Science Lesson Plan: Our Solar System: I Wonder? (I 1-D-R)

Learning Outcomes

(corresponding to science standards for grades 3-5)

1. Generate curiosity to study and explore our surroundings.
2. Design representations in conventional and creative ways to answer spatial and relational questions between objects in our solar system.
3. Think critically and logically to make the relationships between evidence and explanations.
4. Learn that the Earth is one of eight planets orbiting the sun varying in size, structure, appearance, and distance from the sun.
5. Identify the differences between planets, moons, comets and asteroids.

Introduction – Building Connections to Curriculum

Ask students: What is our solar system?

Answers will vary. The solar system is the sun and the objects orbiting it. Explain that you will be identifying a little later what the different objects are in the solar system.

Ask students: Why is it important for us to learn about our solar system?

Answers will vary. Explain that we ***discover because we seek***. Through exploration, we've discovered new continents, we've found cures to diseases, and we've created a whole new way of communicating through computer technology. This is how we've built our civilization. Science, curiosity, and the need to think, study and explore our surroundings drive us to be who we are.

Ask students the rhetorical question: Have you ever looked at the stars and wondered what lies beyond?

Open Demonstration Activity Objectives:

1. Review theories about how the solar system was formed.
2. Create an interest in answering spatial and relational questions between objects in our solar system

Material(s) List:

- Water
- A clear plastic bottle with a cap (that won't leak)
- Glitter
- Dish washing liquid

Instructions:

1. Fill the plastic bottle with water until it reaches around three quarters full.
2. Add a few drops of dish washing liquid.
3. Sprinkle in a few pinches of glitter (this will make your tornado easier to see).
4. Put the cap on tightly.
5. Turn the bottle upside down and hold it by the neck. Quickly spin the bottle in a circular motion for a few seconds, stop and look inside to see if you can see a mini tornado forming in the water. You might need to try it a few times before you get it working properly.

Ask students: What caused the mini tornado in the bottle?
Answers will vary. Explain that the water is rapidly spinning around the center of the whirlpool due to an inward force directing an object or fluid such as water towards the center of its circular path.

Transition to explain scientists believe that the Solar System evolved from a giant cloud of dust and gas. They believe that this dust and gas began to collapse under the weight of its own gravity, and the dust and gas begin moving in a giant circle.

Ask students: Have you ever watched the water as it drains out of a bathtub?

Transition to explain as a bathtub is nearly empty, the water in the drain moves around the center of the drain in a circle that moves faster and faster until there is no more water.

In a similar way, the theory is that at the center of this spinning cloud, a small star began to form. This star grew larger and larger as it collected more and more of the dust and gas that collapsed into it.

Further away from the center of this mass where the star was forming, there were smaller clumps of dust and gas that were also collapsing. The star in the center eventually burst into flames and made one big ball of continually burning fire becoming our sun. The sun is a star. It is the biggest thing found in our solar system. All the light and warmth on the planets come from the sun. The Sun get most gets its energy from nuclear reactions, which release vast quantities of energy. These same nuclear reactions created smaller clumps of matter that became the planets, moons, comets, and asteroids.

How the solar system was formed is an important question, and one that is difficult for scientists to understand. Although, there are different theories about how the solar system formed, one thing everyone agrees on is the creation of our Solar System took place before there were any people around to witness it.

What's the difference between planets, moons, comets and asteroids?

Planets	A planet is a large space object which revolves around a star (the sun is a star).
Comets	Flying chunks of rock and ice with a tail of water vapor usually facing away from the sun due to solar wind.
Moons	Also called a satellite. A chunk of rock rotating around a planet.
Asteroids	Chunks of rocks that come from the outer regions of space and usually come from would-be planets that never made it.

Discussion– Building Connections to Ideas

Ask students (Repeat the original question): What exactly is the Solar System?
Answers will vary. The solar system is our sun and everything that moves around it too. We know that eight planets circle our sun. There might be more that we can't see!

Expand your answer:

Other things orbit the sun, too. Dwarf planets, comets and asteroids orbit the sun. Dust and pieces of ice orbit, too! Before we talk about what makes a "dwarf planet", let's talk about what planets are in our solar system.

A planet is a large space object which revolves around a star. Eight planets have been discovered in our solar system. **Mercury**, **Venus**, **Earth**, and **Mars** are the planets closest to the Sun. They are called the **inner planets** – and are mostly made up of rock.

The **outer planets** are **Jupiter**, **Saturn**, **Uranus**, and **Neptune**. Jupiter, Saturn, Uranus, and Neptune are large balls of gases with rings around them. All eight planets travel around the Sun in a different orbit.

Every planet, except for Earth, was named for an ancient Roman god or goddess.
All eight planets orbit the Sun in their own unique way. The sun is a star. It is the biggest thing found in our solar system. All the light and warmth on the planets come from the sun. Our seasons and how we keep time are set based on where we are in our Solar System.

Who Named the Sun?

The Romans called the sun Sol, which in English means sun. In ancient Greece, the sun was called Helios. Our Sun is not unique in the universe. It is a common middle-sized yellow star which scientists have named Sol, after the ancient Roman name. This is why our system of planets is called the Solar System. There are trillions of other stars in the universe just like it. Many of these stars have their own systems of planets, moons, asteroids, and comets.

The Sun's Family

The Sun is by far the largest object in the Solar System. 98% of all matter within the Solar System is found within the Sun. This means that all the planets, moons, asteroids, minor planets, comets, gas, and dust would all combine to make up only 2% of all the matter in the Solar System. The Sun is so large that the Earth could easily fit inside the Sun a million times.

Because the Sun is so large compared to everything else, it is easily able to hold on to the rest of the matter, causing everything else to orbit around it.

Did you know?

Scientist used to say there were nine planets in our solar system. In 1930, when Pluto was discovered, scientists identified Pluto as the ninth planet in our solar system. **In 2006 Pluto was demoted from the status of a planet to a dwarf planet.**

Should Pluto be a planet?

Dwarf planet is a new class of astronomical objects. It was created in 2006 by the **International Astronomical Union** (IAU is an organization founded in 1919 with a mission to *promote and safeguard the science of astronomy in all its aspects through international cooperation*.) The definition of a Dwarf Planet came about because these planets didn't fit the definition for being a 'planet'. Scientist decided it that to be a planet in our solar system, an object must be in orbit around the Sun AND have enough mass so that it has become round in shape due to its own gravity.

For an object to be a planet, it needs to meet these three requirements defined by the IAU:

- It needs to be in orbit around the Sun – Yes, so maybe Pluto is a planet.
- It needs to have enough gravity to pull itself into a spherical shape – Pluto…check
- It needs to have "cleared the neighborhood" of its orbit – Uh oh. Here's the rule breaker. According to this, Pluto is not a planet. Neptune is the big brother of Pluto's neighborhood, and Neptune tags behind Pluto in its orbit of the sun.

Also, like the name implies, dwarf planets tend to be smaller in size, so small that about 30,000 of them could fit inside the earth.

We are still in discovery mode.

As technology continues to advance, so does our ability to discover more about our universe.

Ask students the rhetorical question: Can you close your eyes and imagine what else is out there in space yet to be discovered? Pause for a moment, before explaining that in the 1800s before we had the ability to study the planets we have been discussing, there was a well-known composer name Gustav Holst who became famous because of composition called **The Planets.**

Gustav Holst - Composer or Visionary?

The Planets - Jupiter, Op. 32

Born in Cheltenham England on September 21, 1874, the British composer, most known for his musical composition called *The Planets*, wrote an impressive piece of music long before we had the ability to see our solar system, as we know it today. Gustav Holst also composed other music, played the trombone and taught at a girl's school in London. His father taught him piano at an early age, but a nerve disease cut his career as a pianist short. He went on to attend the Royal College of Music where he studied composition.

Gustav jobs as a trombonist and a teacher took up a lot of his time, so he did most of his composing in his spare time. *The Planets* music made him successful and he was not very comfortable with all the attention. Holst gave up teaching in 1925 because of his nerve disease, and spent the last years of his life writing music. His works include operas, choral music, orchestral pieces and songs.

The Planets is a seven-movement orchestral suite written between 1914 and 1916. Each movement of the suite is named after a planet of our Solar System.

The movements:

Mars, the Bringer of War
Venus, the Bringer of Peace
Mercury, the Winged Messenger
Jupiter, the Bringer of Jollity
Saturn, the Bringer of Old Age
Uranus, the Magician
Neptune, the Mystic
Earth wasn't included because The Planets has a loose basis in astrology, and in astrology, the Earth is where the planets were seen, and so is not included in *The Planets* composition. (For the purposes of the live show, we used different sections of Jupiter's themes to underscore the Sun, Earth and the Moon.)
Ask students: Why do you think Gustav Holst did not include a movement for Pluto? Answer: Remind students that Pluto wasn't discovered until 1930 (see page 5), and Holst composed *The Planets* between 1914-1916, before the discovery of Pluto.
Ask students: How do you explain how well the musical composition matches the physical characteristics of the planets, since Gustav used his mind's eye, before any telescope provided us with the ability to see as clearly with our physical eyes?

EXERCISE: Dream about it! Materials Needed: Pencils and paper and a CD player and a track of *The Planets - Jupiter, Op. 32*
Instructions: Draw a picture or write a description on what images come to mind after your teacher plays each of Holst's movements.

Hands on activity/Enrichment: Let's Take a Planet Walk

Scale in size solar. Although it will take some thought and preparation to do the Planet Walk no other exercise will create the same level of awe in your student's minds.

Can you picture the dimensions of the solar system?

The fact is that the planets are mighty small and the distances between them are almost ridiculously large. To make any representation whose scale is true for the planets sizes and distances, we must go outdoors.

First, collect the objects you need. They are:

Sun-any ball, diameter 8.00 inches (bowling ball works well)

Mercury-a pinhead, diameter 0.03 inch (stick in an index card, otherwise it's hard to see it)

Venus-a peppercorn, diameter 0.08 inch

Earth-a second peppercorn

Mars-a second pinhead (stick in an index card, otherwise it's hard to see it)

Jupiter-a chestnut or a pecan, diameter 0.90 inch
Saturn-a hazelnut or an acorn, diameter 0.70 inch
Uranus-a peanut or coffee bean, diameter 0.30 inch
Neptune-a second peanut or coffee bean
Pluto- a third pinhead (or smaller, since Pluto is the smallest planet - stick in an index card, otherwise it's hard to see it)

Can use pebbles of the right sizes, however, the advantage of using the objects listed above is that their rough sizes are remembered along with them. It does not matter if the peanut is not exactly .3 inch long.

Having set out the objects with which the model is to be made, the next thing is to ask: **"How much space do we need to make it?"** students may think that the table-top will suffice, or a fraction of it, or merely moving the objects apart a little.

For affect, we have to introduce scale.

This peppercorn is the Earth we live on.

The Earth is eight thousand miles wide! The peppercorn is eight hundredths of an inch wide. What about the Sun? It is eight *hundred* thousand miles wide. The ball representing it is eight inches wide. So, one inch in the model represents a hundred thousand miles in reality.

This means that one-yard (36 inches) represents 3,600,000 miles. Take a pace: this distance across the floor is an enormous space-journey called **"three million six hundred thousand miles."**

Now, what is the distance between the Earth and the Sun? It is 93 million miles. In the model, this will be 26 yards.

This still may not mean much till you get one your students to start at the side of the classroom and take 26 paces. Your student comes up against the opposite wall at about 15 paces!

To fully grasp distance ratios it will be necessary to go outside.

Hand the Sun and the planets to selected students, making sure that each student knows the name of the object he or she is carrying, so as to be able to keep up with their object making up the solar system replica.

You will have found in advance a spot from where you can walk **a thousand yards** in something like a straight line. This may not be easy. Straightness of the course is not critical, and you probably won't be able to see one end of it from the other.

Put the **Sun** ball down, and march away as follows. (After the first few planets, you will want to appoint someone else to do the actual pacing-call this person the "Spacecraft" or "Pacecraft"-so that you are free to talk.)

After 10 paces, call out "**Mercury**, where are you?" and have the Mercury-bearer put down their card and pinhead, weighting them with a pebble if necessary.

After another 9 paces, **Venus** puts down her peppercorn.
After another 7 paces, **Earth** is positioned**.**

Already the thing seems beyond belief. Mercury is supposed to be so close to the Sun that it is merely a scorched rock, and we never see it except in the Sun's glare at dawn or dusk-yet here it is, utterly lost in space! As for the Earth, who can believe that the Sun could warm us if we are that far from it?

The apparent size of the Sun ball, 26 paces away, is now the same as that of the real Sun-half a degree or arc, or half the width of your little finger held at arm's length. (If both the size of an object and its distance has been scaled down by the same factor, then the angle must remain the same.)

After another 14 paces, **Mars** becomes part of the scene.

Students will begin to grasps the vastness of space, after they take another 95 paces to **Jupiter**'s home**.**

Here is the "giant planet"-but it is a chestnut, more than a city block from its nearest neighbor in space!

The space walk continues:

Another 112 paces: **Saturn**
Another 249 paces: **Uranus**
Another 281 paces: **Neptune**
Another 242 paces: **Pluto**

You have marched more than half a mile! (The distance in the model adds up to 1,019 paces. A mile is 1,760 yards.)

Look back toward the Sun ball, it is no longer visible even with binoculars, and to look down at the pinhead Pluto, is to feel the terrifying wonder of space.

That is the outline of the Thousand-Yard Model.

	real	**in model**
Earth's width	8,000 miles	8/100 inch
Sun's width	800,000 miles	8 inches
therefore scale is	100,000 miles	1 inch
So	3,600,000 miles	36 inches or 1 yard
and Sun-Earth distance	93,000,000 miles	26 yards

Follow-up

Having come to the end of the walk, you may turn your class around and retrace your steps. Re-counting the numbers gives a second chance to learn them, and looking for the little objects re-emphasizes how lost they are in space.

It works well, in this sense: everyone pays attention to the last few counts- "240...241...242"-wondering whether Neptune will come into view. But it does not work well if the peanut cannot be found, which is all too likely; so you should, if you plan to do this, place the objects on cards, or set markers beside them (large stones, or flags).

Additional Scale Exercise:

Material(s) List:
144 inch (12 feet) measuring tape
Instructions: Stretch the measuring tape to full length with help of student volunteers.

Explain that if the sun was 144 inches (12 feet), then the planets would be:

Mercury: ½ inch (0.50 inch)
Venus: 1 ¼ inches (1.25 inches)
Earth: 1 ¼ inches (1.32 inches)
Mars: 3/4 inch (0.70 inch)
Jupiter: 14 ¾ inches (14.79 inches)
Saturn: 12 inches (12.05 inches)
Uranus: 4 ¾ (4.86 inches)
Neptune: 4 ¾ (4.70 inches)

Ask the students: Using the inches scale model how many inches apart is our Earth from the Sun?

Answer: Between the Earth and Sun is **936 inches** according to our scale.

Did you know?

The Solar System Has Over 100 Worlds

It is true that there are only eight planets. However, the Solar System is made up of over 100 worlds that are every bit as fascinating. Some of these minor planets and moons are actually larger than the planet Mercury!

The Terrestrial Planets:

- Mercury
- Venus
- Earth
- Mars

The Outer Gas Giants:

- Jupiter
- Saturn
- Uranus
- Neptune

The Dwarf Planets:

- Ceres
- Pluto
- Makemake
- Eris

Did you know?

- The Sun comprises 98 percent of all material in the Solar System.
- The Sun is a medium sized star.
- The Sun was “born” when dust and other space matter came together and ignited.
- The diameter of the Sun is about 864,000 miles, or 1.4 million kilometers.
- We are 93 million miles, or 150 million kilometers, from the Sun.
- It takes 8 minutes for the Sun’s energy to reach the Earth.
- We only get about 1 billionth of the Sun’s total energy.

Some facts about the planets:

- The planets in our Solar System are held in place by the Sun's gravity.
- The planets each have their own orbit duration, depending on their distance from the Sun, so each planet's "year" differs.
- Jupiter is the largest planet in our system.
- Pluto has been reclassified as a dwarf planet.
- The Earth is the only planet in our system that has water. It covers three-quarters of the Earth's surface.
- The planets in the Solar System have a total of 170 moons and more may be discovered.
- Copernicus theorized the planets moved around the Sun (rather than everything revolving around the Earth) about 500 years ago.
- Galileo invented the telescope about 400 years ago, opening a whole new arena of exploration, and proving Copernicus was correct.

Applied/Extended Experience – Building Real World Connections

Remember landing on the moon, or learning about Earth and other planets were only possible because the previous and current leaders decided to pursue those goals. Many of Gustav Holst friends and families probably didn't realize what a visionary they knew. It is part of our human nature to explore and to make new discoveries.

See if you can translate the alien code, alien to most of your parents.

Exercise: Alien space pals
Can you crack the code? You've just intercepted a message between two space pals.
Challenge: Write a 'coded' message to an alien space pal.

Sender	**121?**	One to one
Responder	**F2F?**	Face to Face
Sender	**,!!!!**	Talk to the hand
Responder	**G1**	**Good one**
Sender	**RRR**	Har har har
Responder	**GR8**	Great
Sender	**143**	I love you
Responder	**1432**	I love you too
Sender	**CUL8R**	See you later
Responder	**W8**	Wait
Sender	**L8R**	Later
Responder	**K**	Okay
Sender	**BB4N**	Bye Bye for now

Responder	**CUATU**	See you around the universe

Discussion – Building Connections to Ideas

CHALLENGE: Space day honor it - July 20!

July 20, 1969, the people of the world were brought closer together by the first manned exploration of the Moon.

It is resolved that July 20th be designated as Space Exploration Day, a potential holiday on the order of Flag Day, and July 16 - 24 be designated as the U.S. Space Observance, in commemoration of the nine day Apollo 11 Moon Mission.

GOTO: **http://www.spaceexplorationday.us/** To sign the official petition to declare JULY 20TH as a Space Exploration Day Holiday.

Performance Tasks – Understanding what was learned

The Earth is one of eight planets orbiting the sun varying in size, structure, appearance, and distance from the sun. **Mercury**, **Venus**, **Earth**, and **Mars** are the planets closest to the Sun. They are called the **inner planets** – and are mostly made up of rock. The **outer planets** are **Jupiter**, **Saturn**, **Uranus**, and **Neptune**. Jupiter, Saturn, Uranus, and Neptune are large balls of gases with rings around them. All eight planets travel around the Sun in a different orbit. The universe is so vast, with an unknown boundary yet to be discovered. Dwarf planets, comets and asteroids also orbit the sun. Dust and pieces of ice orbit, too! ***We discover because we seek***. Through exploration, we've discovered new continents, we've found cures to diseases, and we've created a whole new way of communicating through computer technology. This is how we've built our civilization. Science and curiosity is why we need to explore our surroundings.

Science Standards:

A. National Science Education Standard 1 (Analysis, Inquiry, and Design):
S2.1 - make observations and refine explanations
S3.1 Design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research question or hypothesis.
S3.1a organize results, using appropriate graphs, diagrams, data tables, and other models to show relationships
S3.2h use and interpret graphs and data tables
B. National Science Education Standard 4: The Physical Setting
S1.1a Earth's Sun is an average-sized star. The Sun is more than a million times greater in volume than Earth.
S1.1b Other stars are like the Sun but are so far away that they look like points of light. Distances between stars are vast compared to distances within our solar system.
S1.1c The Sun and the planets that revolve around it are the major bodies in the solar system.
Other members include comets, moons, and asteroids. Earth's orbit is nearly circular.

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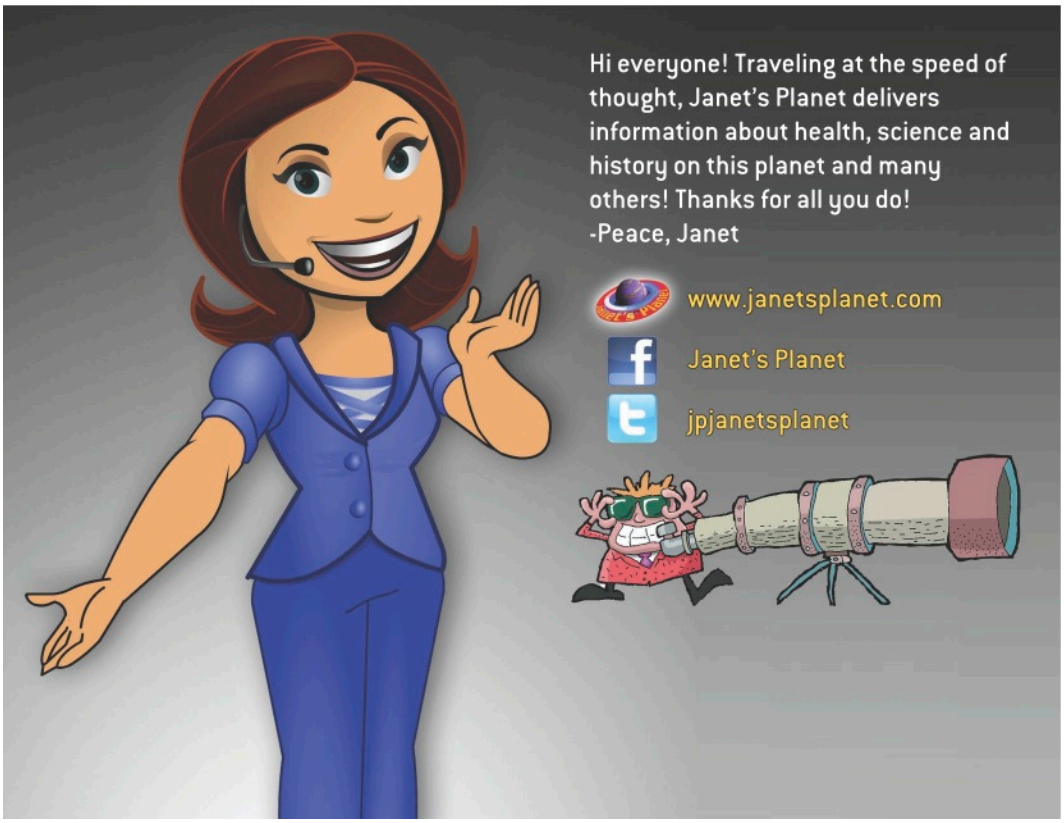
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