planet. It has bright rings of rock and dust around it. These rings can be seen through a telescope from Earth. Saturn is also the least dense of the planets. If you could make a cup of hot chocolate large enough to put Saturn in it, Saturn would float like a marshmallow!

Uranus orbits the Sun tipped over on its side and rotates backwards.

Like Saturn, it has rings made of particles ranging from10 meters in diameter to tiny piece of dust. However, unlike Saturn, Uranus’s rings are dark and very difficult to see.

Neptune has the fastest winds of any planet in the solar system. The winds of this gas giant can reach 1,200 mi/hr.

Pluto is the smallest, coldest planet in the solar system. It is the only one that hasn’t yet been visited by a spacecraft. It is closer to the Sun than Neptune for 20 years out of its 249-year orbit. Like Uranus, Pluto orbits with its poles almost in the orbital plane.

After the students have placed the planets in order and have identified some features of each, discuss the idea of scale. You can take the discussion to varying depths depending on the age of the students. For young students, a common example of scaling is probably sufficient. Here is one you can use: If an automobile is 5 meters (500 cm) long and your model car is 10 cm long, then the scaling factor between them is 500 cm ÷ 10 cm or 50.

The scaling factor for this toilet paper model is below:

Real Model

Sun-Earth distance 93,000,000 mi 0.93 meters

Therefore 100,000,000 mi 1 meter

If the students are old enough and there is time, have them calculate the scaled distances from the Sun to each planet. You could also have them calculate the diameters of the Sun and planets on this scale. (They will be very small! Only the Sun would be wider than 1 cm in diameter. Jupiter, the largest planet, would only be 0.8 cm across.) Take the toilet paper rolls and the index cards to the beginning of your 37 meters. Place the index card Sun on the ground. Unroll the toilet paper, laying the index cards with the appropriate planet names on it at the appropriate distances from the Sun.

Below is a table with the real and scaled distances:

Distance to: From Sun From previous planet

Mercury 36,000,000 3.6

Venus 67,000,000 6.7 31,000,000 3.1

Earth 93,000,000 9.3 26,000,000 2.6

Mars 142,000,000 14.2 49,000,000 4.9

Jupiter 483,000,000 48.3 341,000,000 34.1

Saturn 885,000,000 88.5 402,000,000 40.2

Uranus 1,787,000,000 178.7 902,000,000 90.2

Neptune 2,800,000,000 280.0 1,013,000,000 101.3

Pluto 3,699,000,000 369.9 899,000,000 89.9

Total Distance Needed 37 meters

After building the model, remind students that the planets, even the gas giants, would be smaller than a centimetre on this scale. Have them compare the distances between the planets and reflect on how far away each is from the Sun.

THE SEASONS: The Effect of the Earth’s tilt

The Sun has huge effects on the Earth, and other planets, as we orbit around it. One of these is effects is seasons. The reason for the seasons is something students, and adults, often have trouble understanding and remembering. Hopefully this activity, combined with other ways of reviewing and reinforcing, will help students understand and remember why we have seasons.

Another goal of this activity when working with older students is to build their reasoning skills. This activity walks students through a logical way to think about the seasons. The ability to use logic to arrive at the correct conclusion to a problem is a valuable skill in science and demonstrates a greater understanding of the concepts.

Supplies:

Small lamp without a shade

Small Styrofoam balls (one for each student)

Pencils (one for each student)

Markers

Dark room (such as your classroom with the lights off)

Star cutout (optional)

Give each student a Styrofoam ball. This represents the Earth. Each student should do the following:

Draw a circle around the centre of the ball. This is the Equator. Mark an “X” for his/her approximate location on the globe. Poke a pencil into the bottom of the ball. This will be the axis of rotation.

Place the lamp in the middle of the room on a table. This is the Sun. First, have the students hold their globes with the north and south axes straight up and down at about the same height as the lamp. Each student should be a few feet from the Sun and should do their best not to block the light for other students. Turn off the lights so that students can clearly see the light and shadow on their globes. They should notice that half of the Earth is dark and half is light.

This represents day and night. Have them rotate their globes. See if they can reason out which way to rotate the globe. If they have trouble, ask them where the Sun rises. See if they can turn the globe in the correct direction to make the Sun rise in the East from the perspective of a person standing on its surface. (Looking down on the North Pole, the Earth should rotate counter clockwise.)

Now the students should move in a circle counter clockwise around the Sun, stopping at various points and rotating their globe. What do they observe about the lengths of the days? They should notice that they are all the same length.

Hopefully, when they notice this they will realize that there is something wrong with the model, because our days on Earth are not equal lengths all year long. If they don’t, you can lead them in that direction until they make that conclusion. To make the days different lengths, the Earth must be tilted on its axis. In fact, the Earth is tilted at an angle of 23.5 degrees from the upright position.

Students should tilt their globes about 23 degrees. Each student should keep the axis of his/her globe tilted and walk around the Sun as they did before. The North Pole should always point to the same spot in the room as they circle the Sun. You can hang a star cut out on the wall to symbolize Polaris, the North Star, so students can easily see where their axes should point, or you can simply choose an object in the room to represent the North Star.

The students should stop at least at the following locations around the Sun and rotate their globes, keeping the axes at the same angle.

These four points represent the summer and winter solstices, and the vernal and autumnal equinoxes. Notice how the length of the days changes from season to season. Also, notice the angle of the Sun’s rays on each hemisphere at each season. During half of the year, the Northern Hemisphere is pointed more directly toward the Sun. During this time, the days are more than 12 hours long. This is the spring and summer.

For the other half of the year, the North Pole is tilted away from the Sun. The days in the Northern Hemisphere are shorter, the nights are longer, and the sunlight falls indirectly, or at an angle less than 90 degrees, on this hemisphere. This is fall and winter for the Northern Hemisphere. Halfway between summer and winter, during the spring and fall, the Sun’s rays fall directly on the Equator. These are the spring and autumnal equinoxes, dates when the day and night are of equal length in both hemispheres. In the Southern Hemisphere the seasons are the opposite. This can be easily seen in this model.

At the end of the activity, students should be able to tell you that we have seasons because of the Earth’s tilt on its axis. The axis always points in the same direction in the sky (toward the North Star). As the Earth goes around the Sun, this tilt causes the changing seasons. The days are longer in the summer and shorter in the winter. The sunlight falls more directly on the Northern Hemisphere during its summer. Both the length of the days and the angle of the sunlight affect the seasons. If you wish, you can extend the discussion of seasons to the other planets. How would their seasons compare to ours? You will have to look at the angle of each planet’s axis and at the length of its orbit to answer this.

THE SEASONS: The angle of the Sun’s rays

This activity demonstrates how the angle that the sunlight hits a location on Earth affects the temperature there. As shown in the previous activity, the Northern Hemisphere is tilted toward the Sun during the spring and summer. As a result, the Sun’s rays fall more directly on that hemisphere during those times. During the fall and winter, the Northern Hemisphere receives indirect light, which is light that comes in at an angle less than 90 degrees.

This activity can be done as a class or in small groups. If done in groups, each group will need the following supplies:

2 small flat boxes

2 thermometers

Sand or dry dirt

4 small blocks or bricks

Sunlight

Fill each box with an equal amount of sand and dirt. Place a thermometer in each box, with the bulb covered by the sand or dirt. Set the boxes in the sunlight. Place one box flat on two blocks so that it is off of the ground. This will keep the ground temperature from affecting the box’s temperature. The sunlight should fall at an angle onto this first box. Prop the second box up so that the sunlight falls directly (at right angles) onto the dirt inside it. The other two blocks may come in handy here. Leave the boxes in the sun for about 15 minutes. Then come back and check the temperatures. Notice that when the Sun’s rays fall on the dirt at an angle, such as in the winter, the temperature is lower than when the light strikes at a right angle, as in the summer. This is because the Sun’s rays are spread out over a larger area when they come in at an angle and, as a result, they don’t provide as much heat. Another factor in winter (not demonstrated here) is that, because of

the incident angle, the sunlight must pass through more of the Earth’s atmosphere. In the summer, the sunlight falls directly on the dirt and the Sun’s energy is more concentrated over a small area. When the Sun is overhead, its light also has fewer miles of atmosphere to pass through