

Topic: - Moon, Planets, Solar System, Space Missions

Grade Level - 5th

Time - 4 - 6 weeks

Objectives

- Write observations of the night sky for a week
- Observe the changes of the moon in the sky
- Create a model of the phases of the moon using a flashlight, and two foam balls (representing earth and the moon)
- Correctly name and order the lunar phases (new, waxing crescent, first quarter, waxing gibbous, full, waning gibbous, third quarter, waning crescent)
- Calculate the approximate length of the lunar cycle using data on moon phases found on the internet
- Summarize key historic theories about the structure of our solar system
- Explain and analyze how new technologies and advancements in space science allow us to continually learn about and expand our thinking about space
- Explore current and past space missions and discuss their contributions to the field of space science and in how we know what is in space
- Explore the solar system using NASA's Eyes technology
- Model the size of and distance between the Earth and the Moon, using spheres and balloons
- Calculate distances between the Moon and the Earth
- model distances between the planets in the solar system
- Research one planet in the solar system, creating a fact sheet for this planet
- Create and alien that could live on a given planet within our solar system

Digital Resources

www.nasa.gov

<https://www.jpl.nasa.gov/edu/teach/activity/modeling-the-earth-moon-system/>

http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html

<https://www.thoughtco.com/cosmos-episode-1-viewing-worksheet-1224445>

<https://exoplanets.nasa.gov/5-ways-to-find-a-planet/>

Sources

F. (Ed.). (2015). FOSS: Earth and Sun Teacher Toolkit, Investigations Guide (1st ed.). Madison, WI: Delta Education.

Modeling the Earth-Moon System Activity | NASA/JPL Edu. (2017, October 17). Retrieved from <https://www.jpl.nasa.gov/edu/teach/activity/modeling-the-earth-moon-system/>

Solar System Scroll Activity | NASA/JPL Edu. (2018, June 15). Retrieved from <https://www.jpl.nasa.gov/edu/teach/activity/solar-system-scroll/>

Standards

Science Practices

1. Developing and using models
2. Planning and carrying out investigations
3. Analyzing and interpreting data
4. Using mathematics and computational thinking
5. Constructing explanations (for science) and designing solutions (for engineering)
6. Obtaining, evaluating, and communicating information

Crosscutting Concepts

Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.

Science Content Standards

ESS1.B

By the end of grade 5. The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily and seasonal changes in the length and direction of shadows; phases of the moon; and different positions of the sun, moon, and stars at different times of the day, month, and year.

Lesson One - Introduction to Viewing the Moon - Begin Night Sky

Observations - **1 class session** - this serves as a jumping off point to the rest of the unit, to get students thinking about space, what we can see in the night sky, and how we can learn about it.

Objectives

- Write observations of the night sky for a week
- Observe the changes of the moon in the sky

Materials

Science Notebooks

Moon Calendar - 1 for class - calendar that can be written on for the whole class to see - use copy attached to blow up into poster size for class

Night Sky Observation Sheet (for each student)

1. Ask students what natural objects they can see in the sky (they will have just completed an investigation about the sun and shadows). Guide them into thinking about night sky objects, specifically the moon, planets, and stars. Show some pictures of objects in space from Hubble, or other noted sources.
2. Discuss with students what they already know about the moon, planets, and stars. Ask them how we could learn more about these objects in the sky, with a focus on the moon (because they will be observing the moon over the next week).
3. If no one suggests it, present the idea of observing the moon, just like they did the sun. Tell them they will observe the moon to see what they can learn about it.
4. Take students outside into schoolyard and have them describe what they can see. Point out the moon in the sky. Students should take note of its shape and its position in the sky. Discuss seeing stars and planets in the night sky.

5. In the classroom, have all students draw a picture of the moon in their science notebook and to describe it. Ask for a volunteer to draw it on the board. Discuss observations.
6. Introduce the moon calendar (the teacher should have started the moon calendar about 3 weeks before the lesson, so students can see the whole lunar cycle on it when the next part of the lesson begins – or assign students 3 weeks out to observe the moon for a given day and to record it on the calendar). Tell students that you have been observing and drawing the moon for a number of weeks and that they will continue to observe and draw the moon for the coming week on the calendar. We want to see how the moon changes over time.
7. Give students a copy of the Night Sky Observation sheet. Students will observe the night sky, record their observations, and draw a picture of the moon each night for a week. This will lead into Lesson 3 in a week.

Lesson Two - How do we know what is in space? What is in space? - About 2 weeks (8 - 10 class sessions)

Objectives

- Summarize key historic theories about the structure of our solar system
- Explain and analyze how new technologies and advancements in space science allow us to continually learn about and expand our thinking about space
- Explore current and past space missions and discuss their contributions to the field of space science and in how we know what is in space
- Explore the solar system using NASA's Eyes technology

Materials

Chart Paper, Markers, SMART Board, Chromebook for each student, Cosmos Episode 1 (on iTunes) with viewing worksheet (See attached)

Part 1 - Astronomy Ideas of the Past - 2/3 class sessions

1. Show students a picture of the Ptolemaic model of the universe, with the Earth at the center. Ask students how this differs from our current knowledge of the universe system. Explain to students that our ideas of the structure of our solar system has changed throughout history, as we are able to observe and learn more about it.
2. Go over with students a brief timeline on how our ideas have shifted. Focus on works of Ptolemy, Copernicus, Brahe, Kepler, Galileo, and Newton. After giving an overview, assign each group of 4/5 students one of the names above. Each group will conduct short research on their assigned person, make a small poster showcasing their ideas, and

present to the class. Provide students the remainder of the class period, and the next to prepare and then present at the end of the second period.

3. After presentations, reinforce the idea that our ideas about space change as we learn more, are able to observe more, and as our technologies evolve.

Part 2 - How do we know what is in space? 4 class sessions

1. Show students the first episode of the new Cosmos television series. Provide students with a study guide/list of questions to guide their watching and to focus their thinking in specific places (<https://www.thoughtco.com/cosmos-episode-1-viewing-worksheet-1224445>). Discuss with students after watching, focusing on the questions they were answering.
2. Ask students, how do we know what is in space? Lead the discussion, making sure to guide students towards telescopes (both on land and in space), satellites and missions to space (both manned and unmanned). Try to draw out all student ideas about what they know about space missions, shuttle missions, and telescopes (students may have prior knowledge due to self-interest). Review with them (using www.nasa.gov) some of the major space missions through the years, giving a brief overview. Also provide students an opportunity to explore <https://exoplanets.nasa.gov/5-ways-to-find-a-planet/> or explore it as a class on the SMART Board, to give them examples of how we use these missions to find new objects in space and expand our thinking.
3. Pair students in the classroom, and ask each pair to choose a space mission (see attached list) to research. Students will research their mission, and construct a short 2-3 slide presentation to share with their classmates about the mission. The goal is get students to think about how we learn about space, by exploring space missions and how they contributed to our knowledge of space.
4. After three days, students will make presentations to their classmates. Review key ideas.

Part 3 - 1-2 class sessions (based on student engagement and interest)

1. This will be a free exploration class for students. Students will be given the opportunity to explore the NASA's Eyes app on their Chromebooks, as well as the NASA.gov website.
2. At the end of the class session, discuss with students interesting ideas they have discovered, what they have learned, what they are interested in, and what they have questions about.

Lesson Three - Moon, Lunar Cycle - 2 class sessions

Objectives

- Create a model of the phases of the moon using a flashlight, and two foam balls (representing earth and the moon)
- Correctly name and order the lunar phases (new, waxing crescent, first quarter, waxing gibbous, full, waning gibbous, third quarter, waning crescent)
- Calculate the approximate length of the lunar cycle using data on moon phases found on the internet

Materials

- 8 - Styrofoam balls (about 12 cm diameter)
- 8 - Styrofoam balls or golf balls (about 3 cm diameter)
- 8 - Meter tapes
- 8 - Flashlights
- Computer for each student
- Copy Paper
- Science Notebooks

Moon Calendar – 1 for class – calendar that can be written on for the whole class to see - use copy attached to blow up into poster size for class

Night Sky Observation Sheet (for each student)

Picture of moon phases (preferably on computer to show on SMART Board) - attached

Markers or Crayons

Part 1

1. A week after the first part of the lesson students should have completed Night Sky Observation sheets and the class should have a complete Moon Calendar (with a full lunar cycle presented). Have a class discussion on student observations with anyone wishing to share their notes.
2. Lead the students into talking about the moon and how it appeared to change during the week. Reference the moon calendar, as well, for a more complete look at how it changes over the course of a month. Ask students if they know why it changes shape, or how. Take any and all answers for why this occurs. Tell students that this is called the moon goes through phases and is caused by the sun, earth, and moon working together.
3. Explain to students that today they will attempt to model the movement of the moon and the moon phases or lunar cycle. They will be given a flashlight to represent the sun, a large foam ball to represent earth and a smaller foam ball (or golf ball) to represent the moon. They will use these objects to figure out a working model for why the moon appears to change shape in the sky.
4. Students will write the focus question in their notebook, “Why does the shape of the moon change in the sky?” While working, students will write observations, questions, and draw their model.
5. Group students into groups of 4, with each group receiving one set of materials. Give final behavior guidelines (on task, working together, etc.) and allow students times to model the lunar cycle. Circulate around the room to provide assistance and guidance, as needed.

Part 2

1. Bring students together after most groups have successfully created a model of the earth/sun/moon relationship causing the moon

- phases. Ask student groups to explain how they built their model. Construct a class model using larger objects to represent the sun/moon/earth with class input on how objects should be arranged.
2. Ask students to explain why the moon changes shape in the sky (using their models as evidence). Allow students time to formulate ideas in small groups then bring them to a group discussion. You want to work out with the students that the moon goes through phases due to the revolution of the moon around the earth and its position in relation to the sun. The moon is illuminated by the sun, with different percentages of the moon visible depending on the position of both the sun and moon. When the sun and moon are on opposite sides of the earth then there is a full moon. When they are on the same side then we have what is called a new moon. Demonstrate this using the model constructed for the class. Discuss and model with students.
 3. Explore the idea of why the moon can be seen during the day. Use the model to show the locations of the sun and moon in relation to the earth for when the moon would be visible during day light hours.
 4. Present the phases of the moon to students, using pictures on the SMARTboard (new, waxing crescent, first quarter, waxing gibbous, full, waning gibbous, last quarter, waning crescent). Begin with new moon then work through until you reach new moon again. Name each phase while showing the pictures. Explain to students that the moon phases always follow the same order, then repeat. Have students write down moon phase names and draw a picture for each in their notebook while presenting them.

Part 3

1. Review the moon phases briefly, and the modeled earth/sun/moon system when students are done writing in their notebooks.
2. Ask students if they know how long it takes for the moon to go through one lunar cycle (from new moon to new moon). Brief discussion using evidence from moon calendar and night sky observation sheets. Have students make predictions for how long they think it takes the moon to go through one cycle, using evidence.

3. Introduce students to moon data websites. Go through information found and how to use and navigate the sites.
 - a. <https://svs.gsfc.nasa.gov/4604>
4. Give students the task of calculating the approximate length of a lunar cycle. They will use the websites to gather data then make an educated hypothesis using this data to present to the class. Students will also find the approximate amount of time (or an average amount of time) the moon is visible on a daily basis. All record keeping and observations will be written in science notebooks.
5. Distribute computers and allow students some time to investigate. Circulate and assist, as needed.
6. After ample time is given, bring students back together to discuss their findings. Ask students to present their ideas, using the data found as their evidence. Clarify, if needed. Students should come to the conclusion that the lunar cycle takes about 28 days (or a month), and that the moon is visible for different amounts of times during the cycle. Relate the word month to the length of the lunar cycle.

Part 4

1. Review the lesson with students. Ask them to explain or demonstrate why the moon changes appearance in the sky. Quickly model the moon/earth/sun system and lunar cycle. Have students name the moon phases (in order) and describe each one. Finally, review the length of the lunar cycle.
2. To assess, students will make lunar cycle posters (in small groups), with each phase on its own poster with a picture. Each group will then need to teach a class of younger students (schedule with teachers) the lunar cycle.

Lesson Four - Distances between Objects in our Solar System, Size of Objects in our Solar System - 3-4 class sessions

Objectives

- Model the size of and distance between the Earth and the Moon, using spheres and balloons
- Calculate distances between the Moon and the Earth
- model distances between the planets in the solar system

Materials

Earth globes, Styrofoam balls, straws, meter tapes, calculators, science notebooks, strips of register tape for each student, markers, pencils, crayons, Chromebooks, balloons, calculators, colored pencils

Part 1 - Modeling the Earth and Moon

1. Bring up the question, and have students write into notebook, **How would you describe the size of and distance between Earth, the Moon, and the Sun?** Discuss ideas.
2. Bring up the idea of making a model to show the difference in size and distance. Discuss why models are important to scientists and then ask students how we can model the Moon and the Earth.
3. Blow up a blue balloon for the class and tell them it represents the Earth. Then blow up a gray balloon and tell them it represents the Moon. Ask students if the Moon should be bigger, smaller, or the same size as the Earth. Then increase or decrease the size of the gray balloon until students are satisfied it meets the correct size, in relation to the Earth balloon. Ask students how they could figure out if the model is correct.
4. Project Moon and Earth data on the board, showing the Earth diameter to be 12,742 km and the Moon diameter being 3,476 km. Ask students to calculate how much bigger the Earth is than the Moon (they may use calculators). Students should find that the Moon is about $\frac{1}{4}$ the size of the Earth. Use this data to guide students in measuring the balloons, first the Earth, then the Moon, and checking to see that the Earth is four times larger. If needed, make adjustments to the Moon balloon to achieve the correct size.
5. Explain to students that now that we have the correct sizes, we need to figure out how far away the Moon must be from the Earth in our model. Move the gray balloon away from the blue balloon until students tell you to stop, showing their thoughts on how far away the Moon should be. Project distance data onto the SMART Board, showing that the Moon is 384,400 km away from the Earth. How can we use this data in our model? Allow students time to discuss in small groups.
6. If students don't come up with a solution, guide them into thinking about the diameter of the Earth and the distance between the Earth and the Moon. Lead them into dividing the actual distance by the

actual diameter of the Earth, to find that the Moon is about 30 Earth diameters away. Use the diameter of the balloon x 30, to figure out how far the Moon should be. Measure out the distance with students to complete the model.

7. Students will now complete this same modeling with new materials, a 12 cm Earth globe and a 3 cm Styrofoam ball to represent the Moon. Students will calculate how far away they should be and complete their new models (about 360 cm distance). Circulate and assist to guide students and assess progress and ability to create a model.
8. When students finish, discuss challenges and results. Introduce the Sun into the model. How big would it need to be and how far away? Discuss. Explain that the Sun would need to be 110 greater in size than the Earth (1320 cm in our model) and would be 12,000 Earth diameters away (1.4 km or about 14 blocks away).
9. Have students answer the question from the beginning in their notebooks.

Part 2 - Modeling distances in the solar system

1. Review the models of the students made of the Earth and Moon, and how they modeled the distance between the two. Ask students where they think the other planets would be in their systems. Discuss.
2. Discuss the idea of modeling the entire solar system, to find out where the other planets are in relation to each other, the Sun, and to Earth. Explain to students that they will model this in two ways in the coming days.
3. Give each student a meter long strip of register tape. Students will use colored pencils for this part of the lesson. Instruct students to write/draw the Sun on one end of the tape and then to write/draw Pluto on the other end. Then have students write/draw each of the other planets onto the strip where they think they should go in relation to each other. Give students a few minutes.
4. When students are finished lead them in marking the correct placement of the planets on the strip. Students should complete this part in marker. Have students fold the paper in half and unfold, and label the crease Uranus. Fold the Sun side into the Uranus mark, unfold and label the crease Saturn. Repeat with the Pluto side, labeling this new crease as Neptune. Fold the Sun side of the strip to the Saturn mark, unfold and label the crease Jupiter. Fold from the Sun to Jupiter and label the new crease the asteroid belt. Repeat again, folding from

the Sun to the asteroid belt, and label it as Mars. Explain to students that the other three planets (Earth, Mercury, Venus) lie in the small space between Mars and the Sun. Have students label their scroll to show which are the guesses and which are the correct placements. Discuss - What surprised them?

5. Allow students time to explore the website *If the Moon were Only 1 Pixel* http://joshworth.com/dev/pixelspace/pixelspace_solarsystem.html, to reinforce the distances between the planets, in preparation for the next activity.
6. Discuss and review.
7. The following day, take students outside. Assign one of them to be the sun and to stand in the center of the yard. Ask students where they think the planets should go in our new model. How far away should they be. Assign each planet to a group of $\frac{3}{4}$ students and have each group walk to the spot where they think their planet should be. Discuss.
8. Bring students back to the sun and have them begin walking out the actual distances (to scale). Mercury - 1 step, Venus - 1.5 steps, Earth - 2 steps, Mars - 3 steps, Jupiter - 10 steps, Saturn - 19 steps, Uranus - 38 steps, Neptune - 60 steps.
9. Once inside, ask students to reflect in their science journal. Include things they learned, found interesting, and questions they may still have. Discuss journal entries.

Culminating Activity/Project - 2 weeks of in class time

Objectives

- Research one planet in the solar system, creating a fact sheet for this planet
- Create an alien that could live on a given planet within our solar system

Materials

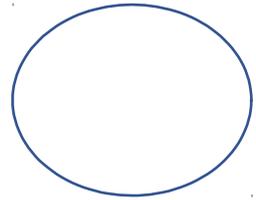
Solar System Passport packet, Chromebooks, Art materials to construct an alien, paper, glue, markers, crayons

1. Students will complete an Alien passport. Students will be assigned one planet to research and then to create an alien that could live on the planet. A sample project is attached.

Night Sky Observations

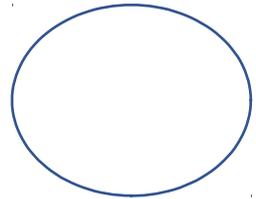
Night 1

What do you see? Draw the moon in the circle.



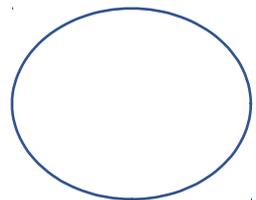
Night 2

What do you see? Draw the moon in the circle.



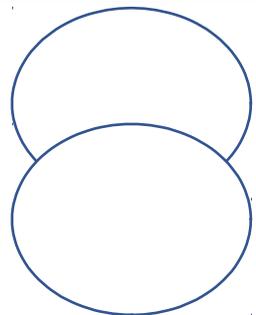
Night 3

What do you see? Draw the moon in the circle.



Night 4

What do you see? Draw the moon in the circle.



Night 5

What do you see? Draw the moon in the circle.

Moon Calendar

Sunday Monday Tuesday Wednesday Thursday Friday
Saturday

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Cosmos Episode 1 Worksheet

Name: _____

Directions: Answer the questions as you watch episode 1 of Cosmos: A Spacetime Odyssey

1. What is the name of Neil deGrasse Tyson's "spaceship"?
2. What is responsible for creating wind and keeping everything in the solar system in its clutches?
3. What lies between Mars and Jupiter?
4. How big is the centuries old hurricane on Jupiter?
5. What had to be invented before we could discover Saturn and Neptune?
6. What is the name of the spacecraft that has traveled the farthest away from Earth?
7. What is the Oort Cloud?
8. How far from the center of the Milky Way Galaxy do we live?
9. What is the "address" of Earth in the cosmos?
10. Why do we not know yet if we live in a "multiverse"?
11. Who wrote the banned book that Giordano Bruno read that gave him the idea that the Universe was infinite?

12. How long was Bruno jailed and tortured?
13. What happened to Bruno after he refused to change his mind about his beliefs of an infinite Universe?
14. Who was able to prove Bruno right 10 years after his death?
15. How many years does one month symbolize on the “cosmic calendar”?
16. What date on the “cosmic calendar” did the Milky Way Galaxy appear?
17. What date on the “cosmic calendar” was our Sun born?
18. What day and time did [human ancestors](#) first evolve on the “cosmic calendar”?
19. What do the last 14 seconds on the “cosmic calendar” represent?
20. How many seconds ago on the “cosmic calendar” did the two halves of the world find each other?
21. How old was Neil deGrasse Tyson when he met Carl Sagan in Ithaca, New York?
22. What is Carl Sagan most famous for?

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