By: Phairleania Brice
Dorothy J Vaughan Academy of Technology

Exploring the Solar System using Fluorescence and Luminescence

This Curriculum Unit is recommended for:
Third Grade

Keywords: Star, Sun, Constellation, planets, Electromagnetic Spectrum, Prism, Observations, Orbit, Spectra

Teaching Standards: See Appendix A for teaching standards

Synopsis: In this Unit, students will explore the moon with the focus on the Earth, as well as the Sun and other stars. This inquiry unit is based on four main essential questions

- "What makes the Moon glow?"
- "Does the Moon's glow change?"
- " How do we study the Moon, Earth and Solar System?"
- "How does Fluorescence help us study the Moon, Earth and other planets?"

Using inquiry-based learning strategies the students will discover and research how the solar system functions and actively operates. Inquiry-based learning is an approach to learning that emphasizes the student's role in the learning process. Rather than the teacher telling students what they need to know, students are encouraged to explore the material, ask questions, and share ideas. Inquiry-based learning uses different approaches to learning, including small-group discussion and guided instruction. Instead of memorizing facts and material, students learn by doing. This allows them to build knowledge through exploration, experience, and discussion. The unit will begin with the students accessing prior knowledge. The class will complete a K-W-L chart. The K-W-L chart will be used by the students throughout the unit to track what they have learned. Students will then begin conducting observations of the moon. The moon is a natural object that students see frequently. Students have also learned about the moon in all of the prior grade levels. Accessing prior knowledge and observing the moon first, promotes relative and relatable instructions. Starting with content that is already a part of students' world facilitates effective learning. When students effectively learn they are engaged and retain more information.

Scholars will observe the moon for three days and answer essential questions. During their observations they will also discover how the moon glows.

Students will explore how fluorescence helps current space exploration and understand how the earth and universe around us are constantly changing. The unit will pose two overall inquiry-based questions that the students will research. The students will be given their research question at the beginning of the unit. The research question will increase engagement and promote increased comprehension of the lesson. Scholars will conduct their research through numerous lessons that lead back to an answer.

I plan to teach this unit to Third grade scholars, this upcoming spring semester.

I give permission to the Charlotte Teacher Institute to publish my Curriculum Unit and Synopsis in print and online.

Exploring the Solar System using Fluorescence and Luminescence

Introduction

I am currently a third grade teacher at Dorothy J Vaughan Academy of Technology in Charlotte, North Carolina. Charlotte, North Carolina is the most populated city in North Carolina. It is also the 15th largest city in the United States. Charlotte is in the Piedmont region, in the county of Mecklenburg. Charlotte- Mecklenburg is the biggest school district within North Carolina. The average household income in Charlotte North Carolina earns over 90,000 per year and the poverty rate of 13%. The estimated population within the city is 885,708. Dorothy J Vaughan is a technology magnet school, that specializes in coding and engineering. Dorothy J Vaughan is a Title 1 School. There are a total of almost 500 students ranging in grade levels K-5. The population is 96.8 % African American and 3% Hispanic. More than 50 percent of the school receives free lunch. There are approximately 577 students ranging from grades Pre-K -5. The school's population includes 93% Minority. Dorothy J Vaughan is a Community Eligibility Provision school, in which all of the students receive free lunch. The students that I will teach the lessons to are third graders. 15 percent of students qualify for Talent Development (TD) services. This is my second school year at Dorothy J Vaughan.

As an Expanded Impact teacher in Charlotte- Mecklenburg school system, I feel as though it is important for all students despite their demographics, culture and class to be exposed to an extensive curriculum. Exposing them to the scientific content will give them necessary background knowledge. Teaching at a low-income school, students may never be exposed to a higher order of thinking. Integrating the North Carolina Standard Course of Study with the Charlotte Teaching Institute topic will allow students to fully understand the content, while also promoting scientific knowledge. Science education usually begins in Kindergarten, however

science inquiry begins as a young toddler. Children are naturally curious about science. However, with science in schools it often only scratches the surface of science.

This unit will give students the opportunity to understand and examine the complex tools used to observe and recognize the characteristics of the solar system. Students will learn that scientists use fluorescence and luminescence tools to observe the planets, sun, and moon. Before students study the Spectroscope they will develop an understanding of the universe around them. The lessons will also examine the solar system and how children are naturally curious about the universe. While beginning with the luminescence of the moon, scholars will engage in collaborative discussion, writing reflections and simple experiments. Despite what some have been taught, the Moon's surface contributes to some of the it's light. The students will observe the moon's natural glow. Understanding that science is always changing will make science relative and prompt continuous learning. Taking their natural curiosity into account will promote engagement and active learning. In this unit, students will explore the many wonders of science. Students will be encouraged to research, and to answer chosen essential questions, based on their observations and discussions. This unit will be enhanced by the detailed lessons, experiments, books, videos and students facilitating their own learning. The goal of this unit is to teach the students how light helps scientists learn more about the world around us.

Content Research

The unit will start with the essential questions created by the district. Essential questions guide students to find deeper meaning, and they set the stage for further questioning. This fosters critical thinking and problem-solving skills, while showing students how to ask the right types of questions to find the answers they need. These questions will promote academic engagement and also curiosity. An essential question frames a unit of study as a problem to be solved. It should connect students' lived experiences and interests (their only resources for learning something new) to disciplinary problems in the world. It should connect what they learn back to the real world, where they can put their new understandings to work. The students will start with the first essential question "What is the Solar System composed of?" This question will prompt students to investigate the planets that are around us. The planetary system we call home is located in an outer spiral arm of the Milky Way galaxy. Our solar system consists of our star, the Sun, and everything bound to it by gravity — the planets Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune, dwarf planets such as Pluto, dozens of moons and millions of asteroids, comets and meteoroids. In the text books Our Solar system consists of 8 planets, the sun and smaller dwarf planets. However, there is far more to learn about within our Milky Way galaxy. The Galaxy is a system of solar systems. Within our Galaxy the Milky Way scientists have discovered many other planets orbiting their star like the sun. Science is constantly evolving, every second of every day. Scientists also use fluorescence and luminescence to discover life and past life within our Solar System and the Milky Way galaxy. However, luminescence and fluorescence are a big part of science and it is closer than what students may think.

In this unit, the moon will be our first observation of luminescence around us. The moon is a very important part of our solar system. Understanding what planets make up our solar system is the first step in understanding the unit. The lessons will begin with the essential question “What is our solar system made up of?” should prompt the inquiry and jump start our unit. In this unit we will discuss the Moon and why it glows. The moon's light comes from the sun. The Moon reflects light from the sun. Sometimes the moon may appear to change shape because the moon orbits the Earth. The sun may light up different parts of the surface.

The unit will build off of prior knowledge of previous grades. In prior grades, students learned about the phases of the Moon and how it illuminates the sky. However, despite what most have been taught the moon reflects the sun’s light however only in small percentages. According to Paleramo (2016), the moon reflects only between 3 and 12 percent of the sunlight that hits it. The perceived brightness of the moon from Earth depends on where the moon is in its orbit around the planet. The moon travels once around Earth every 29.5 days, and during its journey, it's lit from varying angles by the sun. The moon does, in fact, play a part in its glow in the night sky. The moon’s surface often glows with its own luminescence. The luminescence, emission of light by a substance that has not been heated, of the moon is stimulated by the impact of charged particles from Solar flares. Also, the ultraviolet rays from the sun activates the molecules of the moon.

According to Kopal (1965), the surface of the moon is left unprotected by any atmosphere to speak of and is exposed not only to the visible radiation of the sun, ultraviolet, and x radiation, but also to corpuscular radiation. All of these factors contribute to the solar flares in the environment on the lunar surface. Scientists have determined that this process occurs and caused radiation and light to penetrate the Earth's surface. This in terms makes an appreciable contribution to the total light that we can observe from the moon. This is one reason why the brightness of the moon always varies that cannot be attributed to the sun. These changes have led scientists to believe that the Moon’s glow is caused by more than the reflection of the moon.

Analyzing Other Planets

The study of luminescence and fluorescence is all around us. It helps us understand not only the characteristics of Earth but also the characteristics of other planets in relationship to Earth. Scientists use Fluorescence to measure the distance between Earth and other planets. Scientists use a strategy called Fluorescence Spectroscopy. Fluorescence spectroscopy uses a beam of light that excites the electrons in molecules of certain compounds, and causes them to emit light. That light is directed towards a filter and onto a detector for measurement and identification of the molecule or changes in the molecule.

Science is always changing. Lately in science they have been using Fluorescence lights to measure the distance between planets and life on other planets. Recently, Astronomers have been looking at the glow of exoplanets to understand if the planet is habitable. Over ten years ago,

astronomers detected gas glowing like a fluorescent bulb in the atmosphere of a planet orbiting a distant star. Researchers have had glimpses of the atmospheres of so-called exoplanets before, but never in this way. The fluorescent signature of HD 189733b, a Jupiter-size planet in the faint constellation of Vulpecula, could help astronomers explore exoplanets in more detail – including ways that help them in the search for life elsewhere in the galaxy. This year two space shuttles have left earth to explore the galaxy. Accurately learning about how scientists learn about the other planets will be pivotal in the higher levels of thinking.

Students will learn about fluorescence and luminescence with something observable such as the moon and them moving on to other space objects. There are several spacecraft that are exploring the galaxy for life. While this is very extensive work, that many people devote their life too it can be simplified by one-word glow. Scientists are looking for planets that glow to detect any living organisms or an environment that could be habitable. The astronomers used emission characteristics of common coral fluorescent pigments from Earth to create model spectra and colors for planets orbiting active M stars to mimic the strength of the signal and whether it could be detected for life. Scientists are looking for other planets that project similar Fluorescent colors as to earth. This lets them know that the possible planet could be inhabitable and have life. Students will explore the 8 planets within our solar system, but they will also explore other exoplanets within the Galaxy. While discovering exoplanets, astronomers look for planets that have several gases in their atmospheres.

According to Spots (2010), the discovery of fluorescence from methane in the atmosphere was a complete surprise," says Swain, an astronomer at NASA's Jet Propulsion Laboratory in Pasadena, California. In fact, the methane signature in the planet's fluorescence was stronger than the one gathered by Hubble and Spitzer. Methane itself is of keen interest. Methane on Earth comes from geologic and atmospheric processes. It also comes from biological sources – from bacteria and termites and dairy cows. Thus, if methane is found in unexpectedly large concentrations in the atmosphere of an Earth-like planet at the right distance from its host star, it could suggest that the planet harbors life. Moreover, fluorescing molecules can help scientists probe an exoplanet's magnetic field, which could help determine if a planet would even be hospitable to life. Strong magnetic fields can serve as a barrier against cosmic radiation. Fluorescing molecules can help scientists probe an exoplanet's magnetic field, which could help determine if a planet would even be hospitable to life. Strong magnetic fields can serve as a barrier against cosmic radiation.

In this unit students will explore the basic third grade standards about the Moon, characteristics of Earth, and other planets around us. Students will learn that fluorescence does not just make things glow, but it also is the beautiful colors that help us learn and understand the world. Fluorescence is the visible or invisible light emitted by some animals in the ocean as a result of absorbing light energy. By analyzing the fluorescent colors of the planets, scientists understand what the atmosphere is made of and if people could live there. Science is always

evolving, it is very important that scholars learn more than what is inside of their science books. This unit is designed for students to explore how fluorescence

Instruction Implementation

Teaching Strategies: Inquiry Based learning, turn and talk, collaboration, anchor charts, Writing about science

Videos: In order to increase instructional growth and engagement, videos help promote collaborative conversations among scholars. Videos provide information that the student may not receive through text books and reading.

Anchor Charts: The anchor chart will support instruction and move students towards facts. The anchor chart will aid in the understanding of vocabulary. The anchor chart will stay up as a tool to help students remember past lessons. The anchor charts can also be used to take notes and also allow students to refer back information using pictures and graphic organizers.

Inquiry groups: The groups will allow students to collaborate with their peers on a common goal. In these groups the students will answer essential questions of the lessons, and analyze information read through the text.

Text: Using text and read alouds students will learn and be entertained while also promoting a deeper understanding of fluorescence, luminescence, the moon and other planets. This will expand an understanding of complex vocabulary, as well as improve comprehension.

- *Glow in the dark stars, moon and clouds* by Eugene Bradley
- *The Moon* by Melanie Chrismer
- *The Planet*s by Gail Gibbons
- *First Big Book* of space By
- *Everything space* By National Geographic
- *Space Exploration for Kid*s by Bruce Betts

Rubrics: The rubrics will give coherent expectations and criteria. This will give students a clear description of required assignments. This will make it easy for students to reflect and meet the criteria. The rubric will give students an opportunity to explore a broader answer instead of the usual multiple choice.

Assessment: The assessment will take place after student discussion. The students will discuss what they have learned as a result of the research question. Students will complete a research planner assessment to show what the students have learned. Students will be asked what they know about the galaxy and our solar system.

Lessons/ Activities
Day one:
Objective: Students will access prior knowledge about the solar system and outer space. The student's I can statements are:

- I can ask and answer questions about the solar system using an anchor chart
- I can write a short paragraph about a specific topic.

Connection: In prior grades you have learned about the solar system and outer space. Do you remember learning about the phases of the moon? What else do you remember learning in second grade about the solar system and outer space?

Teacher Input: Ask the students to activate prior knowledge and continue being curious. Today I want you to think about what you know, and what you want to know about planets, Earth, Moon, and sun. We are going to take that information and complete a K-W-L chart. Students will be asked to complete a KWL anchor chart. What the students know, want to know, and what they want to learn about outer space. This will connect past lessons as well as increase curiosity on upcoming lessons. Give students different color stickies for each section. Each student will receive three stickies. Ask students to come up and share one sticky and place them all on the anchor chart. Now we only have one more category on our anchor chart. What we have learned. Explain to the students that you will leave the stickies by the anchor chart for them to complete when they have learned something new. Once the students have completed their stickies begin to read the book *The Planets* by Gail Gibbons.

Guided Practice: While reading *The Planets* define the academic vocabulary. Cold call different students to help you define the vocabulary. The academic vocabulary in the text is planets, orbit, meteors, solar storms, solar flares

Independent Practice: Students use academic vocabulary from the text and write three sentences about what they learned from the text today

Closure: Students share their sentences with their assigned turn and talk partner.

Lesson 2:

Objective: In this lesson students will begin their inquiry based instruction. Students will be asked the essential questions and given time to think about what they are going to learn in this unit. The students I can statements will be:

- I can observe the world around us to learn about the solar system

- I can write about my observations using complete sentences
- I can ask and answer questions about a specific topic

Connections: Yesterday we read a book, started our unit anchor chart called *The Planets*. Every day in science we are going to learn a little more about the world around us. Direct the student's attention to the essential questions on the Science Focus Wall. Ask students to choral read the essential questions and I can" statements together.

Teacher Input: In this science unit we will discuss the large and vast outer space. We will learn about the Moon, Earth, and planets. It is very important that you understand that science is always changing, and is all around us. There are scientists somewhere that could be discovering something new, that we could not even imagine in our wildest dreams. Recap some of the things that students want to learn about in this unit. Ask the students to turn and talk with their partner about what they notice in the sky at night. Students will share some of their discussions. Today we are going to focus on the beautiful moon. Did anyone discuss the moon with their turn and talk partner? Allow the students time to share with the class. Teacher will read the book *The Moon.* Ask students to turn and talk with their partner about the things they learned from the book. Tonight we are going to" notice" some of the things we learned about in the book., by observing the Moon. Give the students examples of places they can observe the moon. Remind the students of the science vocabulary word observation. Remember observe means to closely look at an object. Take out the science observation sheet. Model to the students how to complete the observation sheet.

Guided Practice: Turn the lights out in the class, and project a picture of the last recent moon on the screen. Model your thinking using" I notice" and "I wonder" sentence starters. While modeling how to complete the observation, ask the students what they predict that they will see tonight. Students complete the prediction side of the Observation sheet in class

Independent Practice: Students will make observations about the moon by drawing a detailed picture and writing a short paragraph.

Closure: students will share their observations with the class.

Lesson 3

Objective: In this lesson students will begin their inquiry-based instruction. Students will be asked the essential questions and given time to think about what they are going to learn in this unit. The students I can statements will be:

- I can observe the world around us to learn about the solar system
- I can write about my observations using complete sentences
- I can ask and answer questions about a specific topic

Connections: Yesterday I gave everyone an assignment. Today we are going to discuss our observations and learn a little more about what we observed.

Teacher input: We are going to work in collaborative groups today. In your groups you will discuss observations and share your assignments. Model a successful collaborative circle. A collaborative circle is a strategy that encourages students to have discussions with classmates about a topic. During a collaborative circle each student takes their turn to discuss what they notice and wonder. Scholars engage in discussion with sentence starters. Remind the students that they will receive feedback from the students in their group about their assignment. After students have completed their groups, ask the students what the group noticed as a whole about their observations. One student from each group will share what the group noticed. After all groups are complete ask the question "Why do you think the moon glows?" Show the students the video "*Nasa solved the mystery of the moon's glow".* Discuss how in our books it says that the reason the moon glows is because of the sun's rays behind it. However, scientists are still studying the absorption of the moon's surface. Fluorescence means **the** light given off by certain substances when it absorbs light or other electromagnetic radiation. Refer the students to the vocabulary wall. Scientists are still studying the surface of the moon. Right now they only have studied 9 percent of the Moon's surface. Refer to the Moon anchor chart to review the current findings. The fluorescent surface increases the Moon's glow. Teachers will use an anchor chart to help aid in the understanding of complex vocabulary.

Guided Practice: Students will discuss what they notice about the small painting experiment. Teacher will prompt students to use I notice and I wonder statements. Students turn and talk about what they learned from the video and the mini lesson. Model the daily activity. Remind the students that if they have learned something new to use the K-W-L anchor chart. Show the students the material for today. Ask the students why do they think we are painting the moon's surface with glow paint.

Independent Practice: Students will all receive a Moon sheet. Students will paint the Moon with glow paint. The glow paint will be a symbol of the moon's surface. Students will write a short paragraph about the Moon's surface

Closure: Students will share their moon surface sheets and paragraphs with their collaborative groups. Students will reflect about the daily activity and what they learned from the lesson.

Lesson 4:

Objective: In this lesson students will begin their inquiry-based instruction. Students will be asked the essential questions and given time to think about what they are going to learn in this unit. The students I can statements will be:

- I can observe the world around us to learn about the solar system
- I can write about my observations using complete sentences
- I can ask and answer questions about a specific topic

Materials: Empty paper towel roll

- Craft knife and/or scissors
- Blank or old CD
- Pencil
- Small piece of cardboard or cardstock
- Tape
- Paint (optional)

Connection: In previous lessons we have been learning about the Moon. The Moon's shape and glow changes every night. Let's read about how we know so much about the moon and the solar system. Teacher reads *Moonshot: The flight of Apollo 11* by Brian Floca

Teacher Input: Last night we all made observations about the moon. Ask the students prompting questions. What did we notice? Were there any differences with the moon last night and our previous observations? Do you think the moon's glow was the same? Earlier we read about Apollo 11. What did we learn from the book? How does the book connect with our lunar observations? We read about Apollo 11, however Apollo 15 and 16 are the spacecraft that studied the Moon's surface. Apollo 16 had three missions; one of those missions was to inspect the surface of the Moon. When X-ray waves from the Sun strike the lunar surface, they can cause some elements to emit additional X-rays, a process known as fluorescence. The elements that emit the X-rays can be identified based on the energy of the X-rays that are emitted. The abundance of these elements can be determined from the intensity of the emitted x-rays (the greater the intensity of the X-rays, the greater the abundance of the element). The X-ray fluorescence spectrometer measured the abundances of the elements magnesium, aluminum, and silicon. In all, about 9% of the Moon's surface was studied by this experiment. A spectrometer is a very important tool when studying the Solar system, and outer space. Today we are going to experiment with a spectrometer. A spectrometer shows the colors of the rainbow. Ask the

students what colors the Spectrometer shows. Scientists use those colors of light and how they hit objects to make observations. Today we are going to make a spectroscope, which is very similar to a spectrometer.

Guided Practice: Model to the students how to decorate their paper towel roll. You will only have 10 minutes to decorate your roll, so please work quickly. Instruct the students to not place any decorations over the slit. It may change your observations, it's very important. Model how to trace one end of your paper towel roll onto your small scrap of cardboard or cardstock. Cut it out. Cut a straight slit right across the center of your cardboard circle. Tape the circle to the top of your spectroscope. Model putting a CD inside of the slit. Ask the students what they think we are going to do with our spectroscope. We are going outside to make observations.

Figure 1.1 Diagram of Spectroscope

Independent Practice: Students will create their own spectroscope. Students will make observations on the colors they see and their positions in their observation journal.

Closure: Students will reflect on their observations with their collaborative groups. Students will use what they learned today to answer one of the essential questions of their choice.

Lesson 5

Objective: I can identify how scientists study the Moon, Earth and planets. In this lesson students will understand how scientists use different tools to study the Solar System.

Connection: Show students *The Planets* video. Ask the students one of the essential questions: How do scientists study the Moon, Earth and the Solar System? Students will use the previous lessons to expand their understanding.

Teacher Input: Ask the student to Use the anchor chart to help them count the planets. These are the planets in our solar system. That means that these eight planets orbit around our large star which is the sun. Review the segment of the planets video with the planets orbiting around the Sun. How do you think scientists observe the planets in our solar system? Using tools like the spectrometer helps scientists study the moon, Earth, and other planets. NASA scientists often use a technique called "remote sensing" to study the composition of different elements and structures on planets. Remote sensing refers to making measurements without directly touching the object being measured. Show the two pictures from NASA. These images are one kind of remote-sensing measurement. But what we can see with the naked eye only tells us part of the story. When NASA looks out into the solar system and beyond, they use remote sensing to see things far beyond what we can see with our naked eye. For example, using remote sensing scientists able to detect the jets of water on Saturn's moon. Remote-sensing tools see the same colors as the spectrometer. The remote sensing sees Red, Orange, Yellow, Green, Indigo, and Violet light. Scientists look at the different colors to study the different planets. Each planet shows different colors because the atmosphere is different. Yesterday we made a spectroscope, we are going to use a spectroscope again today.

Guided Practice: Yesterday when we made a spectroscope what colors did we notice? Promote active conversations. Ask students to look back at observation notes. What do we notice about the colors we observed yesterday? Discuss with the students the different types of spectra light. Show students the Spectra light anchor chart. Show scholars the spectra of different elements. Explain the different elements to the students. Helium is the gas that is inside of a balloon, Oxygen is the gas that we breathe, and Hydrogen is a gas that can be found in Water.

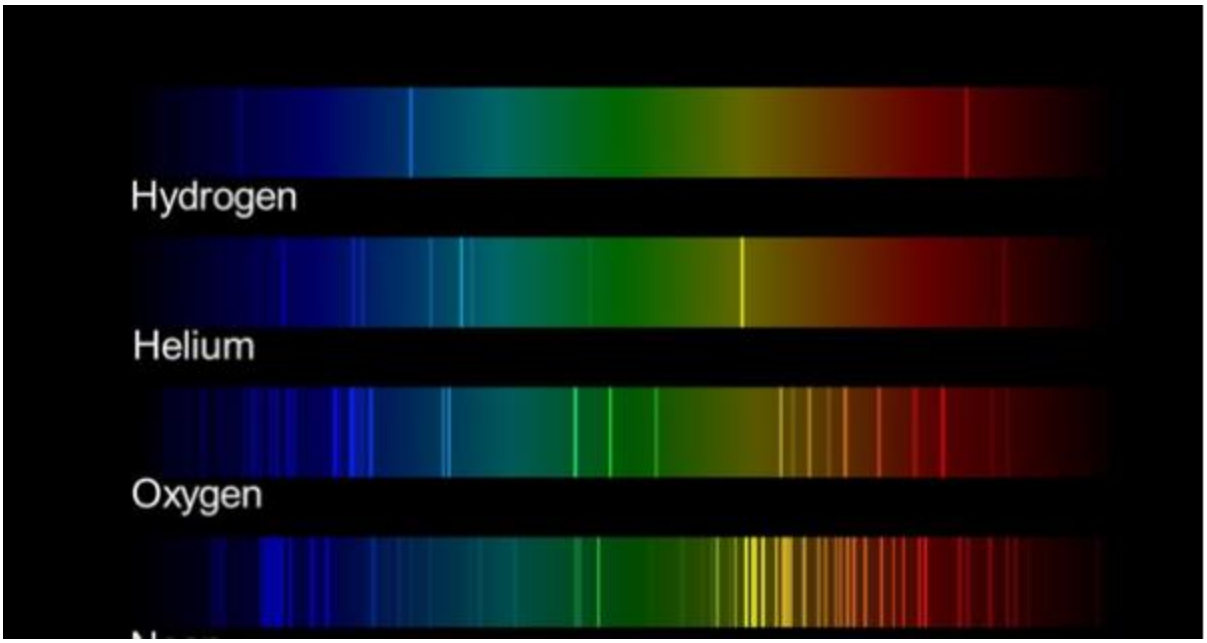


Figure 1.2 Examples of the spectra of various elements.

Independent Practice: Have students fill out their worksheet, drawing in their absorption spectra and predicted emission spectra. Encourage students to capture line resolution by indicating whether the lines are broad or thin, blurry or clear.

Closure: Students will reflect on their observations with their collaborative groups. Students will use what they learned today to answer one of the essential questions of their choice.

Lesson 6

Objective: I can answer the essential questions using the information that I have learned in this unit.

Connection: Ask students to get a sticky and to complete our K-W-L chart that we started in a previous lesson. If students cannot remember something that they learned, ask them to refer back to their observation journal and anchor charts.

Teacher Input: Today we are going to look at our observations that we conducted this week to answer all of the essential questions on our science focus wall. There are four essential questions on our focus wall. We have been doing research all week. Today we are going to put all the things that we learned together to create a scientific research report using the essential questions.

Guided Practice: Ask the students to choral read the essential questions. Model how to answer the essential questions using our observation journal, anchor charts and other projects. Review the rubric for the presentation. Ask students to turn and talk about the research expectations.

Closure: Students will read their research report to the class.

Assessment:

Informal: Throughout the curriculum unit the students will be creating projects, and writing scientific observations. All of these things will be counted as an informal grade

Formal: Students will have a rubric for their research presentation and report. The rubric (Appendix C) will give them guidance and list the expectations of the assignment. Each part of the rubric has the criteria to master the objective.

Teacher Resources

Dunbar, B. (2017, May 15). *Apollo 16*. NASA. https://www.nasa.gov/mission_pages/apollo/missions/apollo16.html. Accessed November 16, 2020

This website gives a detailed description of the previous Apollo missions. It will allow the teacher to give a narrative about space exploration. It also gives information about previous Apollo missions.

Gary, S. (2010, October 6). How do astronomers use light to study stars and planets? ABC (Australian Broadcasting Corporation). https://www.abc.net.au/science/articles/2010/10/07/3012690.htm.Accessed November 16, 2020

This article explains how spectroscopy is used to find other planets.It also explains how the spectroscopy determines how far the object is from Earth. It also measures the amount of different elements on the planets.

Nakaya, R. (2019, October 30). *How to Find a Living Planet*. The Kid Should See This. https://thekidshouldseethis.com/post/how-to-find-a-living-planet-nasa-goddard-science. Accessed November 16, 2020

This website has a video that shows how scientists use fluorescence to find other exoplanets. It shows that there are more planets than the nine in our solar system. It describes the Kepler mission, and the Goldilocks zone. The Goldilocks Zone is where they find a lot of Exoplanets.

NASA.*STEMLessonsforEducators–NASAJetPropulsionLaboratory*.NASA.https://www.jpl.nasa.gov/edu/teach/. Accessed November 16, 2020

This website gives teachers different enhancements to lesson plans such as videos, experiments, activities, and programs for children.

Woodfarf, C. (2020, April 27). Luminescence, fluorescence, and phosphorescence. Explain that Stuff. https://www.explainthatstuff.com/luminescence.html.

This website gives a detailed definition of Luminescence, fluorescence and phosphorescence. It shows relative objects in the world to help simplify the definition.

ZHU, J. X. A CD Spectrometer https://www.cs.cmu.edu/~zhuxj/astro/html/spectrometer.html.

This website depicts the spectra of different light sources. It will give the students more examples of the different colors that may appear in a spectroscope or spectrometer.

Student Resources

Kiddle For Kids, https://kids.kiddle.co/Spectrometer

This is a search engine for kids that explains the spectrometer in kid friendly terms. This can be used to help students conduct their research.

Kiddle For Kids, https://kids.kiddle.co/Spectrocopy

This is a search engine for kids that explains spectroscopy and how it is used in kid friendly terms.

Meet the Exoplanets, https://www.youtube.com/watch?v=yDoWWaCG7LA

This video explains what exoplanets are in a song. It shows students different exoplanets and how they are similar to each other.

Appendix A: Teaching Standards

3.E.1.1 Recognize that the earth is part of the solar system that includes the sun (a star), a planet, and many moons and earth is the third planet from the sun in our solar system.

3.E.1.2 Recognize that changes in the length and direction of an object's shadow indicate the apparent changing position of the Sun during the day although the patterns of the stars in the sky, to include the Sun, stay the same.

RI.3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answer

RI.3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

RI.3.7 Use information gained from illustrations and the words in a text to demonstrate understanding of the text.

RI.3.10 By the end of grade 3, read and understand informational texts at the high end of the 2-3 text complexity band proficiently and independently for sustained periods of time. Connect prior knowledge and experiences to text.

RF.3.4 Know and apply grade-level phonics and word analysis skills in decoding words.

W.3.2 Write informative/ explanatory texts to examine a topic and convey ideas and information clearly

a. Organize information and ideas around a topic to plan and prepare to write. b. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension. c. Develop the topic with facts, definitions, and details.

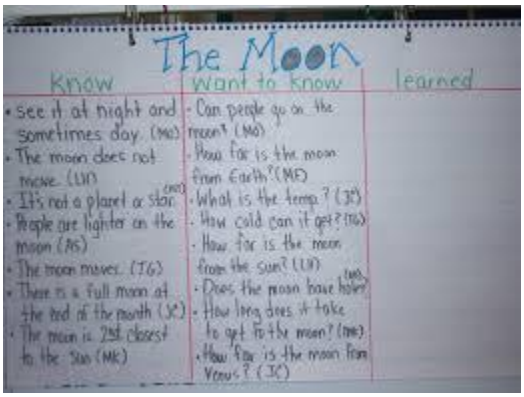
c. Develop the topic with facts, definitions, and details.

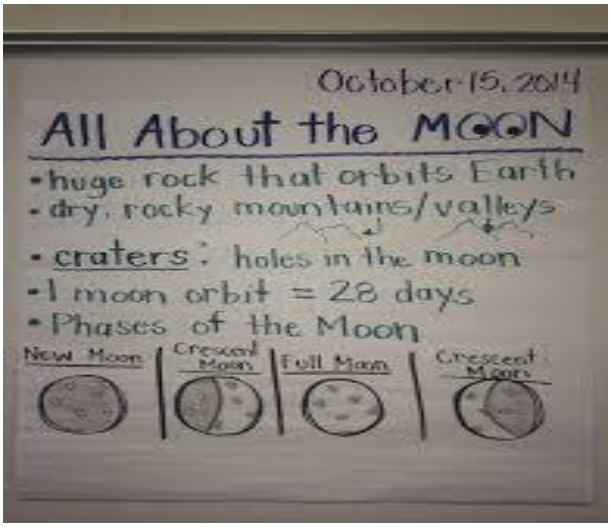
f. With guidance and support from peers and adults, develop and strengthen writing as needed by revising and editing, with consideration to task and purpose

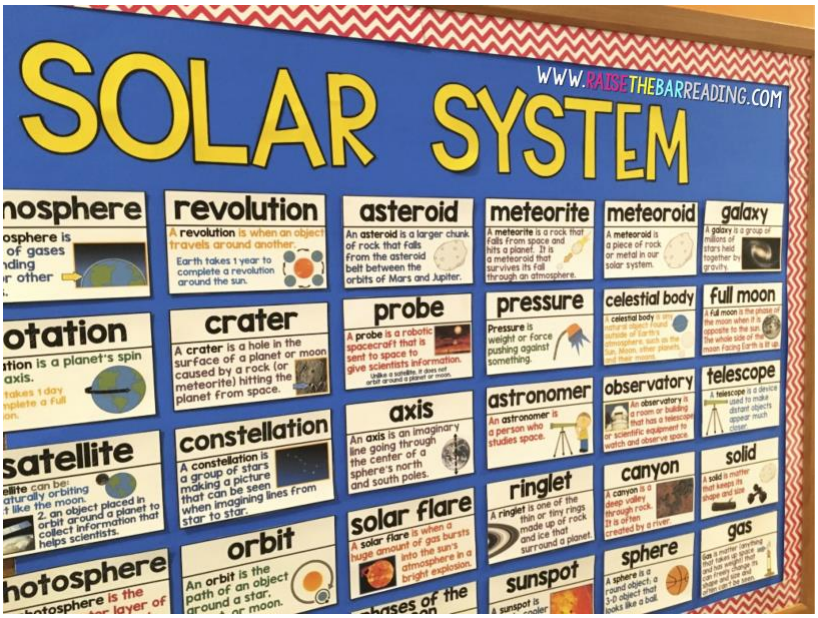
W.3.5 Conduct short research projects that build knowledge about a topic.

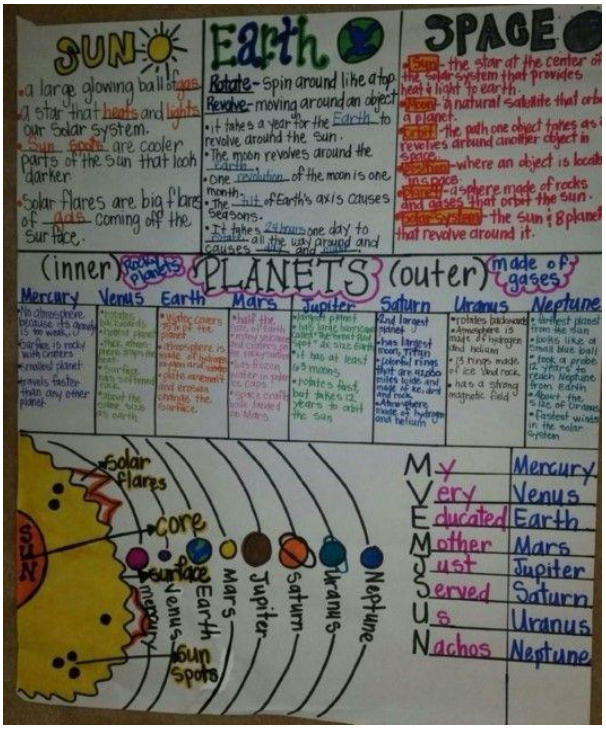
W.3.6 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Appendix B: Anchor Charts Examples









Appendix C: Rubric

Oral Presentation Rubric

	1	2	3	4
Quality of Presentation	Our presentation was not well organized and there were many incomplete details.	Our presentation was organized, but there were some details that were incomplete.	Our presentation was well organized and everything was completed in some detail.	Our presentation was very well organized and everything was complete in great detail.
Voice Inflections	Our voice inflections were not well-rehearsed, and you could not hear the passion in our voices.	Our voice inflections were not well-rehearsed, but you could hear the passion in our voices.	Our voice inflections were well-rehearsed, but you couldn't hear the passion in our voices.	Our voice inflections were well-rehearsed and you could hear the passion in our voices.
Eye Contact	We looked at our notes most of the time and never looked at the audience.	We looked at our notes some of the time, and made some eye contact.	We looked at our notes some of the time, but mostly made eye contact.	We looked at the audience most of the time and rarely looked at our notes.
Prepared	It was not apparent that our team practiced before presenting the one-pager.	It was somewhat apparent that our team practiced before presenting the one-pager.	It was mostly apparent that our team practiced before presenting the one-pager.	It was very apparent that our team practiced before presenting the one-pager.

Name: **Subject:** **Date:** **Score** ____

Writing Process Rubric

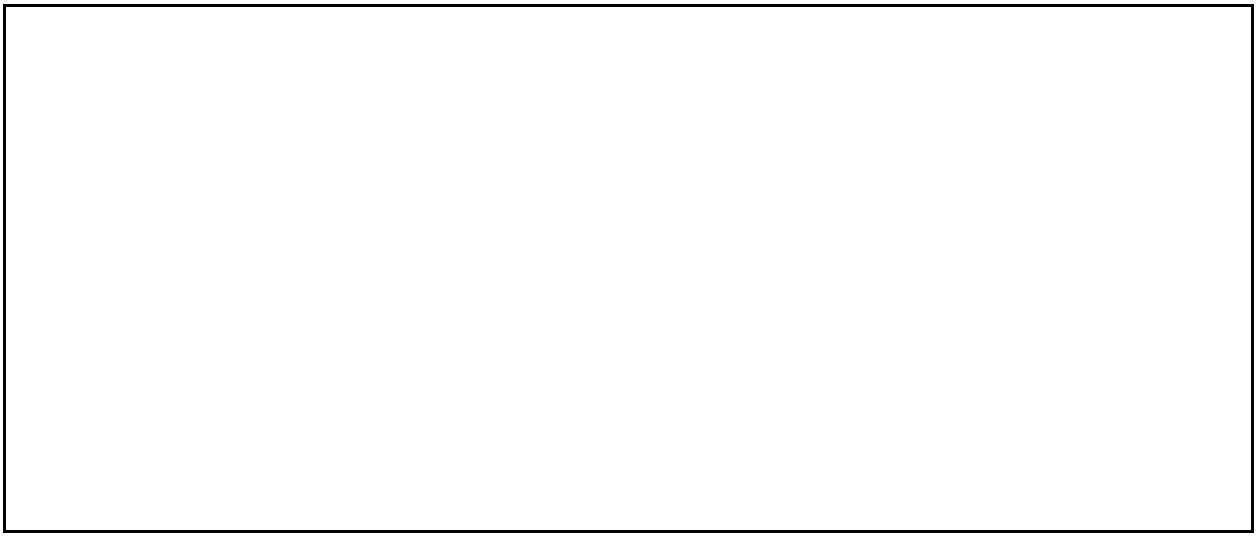
Score ____ /20

Scores: ⟶	1-5: **Below Basic**	6-10: **Basic**	11-15: **Proficient**	16-20: **Goal**
Steps	1	2	3	4
Planning/ Brainstorming	No or limited key words/ideas were recorded and organized on paper/organizer to support this piece of writing.	Few key words/ideas were recorded and organized on paper/organizer but lacked parts to support this piece of writing.	Numerous key words/ideas were recorded and organized on paper/organizer to support this piece of writing.	Detailed ideas were listed and highly organized on paper/organizer to support this piece of writing.
First Draft/ Rough Copy	No or limited key words/ideas were used from planning stage. No or weak organization and structure in first draft.	Few key words/ideas were used from planning stage. Beginning to show organization and structure in first draft.	Numerous key words/ideas were used from planning stage. Most of first draft is organized and structured.	All key words/ideas were used from planning stage. Additional ideas were used too. First draft is highly organized and structured.
Revise	No or limited key words/ideas were added, deleted, and/or rearranged in first draft. Details aren't specific and clear.	Few key words/ideas were added, deleted, and/or rearranged in first draft. Details are beginning to be specific and clear.	Adequate key words/ideas were added, deleted, and/or rearranged in first draft. Most details are specific and clear.	Numerous key words/ideas were added, deleted, and/or rearranged in first draft. Details are specific and clear.
Edit	☐ No or little attention to sentence structure. ☐ No or little attention to spelling. ☐ No or little attention to punctuation. ☐ No or little attention to capitalization.	☐ Some attention to sentence structure. ☐ Some attention to spelling. ☐ Some attention to punctuation. ☐ Some attention to capitalization.	☐ Adequate attention to sentence structure. ☐ Adequate attention to spelling. ☐ Adequate attention to punctuation. ☐ Adequate attention to capitalization.	☐ Full attention to sentence structure. ☐ Full attention to spelling. ☐ Full attention to punctuation. ☐ Full attention to capitalization.
Final Copy/ Publish	The final copy wasn't written correctly in best handwriting or typed correctly on a computer. Sentence fluency is poor.	Parts of the final copy were written correctly in best handwriting or typed correctly on a computer. Sentence fluency is strong in some parts.	Most of the final copy was written correctly in best handwriting or typed correctly on a computer. Sentence fluency is strong in most parts.	The final copy was written correctly in best handwriting or typed correctly on a computer. Sentence fluency is strong throughout.

Which step(s) does student need to work on? _____

Appendix D: Observation Worksheet

Observation Sheet Date:



_____
_____
_____
_____
_____
_____
_____

Appendix E: Spectra Emission worksheet

Name:_____ Date:_____

Complete the following Spectra emission.

Source 1:

R	O	Y	G	B	I	V

Source 2:

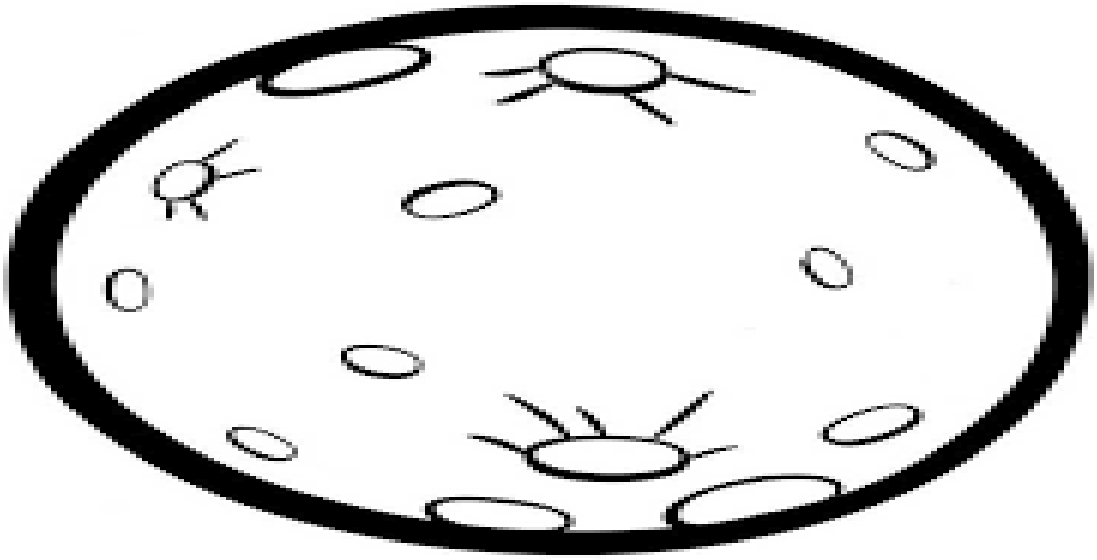
R	O	Y	G	B	I	V

Explain what you observed using the Spectrometer.

Appendix F:

Name: _____

Date:_____



Bibliography

"Educator Guide: Using Light to Study Planets." NASA. NASA, January 14, 2020. https://www.jpl.nasa.gov/edu/teach/activity/using-light-to-study-planets/.

"Educator Guide: Using Light to Study Planets." NASA. NASA, January 14, 2020. https://www.jpl.nasa.gov/edu/teach/activity/using-light-to-study-planets/.

"Fluorescent Glow May Reveal Hidden Life in the Cosmos." Cornell University College of Arts and Sciences Cornell Arts & Sciences, August 13, 2019. https://as.cornell.edu/news/fluorescent-glow-may-reveal-hidden-life-cosmos.

Gary, Stuart. "How Do Astronomers Use Light to Study Stars and Planets?" ABC (Australian Broadcasting Corporation), October 6, 2010. https://www.abc.net.au/science/articles/2010/10/07/3012690.htm.

Kopal, Zdeněk. "Luminescence of the Lunar Surface." SpringerLink. Springer, Dordrecht, January 1, 1966. https://link.springer.com/chapter/10.1007/978-94-011-7545-6_22.

Nakaya, Rion. "How to Find a Living Planet." The Kid Should See This, October 30, 2019. https://thekidshouldseethis.com/post/how-to-find-a-living-planet-nasa-goddard-science.

"STEM Lessons for Educators – NASA Jet Propulsion Laboratory." NASA. NASA. Accessed October 19, 2020. https://www.jpl.nasa.gov/edu/teach/activity/using-light-to-study-planets/ Luminescence.

Steigerwald, B. (2016, December 14). *Solar Storms Could Spark Lunar Soil*. NASA. https://www.nasa.gov/feature/goddard/2017/solar-storms-charge-lunar-soil.