Wonders of the Solar System
Teacher's Guide

Wonders of the Solar System is a planetarium program that explores the sizes, distances, and amazing natural features of the nine known planets, many of the moons, and the Sun. Because this is a live presentation, there will be ample time for questions. We encourage participation and discovery.

This Teacher's Guide is designed to help you, the teacher, prepare your class for their upcoming visit *The Northern Stars Planetarium* when it comes to your school. Please be aware that this program is offered to a variety of grade levels (3rd through 7th), being a live presentation it is not difficult to adapt the material to the proper age level; however, everyone gets this Teacher's Guide. Not everything presented here will be appropriate for your specific grade level, some of it may be too old, some too young. Use only what is appropriate and useful to you.

Study  Questions

1. What is a planet? What is the difference between a planet and a star? What is the difference between a planet and a moon?

2. What is the difference between *revolution* and *rotation*?

3. What are some of the differences between the *inner planets* and the *outer planets*? (Inner planets: Mercury, Venus, Earth, Mars. Outer Planets: Jupiter, Saturn, Uranus, Neptune, Pluto.)

4. Is Pluto like the other planets? How is it different?

5. Do all planets have gravity?

6. How does the size and mass of a planet affect the amount of gravity?

7. How many stars are in the Solar System?

8. What is the Sun? How is it different from all the other stars?

9. What are the constellations? Who created them?

10. Do astonomers think there are planets going around other stars? Why?

Vocabulary

Albedo The reflecting power of a planet or other non-luminous object. An albedo of 1.0 means that it reflects 100% of the light that hits it; 0.0 means it absorbs 100% of the light or reflects 0% of the light. Our moon's albedo is a low 0.07, while Venus has a high albedo of 0.7.

Asteroid Also called *Minor Planets*, they are small rocky objects that orbit the Sun. Most (95%) are found in the *asteroid belt*, which is the region between Mars and Jupiter. There may be up to 100,000 asteroids, but only about 3,000 have been catalogued.

Atmosphere The outer gaseous layers of a star or planet. The air. Not all planets have atmospheres.

Constellation: Dot-to-dot pictures drawn in the stars, using stars as the dots. There are 88 official constellations in the sky. They are a means of mapping the night sky. Many of them have their origins in ancient times, for example, 48 of the 88 came from Greek mythology.

Crater Circular ridges with deep centers. They are most often caused by either meteorite impacts or volcanic eruptions. Impact craters are more common on planets and moons with thin or no atmospheres; thicker atmospheres tend to burn up the meteoroid before it can hit the surface.

Gas This refers to substances in a gaseous state (as opposed to solid or liquid). The air is a gas. Do not confuse this term with gasoline.

Gas Giant Planet This refers to a planets such as Jupiter, Saturn, Uranus, Neptune. These planets are gaseous without any solid surface that could be landed upon.

Gravity The force that attracts objects together. Earth's gravity pulls us down when we jump. The Sun's gravity keeps the planets from flying out of their orbits. All objects have gravity (even you!), the more massive something is the more gravity it has. All planets have gravity.

Orbit The invisible path a planet follows around the Sun.

Planetarium A special room with a domed ceiling and special projectors used to make the ceiling look like the night sky. A planetarium is not an observatory. Observatories are buildings that house telescopes for viewing the real sky.

Revolution The motion when one object goes around another. (ie. The Earth revolves around the Sun once every 365.25 days.)

Rotation The motion when an objects spins on an axis going through itself. (ie. The Earth rotates or spins on its axis once every 24 hours.)

Space Probe This is a type of satellite that travels from Earth to explore other planets. There are no people on board a space probe, it is run by computers. They take pictures and do scientific experiments to help us learn about these other worlds. Some examples of famous space probes are: *Voyagers 1 & 2, Vikings 1 & 2, Magellan, Galileo, Pioneer, Pathfinder, Mars Global Surveyor.*

Match Game

Match the planet on the left with the features that go with it on the right.

Mercury	Biggest Planet
	Red Planet
Venus	Coldest World
	Planet with Life
Earth	Has Big Red Spot
	Closest to the Sun
Mars	Has 61 Moons
	Is Tilted on its Side
Jupiter	Sometimes is farther from the Sun than Pluto
	Smallest Planet
Saturn	Was hit by Comet Shoemaker/Levy in 1994
Uranus	Rusty Planet
	These Four Planets All Have Rings
Neptune	Rains Acid & is Cloudy
	70% Covered with Water
Pluto	

Making A Scale Model of the Solar System

This exercise is an excellent way for your students to gain a better understanding of the actual scale of our Solar System, in terms of relative sizes, distances, and speeds. The materials needed are simple, inexpensive, and easily obtained. The activity is three-fold. First it deals with relative sizes. Secondly, it covers relative distances. And lastly, it demonstrates relative speeds.

Materials Needed:

1 Beach ball (preferably yellow or orange)
1 Set of Play Doh® or some other modelling clay
1 String (13 meters or 40 feet long)

Preparation:

Take the string and tie a loop about 5 centimeters (2") in diameter in one end. This is where you will place the beach ball Sun later on. Then tie an overhand knot  at the appropriate distances that each succeeding planet will be from the beach ball Sun. Use the following planet scale information chart to tell you how far away from the Sun each knot should be tied.

Planet Scale Information Chart:

Planet	*Scaled Distance from the Sun*		*Scaled Diameter*
Mercury	13 cm 5 inches	(=58 million kilometers) (=36 million miles)	1.5 mm 1/16 inch
Venus	23 cm 9 inches	(=108 million kilometers) (=67 million miles)	6 mm 1/4 inch
Earth	31 cm 12 inches	(=150 million kilometers) (=93 million miles)	6 mm 1/4 inch
Mars	46 cm 18 inches	(=227 million kilometers) (=141 million miles)	3 mm 1/8 inch
Jupiter	155 cm 61 inches	(=779 million kilometers) (=483 million miles)	25 mm 1 inch
Saturn	274 cm 108 inches	(=1428 million kilometers) (= 886 million miles)	20 mm 3/4 inch
Uranus	572 cm 225 inches	(=2974 million kilometers) (=1782 million miles)	14 mm 1/2 inch
Neptune	889 cm 350 inches	(=4506 million kilometers) (=2794 million miles)	13 mm 1/2 inch
Pluto	1174 cm 462 inches	(=5913 million kilometers) (=3666 million miles)	1.3 mm 1/16 inch

Scale Model Solar System Continued....

Part One: Size Scale

HINT: You might want to make two or more model Solar Systems so that every student can partake.

Assign every student a planet and give them a lump of clay more than big enough to make their planet. If you are using Play Doh, you might want to use appropriate colors (ie. red for Mars, Blue for Earth, etc.). Explain that you want them to guess how big their planet would be if the beach ball were the size of the Sun. It is best not to have them attempt to make rings for Saturn. Have each student make her planet out of clay according to how big she thinks it should be.

Almost always, everyone's planet will be too big. Once they are done, go through the group and change their planets to the correct size. Correcting the students in this fashion will make the actual size much more impressive. Every student must then be responsible for not losing her planet. This isn't necessarily easy, as some planets, like Mercury and Pluto, are only about the size of a grain of sand!

Part Two: Distance Scale

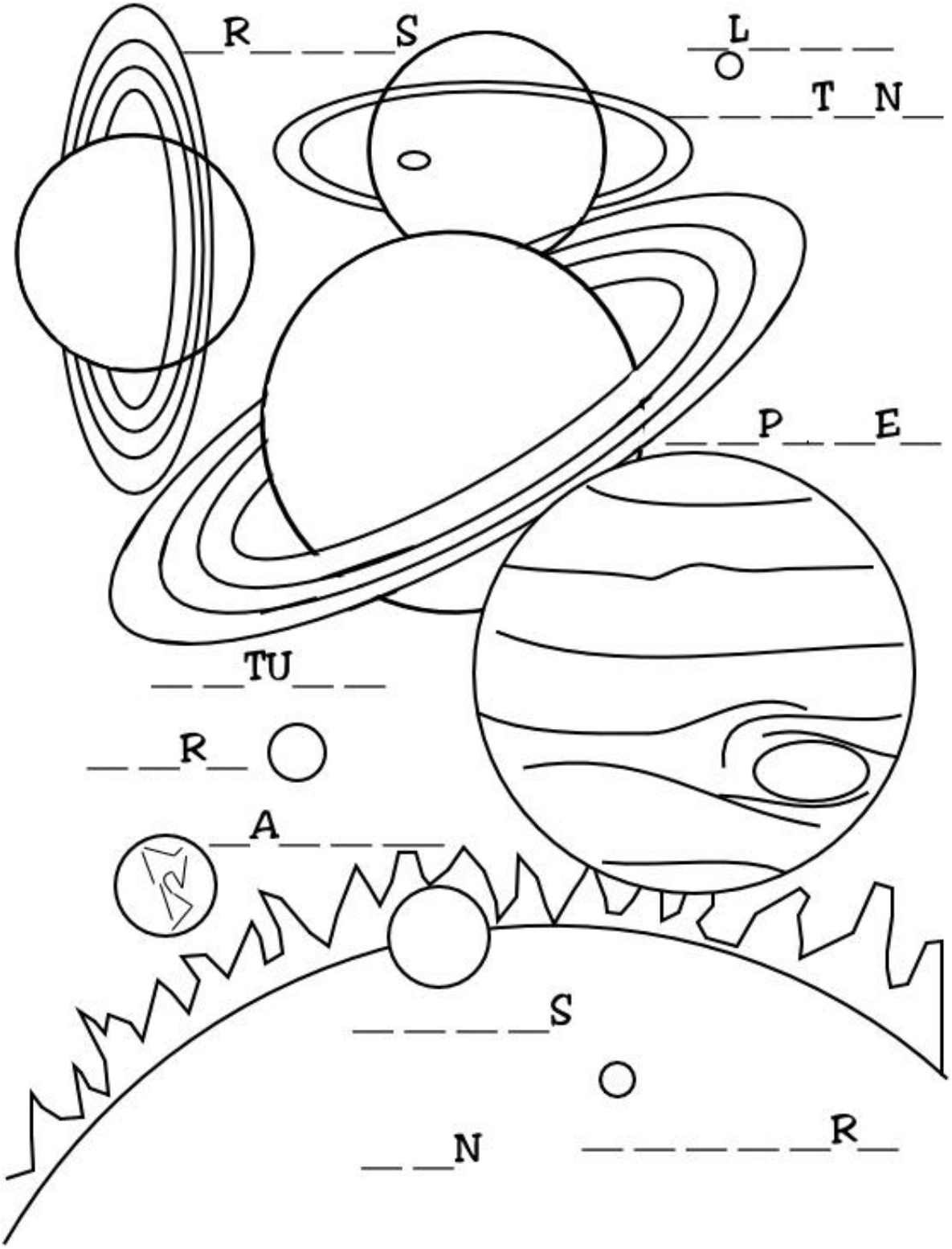
This part of the model should be done either in the gymnasium, cafeteria, or outside. In order to make the distance scale workable within a school environment, we found it best to represent distance on a smaller scale than that used to illustrate size (See the footnote on the previous page).

Separate your students into their various Solar Systems (if you have more than one). Have each student take her clay planet and place it where she thinks the appropriate distance for that planet should be from the beach ball Sun. Once each student has placed her planet down where she thinks it belongs, take out the string with the proper distance scale measured out in knots. Then, one at a time, beginning with Mercury, have each student move her planet to its proper position. Again, this makes the students aware that their perspectives are different from reality. The Solar System is probably much larger than any of them had guessed.

Part Three: Relative Motion

Now that your model Solar System is laid out properly, have your students pick up their respective planets. Tell them to try to keep the same distance from the Sun and have them walk at approximately the same speed around the Sun (in their respective orbits!). Which planet goes around the Sun first? Once Mercury makes one revolution, have them all stop and examine how much of their own orbits they have covered compared to Mercury's complete orbit. *(In actuality the distance is not the only factor in different period orbits. Inner planets do move faster than outer planets. However, for demonstration purposes, having the students all walk at about the same speed works well.)*

*The size scale is 1 cm=140,000 km (1"=225,000 miles) while the distance scale is about 32 times smaller with 1 cm=4,500,000km (1"=7,000,000 miles). We found it best to represent distance on a smaller scale than used for size. If we maintained the same scale for distance as for size, the string would have been 420 meters long rather than 13 meters!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Solar System Facts

The Solar System's Only Star:

SUN Rotates: 26 days. Surface Temp: 12,000°F (6000°C) Core Temp: 27 Million°F (15 Million°C) Diameter: 865,000 mi. (1,395,161 km) A middle aged (4.5 Billion yrs. old), average sized star. It's outer atmosphere "the heliosphere" extends beyond Pluto.

The Inner Planets:

MERCURY Rotates: 58 days 16 hrs. Revolves: 88 days. High Temp: 700°F (350°C) Low Temp: -270° F (-170° C). Diameter: 3,031 mi. (4,878 km.) Gravity: 0.38 X Earth's. No moons, rings or atmosphere. Dominant feature is craters. Visited by the Mariner and Messenger space probes.

VENUS Rotates: 243 days. Revolves: 224.7 days. Average Temp: 900°F (480°C) Diameter: 7,541 mi. (12,104 km.) Gravity: 0.9 X Earth's. Thick Carbon Dioxide (CO_2) atmosphere. No Moons or rings. Visited by Pioneer Venus, Venera, Magellan, Galileo, and several other space probes.

EARTH Rotates: 23 hrs. 56 min. Revolves: 365.25 days. High Temp: 130°F (58°C) Low Temp: -126°F (-88°C). Gravity: 1 X Earth's. Diameter: 7,927 mi. (12,756 km.) Nitrogen & Oxygen atmosphere. 1 moon, no rings. The Earth's surface is 75% covered with water.

MARS Rotates: 24 hrs. 37 min. Revolves: 1.88 yrs. High Temp: 80°F (27°C). Low Temp: -190°F (-123°C). Diameter: 4,197 mi. (6,794 km). Gravity: 0.38 X Earth's. Thin Carbon Dioxide atmosphere. 2 moons, no rings. In 1996 scientist found evidence of fossilized bacteria in a meteorite believed to have originated on Mars--perhaps long ago Mars had life! Visited by Viking 1 & 2, Pathfinder, Sojourner, Mars Global Surveyor, Spirit, Opportunity, Phoenix and several other space probes.

The Outer Planets:

JUPITER Rotates: 9 hrs. 48 min. Revolves: 11.86 yrs. Cloud top Temp: -140°F (-95°C) Diameter: 88,733 mi. (142,796 km.). Gravity: 3 X Earth's. Composition: Mostly Hydrogen, Helium. 63 moons, 1 small ring. Visited by Pioneers 10 & 11, Voyagers 1 & 2, and Galileo space probes.

SATURN Rotates: 10 hrs. 39 min. Revolves: 29.46 yrs. Cloud top Temp: -292°F (-180°C) Diameter: 74,600 mi. (120,000 km.). Gravity: 1.32 X Earth's. Composition: Mostly Hydrogen, Helium. 60 moons. It has a large ring system. Visited by Pioneers 10 & 11, Voyager 1 & 2, and the Cassini Space Probe.

URANUS Rotates: 16 hrs. 48 min. Revolves: 84 yrs. Cloud top Temp: -346°F (-210°C). Diameter: 31,600 mi. ((50,800 km.). Gravity: 0.93 X Earth's. Composition: Mostly Hydrogen, Helium, some Ammonia, and Methane. 27 moons, about a dozen thin rings. Uranus is tipped on its side. Visited by Voyager 2 in 1986.

NEPTUNE Rotates: 16 hrs 3 min. Revolves: 164.8 yrs. Cloud top Temp: -364°F (-220°C). Diameter: 30,200 mi. (48,600 km.). Gravity: 1.23 X Earth's. Composition: Mostly Hydrogen, Helium, some Methane and Ammonia. 13 moons, 3 thin rings, 2 broad rings. Visited by Voyager 2 in 1989.

PLUTO Rotates: 6 days, 9 hrs. Revolves: 248 yrs. Temp: -400°F (-238°C). Diameter: 1900 mi. (3,000 km.). Gravity: 0.03 X Earth's. Has a very thin atmosphere. 1 moon, no rings. The moon, Charon, is half the size of Pluto, some scientists refer to Pluto & Charon as a "Double Planet." Pluto's orbit is very elliptical and tilted; it actually crosses inside Neptune's orbit from 1979-1999. Will be explored in the early 21st century by the space probe named "Pluto Express."

Let's Wonder about Wonders...

Where do you find the most impressive cliffs in the Solar System?

Mercury has cliffs known as "Scarps" that can be as much as 2 miles high and 300 miles long!

Uranus's moon, Miranda, which is only 300 miles in diameter has the highest cliff named "Verona Rupes" which is 9 miles high! If you fell off, you would fall for 30 minutes before you hit the ground at the bottom!

Where is the largest mountain in the Solar System?

Earth's tallest mountain is Mt. Everest at 5.5 miles high.

Mars's tallest mountain is Olympus Mons at nearly 17 miles high!

Which planet has the nastiest atmosphere?

Venus has 90 times the air pressure of Earth! Standing on the surface of Venus would be like being on the bottom of the ocean. The temperature is 900°F. The clouds are made of sulfuric acid, and it is always cloudy with never a sunny day! Nasty!

Where is the largest canyon in the Solar System?

Earth's Grand Canyon is a mile deep, 250 miles long, and ten to fifteen miles wide.

Mars's Vallis Marineras Canyon is 5 miles deep, 3000 miles long and 500 miles wide!

Where is the largest and most active volcanoes in the Solar System?

Jupiter's moon named Io has thousand of volcanoes, many of which are active. The largest volcano in the Solar System is on Io, it is named Pele.

Where would you find an ocean in the Solar System?

Earth is the obvious first choice. It is covered by more than 70% oceans.

Jupiter's moon "Europa" appears to be an ocean moon, it's just cold enough for the surface to be frozen over, but scientists have found evidence to suggest that there is a large liquid ocean beneath the ice.

Saturn's moon "Triton" may also have an ocean, but not made of water. Triton's ocean may be made of methane.

Are there any double planets in the Solar System?

Yes! Many astronomers call Pluto and it's moon Charon a double planet because Charon is almost as big as Pluto!

Where is the darkest object in the Solar System?

Uranus's moon named "Umbriel" is very dark in color--darker than any other planet or moon. But Umbriel does have one bright feature, a bright white crater which has been named "Wunda".

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Older Students:

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For Teachers:

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Planetarium Program Evaluation

After the Northern Stars Planetarium has visited your class, please take a moment to fill out this evaluation. Your suggestions are very valuable to us!

Mail the completed evaluation to :.....Northern Stars Planetarium
15 Western Ave.
Fairfield, Maine 04937
Or Email To :.....info@northern-stars.com

1. Show Name: _____

2.Group grade/age level:_____

3. Was the material presented at an appropriate level for your class? _____

_____

4. Was the amount of material discussed: Enough Overwhelming Not Enough

5. Should any parts of the presentation be developed further? _____. If so, which parts?

6. Was there sufficient time for questions and answers? Yes No

7. Were you studying astronomy or another related subject at the time of the planetarium's visit?
Yes No
If so, was the planetarium visit helpful? _____

8. Was the Teacher's Guide helpful in preparing your class for the planetarium visit? Yes No
Which parts were most helpful? _____
Which parts were least helpful? _____

9. Did the presenter present the material in a clear and understandable fashion? _____

10. How would you rate the overall program given to your class in the planetarium? _____

_____

11. (Optional) Your name & school:_____
Please feel free to write any *further comments* on the back.

Thank you for your time! Your Comments Make a Difference!