ASTRONOMY

LESSON PLAN

Meets the following U.S. National Science Content Standards

Content Standard A: Science as Inquiry
- Column a – Abilities necessary to do scientific inquiry
- Column b – Understandings about scientific inquiry

Content Standard B: Physical Science
- **Column d – Motions and forces (dominant focus of this course)**

Content Standard C: Earth and Space Science
- Column h- Earth in the solar system

Content Standard E: Science and Technology
- Column b – Understanding about science and technology
- Column c – The Outer Solar System

Content Standard G: History and Nature of Science
- Column i- Science as a human endeavor
- Column j – Nature of science

NGSS California State Standards

Grade 5: Earth Sciences

A1-5, B1-2, C1-4, D1-3

The Solar System consists of planets and other bodies that orbit the Sun in predictable paths.

B1, F1-3, G2

Students know the Sun, an average star, is the central and largest body in the Solar System and is composed primarily of hydrogen and helium

B1-2, C1-4, D1-3, I2

Students now the solar system includes the planet Earth, the Moon, The Sun, eight other planets and their satellites, and smaller objects, such as asteroids and comets

C2, B1, I2, G3, E3-4

Students know the path of a planet around the Sun is due to the gravitational attraction between the Sun and the planet

Grade 8: Earth in the Solar System (Earth Science)

4C

Students know how to use the astronomical units and light years as measures of distances between the Sun, stars, and Earth.

4D

Students know that stars are the source of light for all bright objects in outer space and that the Moon and the planets sine by reflected sunlight, not by their own light

4E

Students know the appearance, general composition, relative position and size, and motion of objects in the solar system, including planets, planetary satellites, comets, and asteroids.

OBJECTIVES:

1. Define solar system.
2. Discuss the size of our solar system using the Astronomical Unit (A.U.)
3. Describe our sun: it's composition, power (nuclear fusion), zones, spots, flares, and size of the sun relative to the Earth and our solar system.
4. Define the four planets of the inner solar system, what their composition is like, and how they orbit around the sun.
5. Discuss the asteroid belt, its place in the solar system, and how it works.
6. Define the four planets of outer solar system by taking a close look at Jupiter and how it differs from terrestrial planets.
7. Define a dwarf planet, make observations about Pluto, and then decide whether Pluto is a planet or dwarf planet.
8. Compare the size of Earth's moon relative to its actual size and distance from the Earth.

BACKGROUND:

The little picture of astronomy is bigger than anything we have ever experienced. God has created a vast and magnificent universe that declares the glory of God to everyone on Earth. As we look at the little picture of astronomy—our solar system, we can see the details of God's handiwork. He has created a solar system of order, laws, and beauty that amazes us and demonstrates that God cares even about the little things in life. We will take a look at the actual size of our solar system, the importance of the sun, how gravity works and provides order, and how all of our planets operate according to God's commands.

PROCEDURES:

1. Start outside to define what a solar system is and how we use the astronomical unit (the inch of the universe) to measure the small distances of our solar system.
2. Using three feet to represent the distance between the Earth and the sun (93 million miles), create a scale model of our solar system to put things into perspective.
3. Have your students describe the surfaces of our four terrestrial planets. This will help them see the differences between each other as well as the major differences between Jovian planets.
4. Use the shorter and longer planets on strings to demonstrate that the closer a planet is to the sun the more impact gravity has, which means planets closer to the sun move faster than planets further away from the sun.
5. Study what we know about Jupiter to demonstrate the major differences between terrestrial planets and Jovian planets.
6. Observe Pluto's orbit around the sun to notice initial differences between Pluto and the other 8 planets. Then, describe why Pluto is a dwarf planet.
7. Have the students compare the size of Earth's moon relative to its actual size and distance from the Earth by using Playdough to create an accurate scale.

At the completion of this class the student:

- Should know:
  - The solar system is a very small part of the universe God created.
  - What the sun is like and how nuclear fusion fuels the sun and our own energy.
  - The major role gravity has in keeping order in our solar system.
  - Terrestrial planets are very different from Jovian planets.
  - Why Pluto is a dwarf planet.
- Should be able to:
  - Describe what nuclear fusion is.
  - Describe why Mercury's year is 4 times shorter than Earth's year.
  - Create an accurate model of the moon to the Earth.

ASTRONOMY
TEACHER'S NOTES

Scripture References:
Psalm 19:1- *"The heavens declare the glory of God; the skies proclaim the work of his hands."*

I. Solar System

A. What is a solar system?
   1. The word "solar" represents a **star**. Every solar system has as star at its center.
   2. The word system indicates that there are one or more **planets** that circle/revolve around its star.

B. How big is our solar system?
   1. While the sun is by far the closest star to us, it is still far away at 93 million miles away.
   2. Astronomers use the distance from the sun to the earth (93 million miles) as a distance of measurement called the **Astronomic Unit** or **A**.**U**. This distance is like the inch of the galaxy just like a light year is the mile of the galaxy. A matter of fact, the ratio of inches to miles is almost identical to the ratio of astronomical units to light years.
   3. How long does it take to travel 1 A.U. to the sun?
      i. **176 years** in a car at 60 mph.
      ii. **17.6 years** in a jet at 600 mph.
      iii. **8.3 minutes** on a light ray at the speed of light (186,000 miles a second).

C. Scale model of our solar system
   1. To do this scale model, 1 A.U. equals 3 feet / 1 yard. Begin by asking a student to represent the sun. Walk three feet and ask a student to represent earth. Have the students look up at the sun and tell them that the distance between these two students represents the distance between us and the sun. This will help give them a perspective on the large size of our scale.
   2. Now, finish the scale model of the solar system starting with Mercury all the way to Pluto. Make sure you point out how close the inner planets are when you get to Mars. After you position Pluto, have students take one last visual look before you head inside to the class room.

II. What is our Sun like?

A. Our Sun is at the center of our Solar System.
B. The composition of the Sun is 72% hydrogen, 26% helium, and 2% other gasses.
C. The Sun is powered by nuclear fusion. Deep in the Sun's interior, heat and pressure are so great that hydrogen nuclei fuse together to form helium nuclei.

This reaction releases a large amount of energy that radiates away from the Sun as heat and light. (Starry Night Middle School Curriculum)

1. Have a student read this description from page 10.
2. It is through the process of nuclear fusion where energy is created and released as heat and light that benefits earth so much.

D. The main parts of the Sun are called the Core, Radiative Zone, and Convective Zone.
   1. The Core of the Sun is where nuclear fusion happens as there is so much heat and pressure that the sun literally combines two hydrogen nuclei to form one helium nuclei.
   2. The Radiative Zone is middle layer of the sun. We actually have not "seen" into the Radiative Zone or the Core.
   3. The Convection Zone operates similar to our atmosphere. As the material of the Sun heats up, it rises just like hot air. However, as the hot air rises and gets further way from its source of heat, it starts to cool down and sink back into the earth.

E. Sun spots are "cooler," darkened areas of the sun resulting from the Sun' magnetic field. These spots are created by return of the sun's material from solar flares.
   1. Sun spots are similar to storms in earth's atmosphere. They grow, intensify, and then break up; they can last for months.
   2. Even though they are cooler, Sun spots are still more than $7{,}200^0$ F.
   3. An average Sun spot is about as big as Earth.
   4. Sun spots are a helpful scientific tool. By observing Sun spots, it enables us to see the sun rotate. This allowed us to determine that a "Sun Day" is about 24.5 days.

F. Size of the Sun
   1. The Sun is 110 times wider than the Earth.
   2. One million earths could fit in the Sun.
   3. The Sun is **99.8%** of the mass of our Solar System.

III. What is our inner solar system?

A. Our inner Solar System is composed of 4 planets: Mercury, Venus, Earth, and Mars.

B. Have the students write 2-4 words or short phrases based off your description.
   1. Mercury- Solid, many craters, no oceans
      a. Ask the students why they believe Mercury had so many craters. The answer is that Mercury does not have an atmosphere to burn up meteors; Earth does—which is why we have shooting stars.
   2. Venus- Solid, some craters, no oceans
      a. The picture we saw of Venus is a representation of what we believe the surface looks like. It's sulfuric acid atmosphere is so thick our instruments are not as effective as with other planets.
   3. Earth- Solid, large oceans, vegetation
      a. Earth is the perfect place to live. God has given us everything we need for life, both physically and eternally.
   4. Mars- Solid, no visible liquid water, rust colored soil, polar ice caps

a. Mars atmosphere does not exert enough pressure to allow water to exist in liquid form. On the other hand, Earth's atmosphere exerts about 14.7 pounds of pressure per square inch at sea level which is enough pressure to have liquid water.
b. 96% of Mars' atmosphere is carbon dioxide.
c. First manned mission to Mars by SpaceX will land in 2029. NASA is planning a similar mission in the 2030s.

C. The orbit of our planets is due to gravity from the Sun.
1. The Sun's gravitational force is stronger the closer a planet is to it. As a result, Mercury circles the Sun a lot faster than Neptune which give Mercury a much shorter year than Neptune.
2. 4 Mercury Years is the same time as 1 Earth year. In other words, a 12-year-old on Earth would be 48 on Mercury. This means most humans will live to be 284 Mercury years-old.
3. Mercury travels at 107,082 mph, Venus travels at 78,337 mph, Earth at travels 66,615 mph, and Mars travels at 53.858 mph around the Sun.

D. Use the shorter and longer planets on strings to demonstrate that the closer a planet is to the sun the more impact gravity has, which means planets closer to the sun move faster than planets further away from the sun.

IV. Why is our Solar System Divided?

A. There is an asteroid belt between Mars and Jupiter that separates the inner solar system from the outer solar system just like a belt separates the top half of your body from the lower half.
B. Asteroids can be pulled out of its orbit by larger objects like planets.
1. Astronomers theorize that is how the two satellites of Mars came to orbit the planet.
2. Jupiter protects the inner solar system because its large gravitational pull on the asteroids in the main belt keep them from bombarding the inner planet. Jupiter and the sun sort of play a constant game of tug of war with the asteroids.

C. Asteroids Facts:
1. Asteroids are small, irregular bodies made of mostly rock and metal.
2. Asteroids range in size from hundreds of feet to hundreds of miles.
3. Asteroids orbit the sun just like planets and they do so within 3-6 years.

V. What is our outer solar system?

A. The composition of the planets in the outer solar system are very different from the planets in the inner solar system.
1. The characteristics of planets are related to their distance from the sun.
2. We can imagine what life on Mercury or Mars would look like because they are rock planets like Earth.
3. All of the outer solar system planets are large, gaseous (Jovian), have low density, and have many moons.

B. Jupiter
1. Jupiter is made up mostly of hydrogen and helium.

a. The sun is also made up of mostly hydrogen and helium. Why isn't Jupiter a star then?
b. The answer is that Jupiter does not have enough hydrogen and helium to create the pressure and heat needed to start nuclear fusion and thus become a star.

2. Our understanding of Jupiter is truly skin deep. In other words, we really only know about the outer layer of Jupiter which is about 500 miles thick.
   a. There are storms, high winds, and a lot of movement on the outer layer of Jupiter.
   b. Jupiter has the GRS (Great Red Spot) which has been a super large storm system for hundreds of years.
3. We believe that the further you go into Jupiter the denser material you find.
   a. The second layer is liquid hydrogen and helium
   b. The third layer is liquid metallic hydrogen and helium.
   c. Then you reach the core.
4. Jupiter travels at 29,236 mph, Saturn travels at 21,675 mph, Uranus travels at 15,223 mph, and Neptune travels at 12,146 mph around the Sun.

VI. Is Pluto a planet?

A. The definition of planet has 3 components:
   1. Orbits the sun
   2. Round shape due to gravity
   3. Cleared the neighborhood around its orbit
B. A look at Pluto's orbit shows that it is different from our 8 planets.
   1. Pluto's orbit is not centered around the sun like the other planets, and it orbits inside of Neptune's orbit at one point.
   2. Pluto's orbit is not on a "flat" plane like the rest of the planets, but it has slanted orbit.
C. Take 15 minutes to review the notes with your students.

VII. What! What about moons?

A. Moons, also known as satellites, are large objects that orbit a planet or "minor" planet.
B. 6 of our planets have at least 1 moon; Jupiter has the most at 66 moons.
C. Have you ever wondered how big the earth's moon is compared to the Earth?
   1. Show students a large ball of Play-Doh.
   2. Make five equal balls of Play-Doh.
   3. Take one of those balls and create five more balls of equal size.

Space Exploration

4. https://www.youtube.com/watch?v=hOFRbjjjwCE&t=444s
5. 2018 – James Web Space Telescope launches (significantly stronger than Hubble)
6. 2020 – Construction on Bigelow Aerospace Hotel in space will begin.
7. 2025 – Largest observatory is completed (10x resolution strength of Hubble)