**Saturday Science– Fall 2015**

**Space | Grades 5-8**

**Lesson Plan 1: Planets & Galaxies**

1. **LEARNING OBJECTIVES AND CRITERIA**
   1. Students will understand that our solar system includes the sun, moon and seven other planets.
      1. This objective will be met in the beginning of the lesson, we the class reviews our solar system using the virtual tour.
   2. Students will understand that our solar system is extremely large and the distances between planets spans huge distances.
      1. This objective will be met during the scale model activity, where the students will create a scale model of the solar system outside.
   3. Students will understand what is needed in order for a planet to be habitable.
      1. This objective will be met during the student presentation about what makes Earth habitable, as well as the habitable planet activity where the students will be making a society that can survive on different types of planets.
2. **STANDARDS**
   1. **Content Standards**
      1. **Standard 2: Earth Science |** Observe, describe and ask questions about patterns in the sun-moon-earth system.
         1. **5.2.1 |** Recognize that our earth is part of the solar system in which the sun, an average star, is the central and largest body. Observe that our solar system includes the sun, moon, seven other planets and their moons, and many other smaller objects like asteroids and comets.
      2. **Standard 2: Earth and Space Science |** Understand the relationships between celestial bodies and the force that keeps them in regular and predictable motion.
         1. **6.2.4 |** With regard to their size, composition, distance from sun, surface features and ability to support life, compare and contrast the planets of the solar system with one another and with asteroids and comets.
   2. **Process Standards**
      1. **Nature of Science |** Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.
         1. Incorporate variables that can be changed, measured or controlled.
         2. Use the principles of accuracy and precision when making measurements.
         3. Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns. make inferences based on these patterns.
         4. Compare the results of an experiment with the prediction.
      2. **Design |** As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.
         1. Identify a need or problem to be solved.
         2. Brainstorm potential solutions.
         3. Select the most appropriate materials to develop a solution that will meet the need.
         4. Create the solution through a prototype.
         5. Test and evaluate how well the solution meets the goal.
3. **MATERIALS**
   1. Measuring Tape
   2. Meter Stick
   3. 15-25 Calculators
   4. Different Sized/Weighted Balls *(Marbles, Bouncy Balls, Styrofoam Balls, Tennis Balls)*
   5. Paper and pencils
   6. Cocoa and Flour
   7. Bins
   8. Garbage Bags
   9. In The Room:
      1. Computer
      2. Projector
   10. Supplies to Build a Society
       1. Tongue Dispensers
       2. Pipe Cleaners
       3. Construction paper
       4. Glue
       5. Scissors
       6. Cups
       7. Aluminum Foil
       8. Tins
   11. Supplies to Test Society
       1. Fan
       2. Spray Water Bottle
4. **TEACHER CONTENT KNOWLEDGE**
   1. The teacher needs to have a basic understanding of the planets in our solar system such as the order of the planets and basic characteristics of each. In order to effectively do the ENGAGE section, the teacher needs to know how to work the virtual solar system tour website and be comfortable using it in front of the class.
   2. The teacher needs to know the current event about Pluto that will be discussed. It would be wise for the teacher to brush up on any other relevant information about Pluto that may be brought up; for example, whether or not Pluto is considered a planet.
   3. In order for the Solar System Scale Activity to run smoothly the teacher needs to know how to do all the math involved in finding the relative distances of the planets and how to use those measurements to reconstruct the solar system. This will help the teacher address any problems with the math that may arise or the actual construction of the solar system.
   4. In order for the simulations of the natural disasters to run smoothly the teacher needs to know what exactly the disasters do and how they are formed. It would also be wise for the teacher to do a trial run of the disasters that will be performed during class to make sure any problems are fixed and no surprises happen.
5. **REFERENCES**
   1. Classroom Rules Poster
   2. Virtual Solar System Tour: [*http://nineplanets.org/tour/*](http://nineplanets.org/tour/)
   3. Current Event: [*http://magazines.scholastic.com/news/2015/07/Pluto-s-First-Close-Up*](http://magazines.scholastic.com/news/2015/07/Pluto-s-First-Close-Up)
      1. Video: [*https://www.youtube.com/watch?v=OR1TsDfuf5M*](https://www.youtube.com/watch?v=OR1TsDfuf5M)
   4. Solar System Scale Activity: *AIMS Textbook pg. 115 “Spacing Out the System”*
   5. Simulations
      1. Impact Crater: [*https://www.nsta.org/sciencematters/docs/Shippensburg-Cratering.pdf*](https://www.nsta.org/sciencematters/docs/Shippensburg-Cratering.pdf)
         1. Video: [*https://www.youtube.com/watch?t=125&v=bU1QPtOZQZU*](https://www.youtube.com/watch?t=125&v=bU1QPtOZQZU)
      2. Wind and Water
         1. Video: [*https://www.youtube.com/watch?v=GRst061YTVU*](https://www.youtube.com/watch?v=GRst061YTVU)
   6. Index Cards of features of planets for Habitable Planet Activity
6. **DESCRIPTION OF YOUR LESSON**

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| **ENGAGE:**   * The teachers will do a quick refresher on our solar system by taking the students on a virtual tour of the planets *(*[*http://nineplanets.org/tour/*](http://nineplanets.org/tour/)*)*. The teachers will make sure to ask the students to talk about the different characteristics of each planet. * During this virtual tour the teachers can bring up Pluto, show a short video ([*https://www.youtube.com/watch?v=OR1TsDfuf5M*](https://www.youtube.com/watch?v=OR1TsDfuf5M)), discuss why it is not considered a planet (its orbital path, size, etc.) and have students bring up current events about Pluto. *(*[*http://magazines.scholastic.com/news/2015/07/Pluto-s-First-Close-Up*](http://magazines.scholastic.com/news/2015/07/Pluto-s-First-Close-Up)*).*   + Open up the floor to the students if they want to share about any other current events they have heard of and want to discuss they may. We will also pass around a sign-up sheet for students to pick a day to present their own information on current events they researched at home. We can start with this every Saturday before beginning our main lesson. |
| **EXPLORE:**   * In order for the students to get a better understanding of scale, the students will be assigned a planet and given the task of recreating the solar system. The students will complete this activity outside using the measurements they have come up with and work together to create a visual scale model of our solar system. Their bodies will represent the planet they are assigned, and they will spread out according to how far away they have calculated they are from the Sun in this scale model. To get their measurements, they will be provided with information such as how far away their planet actually is from the Sun so that they will be able to make a ratio to find out how far they are away from the Sun in their scale model.   + Due to the fact that the students assigned to the Sun and the Earth have very little calculations, these students will find out what makes Earth special in regards to being able to sustain life (being a habitable planet). These students will write down their observations and present them to the class, which will help lead into the next activity *(See Explain Phase)*. * Once that activity has finished, the teachers will start the crater activity.   + Have students hypothesize what things affect the appearance of impact craters on planets. (Speed, weight, size, etc.) Students will also discuss in their table groups what natural disasters can happen on planets that might affect the possibility of human life. We will then come together to collaborate what they have discussed in their table groups.   + Watch two short videos involving craters: [*https://www.youtube.com/watch?t=125&v=bU1QPtOZQZU*](https://www.youtube.com/watch?t=125&v=bU1QPtOZQZU)   and wind and water disasters: [*https://www.youtube.com/watch?v=GRst061YTVU*](https://www.youtube.com/watch?v=GRst061YTVU)   * + Next explain the crater activity before handing them the materials. Remind them to be cautious that flour can easily make a big mess so we all need to be mindful of that while having fun. (Teachers will pour the flour into the containers and put the cocoa on top before the lesson). During the first part of the activity, table groups will hold each different type of ball at arm’s length and drop it into the flour- one item at a time. They should be able to see clearly how big the impact crater is due to the cocoa at the top. This will help the students compare the sizes of the impact craters for each different object. After they observe and discuss the differences in their groups they will be able to go do the big drop! Explain that they need to be careful while dropping the balls that they do not hit anyone. Half of the group will be on floor 2 dropping the balls, and half on floor 1 helping them aim and placing the flour container. |
| **EXPLAIN:**   * The students who are in the Sun and Earth group for the scale model activity will be determining the characteristics of Earth that make it a habitable place to live. These students will gather their findings and present them to the class, which will lead into a class discussion about what makes a planet habitable. Students will explain their findings, listen critically to one another and ask questions. * Once the crater activity has been completed, the students will come together as a class and share out their findings. The students will compare the different sizes of the impacts for each of the different object, and discuss why they thought certain objects made the impact that they did. |
| **ELABORATION:**   * To elaborate on what they have learned through the crater activity and the videos, the students will be making their own habitable planets. They will pull a random index card from the teacher that includes random things that their planet has on it naturally- such as water, volcanoes, foot, etc. The students will need to think of how they can add things that they do not have on their planet so that they can live. If there is no water, how will they get water? What if there is no Oxygen? They will be provided materials so that they can build their society on their planet. When they are done, their society will be put to the test by meteors, wind storms, and a huge rain storm! |

1. **EMBEDDED FORMATIVE ASSESSMENT (the 5th “E”)**
   1. Because this is not a formal classroom, we do not want to formally assess the students, but we be informally assessing the students. The main idea of this lesson is for the students to create a society that can live on a planet given certain conditions, based on how well their society survives disasters and if it contains everything that is needed in order to survive is how we will be assessing the students. We will also be informally assessing the students based on the classroom discussion that will be implemented throughout the lesson.
2. **GEARING UP/GEARING DOWN**
   1. **Gearing up:** If one student or group excels and finishes an activity early, they can help others- especially with the math equations. If they want to, they could also figure out their weight on all of the different planets. If the whole class flies through all of the activities faster than expected and we have a lot of time at the end, we could fill that time with discussions about what we will be doing the rest of the days and also watch some of the Bill Nye Space video that we have saved for times like these.
   2. **Gearing down:** If students are having trouble with their math equations, they can get help from another group or student if they like. The teachers will also know how to do the equations so they can ask guiding questions to help the students. Guiding questions can help all students in any of the activities for the day.

**Space | Grades 5-8**

**Lesson Plan 2: Telescopes**

1. LEARNING OBJECTIVES
   1. Students will learn the basic functions of NASA telescopes and how astronomers use them.
   2. Students will learn about various space missions that took place, as well as what they have taught us.
   3. Students will understand all the precautions and testing that needs to take place before sending something into space.
      1. This objective will be met while the students are making their lunar landers, making sure the egg does not break.
2. STANDARDS
   1. ***Content*** 
      1. **Standard 2: Earth Science |** Observe, describe and ask questions about patterns in the sun-moon-earth system.
         1. **5.2.1 :** Recognize that our earth is part of the solar system in which the sun, an average star, is the central and largest body. Observe that our solar system includes the sun, moon, seven other planets and their moons, and many other smaller objects like asteroids and comets.
      2. **Standard 2: Earth and Space Science:** Understand the relationships between celestial bodies and the force that keeps them in regular and predictable motion.
         1. **6.2.2** Recognize that gravity is a force that keeps celestial bodies in regular and predictable motion, holds objects to earth’s surface and is responsible for tides.
   2. ***Process***
      1. **Nature of Science:**  Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.
         1. Make predictions and formulate testable questions
         2. Incorporate variables that can be changed, measured or controlled.
         3. Use the principles of accuracy and precision when making measurements.
         4. Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns. Make inferences based on these patterns.
         5. Compare the results of an experiment with the prediction.
      2. **Design**: As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.
         1. Identify a need or problem to be solved.
         2. Brainstorm potential solutions.
         3. Select a solution to the need or problem.
         4. Select the most appropriate materials to develop a solution that will meet the need.
         5. Create the solution through a prototype.
         6. Test and evaluate how well the solution meets the goal.
         7. Communicate how to improve the solution.
3. MATERIALS
   1. 24 pairs of scissors
   2. Pencils
   3. Scrap paper
   4. 22 rulers
   5. A dozen eggs
   6. Scrap poster board (target)
   7. Miscellaneous materials for building the lunar lander
      1. Foil containers
      2. Foil
      3. Wax paper
      4. Pipe cleaners
      5. Popsicle sticks
      6. Scotch tape
      7. Duct tape
      8. Plastic containers/tupperware
      9. Plastic and Styrofoam cups
      10. Balloons
      11. Cardboard
      12. Poster board
      13. String
      14. Cloth
      15. Cotton balls
      16. Glue
      17. Straws
      18. Paper or plastic plates
      19. Rubber bands
4. TEACHER CONTENT KNOWLEDGE

Teachers should know that astronauts find things out about space through a variety of ways, including sending technology into space to record information, sending a shuttle into space with astronauts who collect data, using telescopes to make observations, and researching both on earth and in space at the international space station space station.

Teachers should know of some space missions and launches. For example, Kepler Space Mission, Mars pathfinder, Genesis, and 2 upcoming launches to the space station. The Kepler space mission’s main goal is to find other habitable planets. The Kepler mission is run by the Kepler space telescope, an observatory. Currently, NASA is investigating a star that they might be home to an alien megastructure. The Mars Pathfinder mission was a mission to see what things were necessary to be able to successfully get a lander on Mars as well as a rover. This mission was a success, they not only were able to land both things, but they were able to collect a vast amount of data from the rover.

1. REFERENCES
   1. Videos:
      1. <http://www.sciencekids.co.nz/videos/space/keplermission.html>
         1. <http://www.space.com/30849-bizarre-kepler-signal-alien-intelligence-speculation.html>
      2. <http://www.sciencekids.co.nz/videos/space/moonlanding.html>
      3. <http://www.nasa.gov/mission_pages/kepler/overview/>
2. DESCRIPTION OF YOUR LESSON

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| **ENGAGE:**   * At the beginning of the lesson, students will be presenting their current events that they signed up for last week. This is an opportunity for students to share something about space that they are passionate or knowledgeable on.   + After the current event is shared, other students in the class can share any additional facts or comments about the event.   + If no student brings a current event, the teachers can share a current event with the class (<http://www.livescience.com/52490-has-kepler-discovered-alien-megastructure.html>) ([http://www.livescience.com/52532-alien-life-search-kepler-megastructure.htm](http://www.livescience.com/52532-alien-life-search-kepler-megastructure.html)) * Pose the question to students: ***How are astronauts able to find things out about space?*** If students do not list a telescope as an answer, then ask the students if they think that telescopes could be an answer. Students will watch a video about the Hubble telescope to give them background knowledge about telescopes and to spark their interest for the field trip to the IU observatory next class period.   + Have students collaborate with a partner about the video that they watched. They will generate questions that we will take to on the field trip to ask. * Students will watch a video about the Kepler space mission (<http://www.sciencekids.co.nz/videos/space/keplermission.html>) and a video of a moon landing (<http://www.sciencekids.co.nz/videos/space/moonlanding.html>). * Once the students watch the video, they will discuss the importance of space missions and technology.   + The teacher should ask students:     - Why is it important for us to have space technology?     - What factors from space might influence the design or materials of space technology?     - What things have astronauts been able to find during missions and why is this information important?       * By asking informal questions, the teacher can answer any information that students did not know and can dig deeper into the students responses for meaning. |
| **EXPLORE:**   * Students will make a lunar lander that will be able to protect an egg, which represents a human, during a landing on a new planet. This planet is much like Earth in regards to gravitational pull. The lander will need to be able to land safely even with the gravitational pull pulling the lander towards the core. The lunar lander prototype will be an accurate model of how the landing would look on the new planet. Along with protecting the egg from breaking, students will also have to try to make their lunar lander land on a target.   + Students will be given a wide range of materials to choose from for building. They will be given the opportunity to test these materials out and make modifications to their lander. Students will have to decide between materials based upon their durability, weight and protectiveness.   + Teachers should walk around to each group while they are building and ask them questions about their process. Some questions include:     - Why did you choose these materials?     - Why did you choose to design \_\_\_\_\_\_ this way?     - After you saw how your lander did during the trial, what are you planning to modify? |
| **EXPLAIN:**   * The whole class will gather to watch everyone land their lunar landers. The students will be required to give a brief explanation of the process that they went through to build their product. By having students explain how they built their model, they will be able to understand the process of modifying and trial and error. In the student's explanation they should include:   + What materials did you use?   + Did these change from your initial plan?   + What challenges did you encounter when you were building your lander? |
| **ELABORATION:**   * After the students return from the egg drop landing, the teachers will travel to each group to discuss with them about the results of their egg drop. Teachers should ask students:   + Did your creation land as expected?   + What would you change about your lander now knowing how it landed with the egg in it?   + Do you think your lander would have been better if there were other materials? If so, what materials? * This part of the lesson requires students to apply what they learned about their design when they dropped their landers and think about what modifications they would make to have better results. |

1. EMBEDDED FORMATIVE ASSESSMENT (the 5th “E”) During each of the 4Es above, the teacher(s) will be asking questions to students as a whole group, small groups and individually to gain knowledge of student understanding.

After watching the video about the Hubble space telescope, the students are formulating questions to take to the observatory with them. The teacher will be able to assess what things the students know and do not know about telescopes. This will influence content for next week. While students are designing their landers, teachers will be asking informal questions about their design process to gain insights into students thinking. The teacher will be able to ask questions which require students to make sense of their ideas. Similarly, in the last part of our lesson, students will be giving a short presentation explaining the process that they went through to make their lunar lander and why they chose to make it the way that they did. This too will require students to make sense of their process and their ideas. In the last portion of the lesson, students will have to reflect on their results and formulate a “next step” to making their prototype.

1. GEARING UP/GEARING DOWN
   1. **Gearing up:**

To make this lesson more challenging for students, the teacher might choose to add on a variety of instructional challenges during the engineering of their lunar lander. The students would be asked to make their lunar lander move on the ground after they land it. Then the students would be asked to write a short explanation of why they think that space technology is necessary for space advances.

* 1. **Gearing down:**

Since this lesson is very open-ended and does not contain any instructions, the teacher might choose to print a couple of copies of directions or suggestions for building. This would help guide students who needed the extra support, but still offer the challenge of creating it without any directions to students who feel like they do not need instructions.

**Space | Grades 5-8**

**Lesson Plan 3: Field Trip**

1. **LEARNING OBJECTIVES AND CRITERIA**
   1. Students will understand the importance of telescopes and how they work.
      1. Through the tour given by Bill, the students will learn about the importance of telescopes and how they work. We will assess the students understanding through the questions asked on the walk back to the school of education.
   2. Students will understand what infrared cameras are and what they are used for.
      1. Through the tour given by Bill, the students will learn about what infrared cameras are and what they are used for. We will assess the students understanding through the questions asked on the walk back to the school of education.
   3. Students will understand what meteorites are and why they are relevant to Earth.
      1. Through the tour given by Bill, the students will learn about meteorites and why they are relevant to our Earth. We will assess the students understanding through the questions asked on the walk back to the school of education.
   4. Students will see real science in action.
      1. Through the tour at the Observatory, students will see science in action and how we study space.
2. **STANDARDS**
   1. **Content Standards**
      1. **Standard 2: Earth Science |** Observe, describe and ask questions about patterns in the sun-moon-earth system.
         1. **5.2.1 |** Recognize that our earth is part of the solar system in which the sun, an average star, is the central and largest body. Observe that our solar system includes the sun, moon, seven other planets and their moons, and many other smaller objects like asteroids and comets.
      2. **Standard 2: Earth and Space Science |** Understand the relationships between celestial bodies and the force that keeps them in regular and predictable motion.
         1. **6.2.4 |** With regard to their size, composition, distance from sun, surface features and ability to support life, compare and contrast the planets of the solar system with one another and with asteroids and comets.
   2. **Process Standards**
      1. **Nature of Science |** Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.
         1. Incorporate variables that can be changed, measured or controlled.
         2. Use the principles of accuracy and precision when making measurements.
         3. Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns and make inferences based on these patterns.
      2. **Design |** As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.
         1. Identify a need or problem to be solved.
         2. Brainstorm potential solutions.
         3. Select the most appropriate materials to develop a solution that will meet the need.
3. **MATERIALS**
   1. 30 Starting Wordsearch *(Attached at the end)*
   2. 30 Pencils
4. **TEACHER CONTENT KNOWLEDGE**
   1. Telescopes
      1. This field trip is a trip to an Observatory where they are well known for their solar telescope. The teacher should have a basic understanding of what telescopes are and how they work.
         1. What is a telescope?
            1. A telescope is a space tool that is used to look at objects that may be far away for us to see with our bare eye.
         2. How do telescopes work?
            1. There are two different types of telescopes: refracting and reflecting.

Refracting Telescopes: These types of telescopes use two convex lenses to bend light to help us see objects closer than they appear.

Reflecting Telescopes: These types of telescopes use concave mirrors to reflect light to help us see objects closer than they appear. These types of telescopes have to be so large that a person can sit in the middle of it!

* + - 1. What are telescopes used for?
         1. Telescopes are used to help us see things that are extremely far away up close; mainly to observe stars and other planets.
      2. Why are telescopes important?
         1. Telescopes are important because they help us learn about the space that surrounds our Earth. Telescopes help us to make space advancements which could potentially improve our quality of life.
    1. At the beginning of the lesson there will be a video about the Hubble Space Telescope, to prepare for any possible questions that may arise the teacher should have a basic understanding of what the Hubble Space Telescope is.
       1. The Hubble Space Telescope was sent out into orbit in 1990. Due to this telescope being in space, it is able to view and take pictures of other planets without the background light of the Earth distorting the pictures.
          1. FUN FACT: “The successor to the Hubble Telescope is the James Webb Space Telescope. It is planned to be launched in 2018.” (Ducksters.com)
  1. Infrared cameras
     1. Infrared cameras are made to help detect infrared energy, in other words heat, and takes that energy and converts it into electronic signals to produce a thermal image. This technology is extremely precise and can detect the different degrees of heat.
  2. Meteorites
     1. At the observatory Bill will be talking mostly about the meteorites, but it is helpful for the teacher to have knowledge on the topic as well. Meteorites are pieces of dust, rock, and other debris from space. When these collide with the Earth’s orbit, we see a meteor or a shooting star. When a meteor is a bright color, these are called fireballs. If a meteoroid hits the Earth, which is rare, it creates an impact crater. The largest impact crater is in Arizona.
  3. Observatory-Kelsey
     1. The Observatory has been open since the 1900’s. The main focus of the observatory was researching comets, meteors, and asteroids in the 19th century. One major attraction at the observatory is their solar telescope. They also have a 12 inch refracting telescope. These devices help with the research that is conducted.

1. **REFERENCES**
   1. Beginning Wordsearch: <http://www.sciencekids.co.nz/quizzes/wordsearch/space.html>
   2. Beginning Youtube Video: <https://www.youtube.com/watch?v=fJmADQkhUeo> (NASA)
   3. Teacher Content Knowledge Resources:
      1. Telescopes:
         1. Ducksters | Physics for Kids: Telescopes
            1. <http://www.ducksters.com/science/physics/telescopes.php>
         2. Department of Physics at the University of Illinois at Urbana-Champaign | The Ask Van
            1. <https://van.physics.illinois.edu/qa/listing.php?id=2078>
      2. Infrared Cameras:
         1. FLIR | Instruments
            1. <http://www.flir.com/thermography/americas/us/view/?id=55706>
      3. Meteorites:
         1. The Meteorite Exchange
            1. <http://www.meteorite.com>
      4. Observatory:
         1. Indiana University Department of Astronomy | Kirkwood Observatory
            1. <http://www.astro.indiana.edu/docs/kirkwood_brochure.pdf>
2. **DESCRIPTION OF YOUR LESSON**

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| **ENGAGE:**   * At the beginning of the lesson, before we leave for the observatory, students will work on their word search as they enter the classroom. The worksheet will have different vocabulary words that will be used throughout the field trip at the observatory.   + The video, Hubble: Window to the Universe (<https://www.youtube.com/watch?v=fJmADQkhUeo>), will be playing as they work on their wordsearch. * On the walk to the Observatory the lead and supporting teachers will group up with some students and ask them questions about what they expect to see at the Observatory, and ask them to think of any questions they may want to know. Some examples of student questions are:   + How long did it take back then to build the Hubble Telescope?   + What did they see through the Hubble Telescope?   + What is “dark matter”?   + How many galaxies are there?   + Why are galaxies moving away?   + How many black holes have been found?   + How many people worked on the Hubble Telescope?   + When was the Hubble finished?   + How was the Hubble brought up to space? |
| **EXPLORE:**   * The tour of the Observatory that Bill will show the students. The tour will include an introduction to the solar telescope (weather permitting), the infrared camera, and the 12 inch refracting telescope. |
| **EXPLAIN:**   * Bill will explain the purpose and use of the solar telescope, infrared camera, and the 12 inch refracting telescope; Bill will go into details for each, keeping the students’ prior questions in mind (that were emailed in advance to Bill). |
| **ELABORATION:**   * At the Observatory, there will be a question and answer session with Bill and the students. |

1. **EMBEDDED FORMATIVE ASSESSMENT (the 5th “E”)**
   1. The lead and supporting teachers will group up with some students and ask them questions to observe how much was comprehended from the field trip and asked on the walk back from the observatory; these questions include:
      1. How do we study space?
      2. What is a meteorite?
      3. How do we get the name “fireball?”
      4. What is an infrared camera?
      5. What surprised you about the telescope at the Observatory?
      6. What was your favorite part?
      7. Was this your first time at the Observatory?
2. **GEARING UP/GEARING DOWN**
   1. **Gearing Up/Gearing Down:** If the questions on the walk back to the Ed School are too easy, we will have the students get with a partner and discuss their experience at the Observatory and what they learned. This is both gearing up and gearing down because the students will be in control of their conversations, so they can adapt the content to their level.

**Space | Grades 5-8**

**Lesson Plan 4:** Expansion of the universe, black holes, space matter and what happens to your body in space

1. **LEARNING OBJECTIVES AND CRITERIA**
   1. Students will understand and be knowledgeable about black holes, eagle nebula, living in space, types of stars, and galaxies.
      1. Through a balloon activity and iPad activities students will research on the given links to learn what black holes are and why they are important in space.
   2. Students will use research to understand different space ideas.
      1. Through formulating a research question, students will conduct a mini research project and then present their findings to the class.
2. **STANDARDS**
   1. **Process**
      1. **Nature of Science:**  Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.
         1. Make predictions and formulate testable questions
         2. Incorporate variables that can be changed, measured or controlled.
         3. Use the principles of accuracy and precision when making measurements.
         4. Analyze data, using appropriate mathematical manipulation as required, and use it to identify patterns. Make inferences based on these patterns.
         5. Compare the results of an experiment with the prediction.
      2. **Design**: As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.
         1. Identify a need or problem to be solved.
         2. Brainstorm potential solutions.
         3. Select a solution to the need or problem.
         4. Select the most appropriate materials to develop a solution that will meet the need.
         5. Create the solution through a prototype.
         6. Test and evaluate how well the solution meets the goal.
         7. Communicate how to improve the solution.
   2. **Content Standards**
      1. (Unfortunately, for this age group, there are no content standards that apply.)
3. **MATERIALS**
   1. 25 iPad’s
   2. 7 balloons (any color)
   3. 5 Rolls of tinfoil
   4. 5 Regular round red balloons
   5. 5 Regular round white balloons
   6. 5 Regular round yellow balloons
   7. 5 Regular round blue balloons
   8. 1 Black marker
   9. 1 Red marker
   10. Scissors
   11. 1” Small Styrofoam ball
   12. 1 Tablespoon powder or confetti
   13. Starr activity cards
   14. 7 Wide-mouth cups
   15. Dry powdered milk
   16. 5 Plastic spoons
   17. Photos of different galaxies, including spirals, elliptical, and irregulars
   18. 5 Poster boards
   19. 23 Copies of the instructions for stations (at the end of the lesson)
4. **TEACHER CONTENT KNOWLEDGE**
   1. Black Holes
      1. They are not really holes. They have very strong gravity because they are so compact. The gravity is so strong that not even light can escape. There are two kinds of black holes: stellar-mass black holes and supermassive. Stellar-mass forms when a star explodes (supernova) and collapses. They are usually between 10-40 kilometers across. We don’t know yet how the humongous, supermassive black holes are formed! They contain as much matter as a million to 100 million Suns. Black holes are still much of a mystery. There is a space telescope called XMM-Newton that can see x-rays from gas and dust particles. This helps us see matter before a black hole takes it.
      2. For more info visit: <http://stem-works.com/external/activity/289>
   2. Eagle Nebula: Also known as the Star Queen Nebula and The Spire. Jean-Philippe de Cheseaux discovered it in 1745. It is a group of stars (about 8100) inside the constellation, Serpens. It was named after the silhouette near the center of the nebula, known as the “Pillars of Creation”. Watch the Image Tour: <http://hubblesite.org/gallery/tours/tour-m16/> it gives pictures and more information.
   3. Living in Space
      1. The body adapts to space conditions:
         1. Decrease in load bearing due to not having gravitational pull. Causes bone breakdown.
         2. Increase risk of kidney stones because extra release of calcium
         3. Muscles weaken
         4. Fluid shift: lack of gravity prevents blood from reaching lower extremities. Legs may be smaller in circumference and face may feel puffy and/or congested.
         5. Heart shrinkage because it does not have to work as hard.
         6. Spine lengthens because of less force on the disks. Astronauts grow an average of 2 inches while in space!
         7. Without gravity, inner ear does not function properly. Therefore, early in the mission astronauts typically lose sense of balance, experience space motion sickness, disorientation, and a loss of their sense of direction.
         8. The loss of a 24-hour day means shift in the “body clock” and can lead to less sleep.
         9. More information: <http://www.nsbri.org/DISCOVERIES-FOR-SPACE-and-EARTH/The-Body-in-Space/>
   4. Types of Stars
      1. There are 7 different main classifications of stars. Within each of these star types, they are placed into subclasses. These classifications and specific details can be found here: <http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml>. Stars are classified by their color, temperature, mass, radius, and luminosity. Stars can be blue, white, yellow, orange, or red.
   5. Galaxies
      1. Galaxies can have from thousands up to trillions of stars. They are made up of clouds, dust, stars, dark matter, and interstellar gas. Galaxies are held together by gravitational attraction. Billions exist in the observable universe, but only a few have names. They can have different shapes such as spiral, elliptical, and others. Their neighboring galaxies influence their shapes. It is not uncommon for galaxies to collide together. The Milky Way (our galaxy) is actually headed to collide for the Andromeda galaxy.
   6. Strangest Things Found in Space (general knowledge of…)
      1. Water Reservoir- Water is not very uncommon in space. In our galaxy, it is usually in the form of ice. There have been other reservoirs found. One in particular was 140 trillion times the amount of all the water on Earth. More info: <http://www.universetoday.com/87669/huge-resevoir-of-water-discovered-in-space-30-billion-trillion-miles-away/>
      2. The Diamond Planet: Planet 55 Cancri E. thought once to be made almost completely of diamond. New studies have shown that its original star was not as carbon-rich as they once thought, making a diamond planet very unlikely: <http://www.space.com/23138-diamond-planet-super-earth-discovery.html>
      3. The Planet of Burning Ice: Gliese 436 b was originally predicted to be mainly hot ice. This was said to be able to happen because of the high-pressure on the planet. However, there have been more studies and there is much more consistency of its mass. <https://machprinciple.wordpress.com/2013/11/10/burning-ice-planet-gliese-436-b/>
      4. Sagittarius B2 is a giant molecular cloud of gas and dust that is about 20-40 times denser than a typical molecular cloud. It has significant amounts of complex organic compounds- serving as evidence that there could be life somewhere other than Earth. (There is also Billions of liters of alcohol there). <http://news.softpedia.com/news/Sagittarius-B-Contains-a-Billion-Billion-Billion-Liters-of-Alcohol-80786.shtml>
      5. Castor System: Originally thought to be one star, Castor is actually a set of 6. When it was thought to be one, it was the 20th brightest star. It is in the constellation Gemini. <http://www.space.com/21940-castor-star.html>
      6. Gliese 581 c is the third planet from its sun, which is actually a red dwarf. It is classed as a Super Earth exoplanet, which means it, has up to 10 times the mass of Earth. It is just outside of the habitable zone, meaning life is highly unlikely to exist there. <http://www.solarsystemquick.com/universe/gliese-581c.htm>
      7. Hypervelocity Stars: 6 stars in the Milky Way moving up to 2 million miles an hour. These stars are not tied to the gravitational pull of the Milky Way and they have masses about the same as our sun. Hypervelocity stars are thought to form when the supermassive black hole at the center of a galaxy devours one star in a binary system and ejects its twin, flinging it through space at superfast speeds. <http://www.space.com/19748-hypervelocity-stars-milky-way.html>
      8. A Massive Electric Current: This is space lightening measuring at 10^18 amps (which is somewhere around 3 trillion bolts of lightning). Scientists aren’t able to tell for sure, but they think that the lightning might be from a giant black hole’s magnetic fields. <http://www.popsci.com/technology/article/2011-06/strongest-current-universe-detected-some-2-billion-light-years-away?cmp=tw> <http://www.huffingtonpost.com/2011/06/22/highest-electrical-current-universe-space-lightning_n_882534.html>
      9. Large Quasar Group: the largest known structure in the entire universe. Quasars are the nuclei of galaxies from the earliest days of the universe that undergo 10-100 million years of extreme brightness. <http://www.sciencedaily.com/releases/2013/01/130111092539.htm>
      10. A Unicorn (Trifid Nebula): It is made up of gas and dust. The nebula is divided into 3 sections, which are very visible when you look at it with a telescope. They are sometimes called “stellar nurseries” because they create stars. <http://earthsky.org/clusters-nebulae-galaxies/trifid-nebula-a-summer-milky-way-treasure>
      11. A Cold Star: these stars are cold enough to touch. The Y-dwarf stars are actually colder than the human body. They are what astronomers refer to as “failed stars”. The low density of these “stars” keep them from fusing atoms at their cores which keeps them from burning and creating heat like other stars. <http://io9.com/5833976/nasa-scientists-have-discovered-stars-that-are-cool-enough-to-touch>
      12. Red Supergiant: This is the largest star in the universe. It is 1,500 times the size of the sun and is located in Death Throes. Because it is so large it has a short life. Scientists believe that soon, the star will explode as a supernova. <http://www.dailygalaxy.com/my_weblog/2013/10/the-largest-star-known-in-the-universe-found-most-luminous-red-supergiant.html>
      13. Himiko Blob: This is a gas cloud that could possibly be the largest mass in the early universe. The gas cloud is 55,000 light years across, and is 12.9 billion light years away. While they are researching this blog in many places, one of the ways they are researching it is by using the Hubble telescope. The cloud is named after an ancient Japanese Queen. <http://www.caltech.edu/news/himiko-and-cosmic-dawn-41097><http://www.space.com/6609-giant-mystery-blob-discovered-dawn-time.html>
      14. Magnetars: these are neutron stars with an extremely strong magnetic field. They are the strongest magnets in the universe. When a massive star collapses under its own gravity during a supernova explosion it forms either a neutron star or black hole. Magnetars are an unusual and very exotic form of neutron star. Like all of these strange objects they are tiny and extraordinarily dense — a teaspoon of neutron star material would have a mass of about a billion tons — but they also have extremely powerful magnetic fields. Magnetar surfaces release vast quantities of gamma rays when they undergo a sudden adjustment known as a star quake as a result of the huge stresses in their crusts. <http://earthsky.org/space/magnetars-most-powerful-magnets-in-the-universe>
      15. Neutrinos: These are particles produced by the decay of radioactive elements and are elementary particles that lack an electric charge. They make up the universe. F. Reines suggests, “...the most tiny quantity of reality ever imagined by a human being”. They are like electrons, except that they are neutral while electrons are negatively charged. <http://www.ps.uci.edu/~superk/neutrino.html>
      16. Dark Matter: the matter that cannot be seen by a telescope but would account for most of the matter in the universe. We know more of what it is not than what it is. It is not something we can see so it is not stars or planets. It is not dark clouds made of baryons, it is not antimatter because we do not see the gamma rays, and it is not galaxy-sized black holes. <http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/>
      17. Dark Energy: makes up about 68 percent of the universe. It is a property of space. We do not know much about it, other than it is not the matter we are used to seeing. It is nothing on Earth or anything we have ever seen. <http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/> (Same as xviii)
      18. Planets: There are 9 in our solar system, but there are many more out there in space. Planets are massive enough to be rounded by its own gravity, not massive enough to cause thermonuclear fusion, and has cleared its neighboring region of planetesimals. They do not have to orbit stars. When they do not orbit a star, they are called Rogue Planets.
      19. Gravity: Every object has gravity. Gravity is found everywhere in space. It is what holds planets and moons in their orbits.
      20. Black Hole: region of space-time exhibiting such strong gravitational effects that nothing, including light, can escape. Black holes are still very unknown and mysterious. (Explore links provided for students in first station of Engage.)
      21. White Hole: In general relativity, a white hole is a hypothetical region of space-time, which cannot be entered from the outside, although matter and light can escape from it. In this sense, it is the reverse of a black hole, which can only be entered from the outside, from which nothing, including light, can escape.
5. **REFERENCES**
   1. <http://stem-works.com/external/activity/289>
   2. <http://hubblesite.org/gallery/tours/tour-m16/>
   3. <http://discovermagazine.com/2007/nov/20-things-you-didn2019t-know-about-living-in-space>
   4. <http://www.nsbri.org/DISCOVERIES-FOR-SPACE-and-EARTH/The-Body-in-Space/>
   5. <http://www.enchantedlearning.com/subjects/astronomy/stars/startypes.shtml>
   6. <http://www.universetoday.com/87669/huge-resevoir-of-water-discovered-in-space-30-billion-trillion-miles-away/>
   7. <http://www.space.com/23138-diamond-planet-super-earth-discovery.html>
   8. <https://machprinciple.wordpress.com/2013/11/10/burning-ice-planet-gliese-436-b/>
   9. <http://news.softpedia.com/news/Sagittarius-B-Contains-a-Billion-Billion-Billion-Liters-of-Alcohol-80786.shtml>
   10. <http://www.space.com/21940-castor-star.html>
   11. <http://www.solarsystemquick.com/universe/gliese-581c.htm>
   12. <http://www.space.com/19748-hypervelocity-stars-milky-way.html>
   13. <http://www.popsci.com/technology/article/2011-06/strongest-current-universe-detected-some-2-billion-light-years-away>
   14. <http://www.caltech.edu/news/himiko-and-cosmic-dawn-41097>
   15. <http://www.sciencedaily.com/releases/2013/01/130111092539.htm>
   16. <http://www.cfhtlens.org/public/what-gravitational-lensing>
   17. <http://earthsky.org/clusters-nebulae-galaxies/trifid-nebula-a-summer-milky-way-treasure>
   18. <http://io9.com/5833976/nasa-scientists-have-discovered-stars-that-are-cool-enough-to-touch>
   19. <http://www.dailygalaxy.com/my_weblog/2013/10/the-largest-star-known-in-the-universe-found-most-luminous-red-supergiant.html>
   20. <http://www.space.com/6609-giant-mystery-blob-discovered-dawn-time.html>
   21. <http://earthsky.org/space/magnetars-most-powerful-magnets-in-the-universe>
   22. <http://www.ps.uci.edu/~superk/neutrino.html>
   23. <http://science.nasa.gov/astrophysics/focus-areas/what-is-dark-energy/>
   24. <http://m.space.com/30895-supermassive-black-hole-devours-star-in-event-called-asassn-14li-animation.html>
   25. <http://hubblesite.org/explore_astronomy/black_holes/modules.html>
   26. <https://www.cfa.harvard.edu/seuforum/einstein/resources/JourneyBlackHole/JourneyBlackHoleManual.pdf>
   27. [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAAahUKEwi8yIarqPXIAhVGKB4KHaaSB-8&url=http%3A%2F%2Fwww.communicatingastronomy.org%2Fcap2010%2Fastronomy101%2Fstar\_cycle\_balloons.doc&usg=AFQjCNHuP6M3HSFzoFCBlQZdV5IJ8rMyhA](http://www.communicatingastronomy.org/cap2010/astronomy101/star_cycle_balloons.doc)
   28. <http://school.discoveryeducation.com/curriculumcenter/universe/activity1.html>
   29. <http://www.space.com/28140-best-galaxy-simulation-eagle-video.html>
   30. <http://list25.com/25-strangest-things-found-in-outer-space/>
6. **DESCRIPTION OF YOUR LESSON**

|  |
| --- |
| **ENGAGE:**   * Model Presentation * All the teachers will present a topic to the students as a group. We will tell them that they will be doing this with their own groups and topics after the station activities. This will hopefully get them excited to research their own topics and get them thinking about what space topic they might like to present on.   + Our topic we will be presenting is the diamond planet! (Planet 55 Cancri E) Here is where we will get our information for the poster we will create: <http://www.space.com/23138-diamond-planet-super-earth-discovery.html>   + The poster should include facts about the planet as well as art to show the planet. The poster can be specifically research or be in the format of a newspaper article. Some facts about the diamond planet that will be included on the poster are:     - We know that the carbon to oxygen ratio is higher than earth.       * In 2012 they thought that the planet was very carbon rich making it likely to have a diamond core.     - After continuing research, they now know that there is not as high of a carbon to oxygen ratio in the planet’s sun as originally thought.       * Making the theory of the core being made of diamond not as likely     - Planet 55 Cancri E is known as Super-Earth because it is likely a rocky planet (like earth) that orbits a sun.     - The mass is 8 times larger than Earth.     - The planet orbits its sun in 18 hours (earth orbits our sun in 365 days)     - We can only indirectly observe the planet, making all information about the planet theories. |
| **EXPLORE:**   * The students will travel through 5 different stations, which will be set up at each of the tables around the room (besides the parent sign-in table). * Station 1: Black Holes   + Watch black hole video     - <http://m.space.com/30895-supermassive-black-hole-devours-star-in-event-called-asassn-14li-animation.html>      * + Simulation     - <http://hubblesite.org/explore_astronomy/black_holes/modules.html>      * + Balloon activity     - <https://www.cfa.harvard.edu/seuforum/einstein/resources/JourneyBlackHole/JourneyBlackHoleManual.pdf>   + Have information sheet at the station     - <http://stem-works.com/external/activity/289> * Station 2: Eagle Nebula   + Simulation      * + Prezi about Eagle Nebula      * Station 3: Living in Space   + Human Body Simulation      * + Things You Didn’t Know About Living in Space Discussion     - What do you think happens when you go in space?     - What parts of your body are affected?     - The body adapts to space conditions:       * Decrease in load bearing due to not having gravitational pull. Causes bone breakdown.       * Increase risk of kidney stones because extra release of calcium       * Muscles weaken       * Fluid shift: lack of gravity prevents blood from reaching lower extremities. Legs may be smaller in circumference and face may feel puffy and/or congested.       * Heart shrinkage because it does not have to work as hard.       * Spine lengthens because of less force on the disks. Astronauts grow an average of 2 inches while in space!       * Without gravity, inner ear does not function properly. Therefore, early in the mission astronauts typically lose sense of balance, experience space motion sickness, disorientation, and a loss of their sense of direction.       * The loss of a 24-hour day means shift in the “body clock” and can lead to less sleep. * Station 4: Types of Stars   + Balloon Activity     - [https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB0QFjAAahUKEwi8yIarqPXIAhVGKB4KHaaSB-8&url=http%3A%2F%2Fwww.communicatingastronomy.org%2Fcap2010%2Fastronomy101%2Fstar\_cycle\_balloons.doc&usg=AFQjCNHuP6M3HSFzoFCBlQZdV5IJ8rMyhA](http://www.communicatingastronomy.org/cap2010/astronomy101/star_cycle_balloons.doc)   + YouTube Video      * Station 5: Galaxies   + Make Your Own Galaxy     - <http://school.discoveryeducation.com/curriculumcenter/universe/activity1.html>   + Galaxy Simulation and Information     - <http://www.space.com/28140-best-galaxy-simulation-eagle-video.html> * The students will then choose a topic to research in their table groups (4-5 people), based off of the 25 strangest things found in outer space, in the following article:   + <http://list25.com/25-strangest-things-found-in-outer-space/> * The students will display their findings in one of the following options: Poster board, 3-D model, or newscast * We will give them about 35 minutes to research and prepare for their presentations. During this time all teachers will walk around, monitor student progress, and assist when necessary. Teachers will engage with the students by asking them questions, which they will also be addressing in their presentations such as:   + Why did you choose this topic?   + What makes this topic interesting/strange?   + What can you teach the class about this topic, that we probably don’t already know? |
| **EXPLAIN:**   * The whole class will settle back into their seats in the classroom and each group will give presentations over their chosen topic.   + Why did you choose the topic you did?   + What makes this topic interesting/strange?   + What can you teach the class about this topic, that we probably don’t already know? |
| **ELABORATION:**   * Students will discuss and write down anything they are still wondering about their topic or another group’s topic. Teachers will ask the students to think about ways they, as astronauts, could figure this out? Would they need certain tools or technologies? Is there anything else they would like to research about that nobody in the class chose? |

1. **EMBEDDED FORMATIVE ASSESSMENT (the 5th “E”)**
   1. Throughout the stations the teachers will be asking questions to gather information about what the child is learning. Each teacher will ask questions at the end of each station about the information provided at that station. For example the black hole station teacher may ask towards the end, “So what did you learn about black holes? What is a black hole? Are there any other things similar to a black hole in space?”
   2. Through each group’s presentation of their chosen topic, it should be clear what they researched and learned about it. If needed, teachers may ask questions to clarify their understanding of the students’ understanding of the topic.
2. **GEARING UP/GEARING DOWN**
   1. **Gearing up:** If students get done with a station before the allotted 15 minutes for that station, the teacher can ask them questions about the topic as a fun type of trivia game.
   2. **Gearing down:** If students do not get through everything at their station in the 15 minutes, they could come back to it during spare time (snack, if they finish early with their research projects, etc.). If there is not free time available to them during the day, the teacher at that station or students that finished the activities could explain what happened to that student.

**Space | Grades 5-8**

**Lesson Plan 5: Rockets**

1. **LEARNING OBJECTIVES AND CRITERIA**
   1. Students will develop an effective rocket by generating ideas and making modifications.
      1. Students will do this by making a rocket and designing it for a more effective launch. This will be met during the Explore part of the lesson.
   2. Students will demonstrate their understanding of the design process by explaining how they determined how to make their model.
      1. Through our Explain portion of the lesson, students explain their rocket and the modifications they made to it to get to their final project.

**STANDARDS**

* 1. ***Process***
     1. **Nature of Science:**  Students gain scientific knowledge by observing the natural and constructed world, performing and evaluating investigations, and communicating their findings. These principles should guide student work and be integrated into the curriculum along with the content standards on a daily basis.
        1. Make predictions and formulate testable questions
        2. Incorporate variables that can be changed, measured or controlled.
        3. Use the principles of accuracy and precision when making measurements.
        4. Analyze data, using appropriate mathematical manipulation as required, use it to identify patterns, and make inferences based on these patterns.
        5. Compare the results of an experiment with the prediction.
     2. **Design**: As citizens of the constructed world, students will participate in the design process. Students will learn to use materials and tools safely and employ the basic principles of the engineering design process in order to find solutions to problems.
        1. Identify a need or problem to be solved.
        2. Brainstorm potential solutions.
        3. Select a solution to the need or problem.
        4. Select the most appropriate materials to develop a solution that will meet the need.
        5. Create the solution through a prototype.
        6. Test and evaluate how well the solution meets the goal.
        7. Communicate how to improve the solution.
  2. **Content Standards**
     1. **Standard 2: Earth Science |** Observe, describe and ask questions about patterns in the sun-moon-earth system.
        1. **5.2.1 |** Recognize that our earth is part of the solar system in which the sun, an average star, is the central and largest body. Observe that our solar system includes the sun, moon, seven other planets and their moons, and many other smaller objects like asteroids and comets.
     2. **Standard 2: Earth and Space Science |** Understand the relationships between celestial bodies and the force that keeps them in regular and predictable motion.
        1. **6.2.4 |** With regard to their size, composition, distance from sun, surface features and ability to support life, compare and contrast the planets of the solar system with one another and with asteroids and comets.

1. **MATERIALS**
   1. “THE CART”
   2. 24 Bottles (multiple sizes)
      1. 2-Liters
      2. 16 oz. Bottles
   3. Tape
   4. Hot Glue
   5. Glue
   6. Clay
   7. Card Board
   8. Construction paper
   9. Poster Board
   10. Aluminum Foil
   11. Styrofoam
   12. Duct Tape
   13. Cork\*
   14. Play Dough
   15. Cotton Balls
   16. String
   17. Yarn
   18. Tape measure
   19. Pop rocket launcher (PVC Pipes)-Provided by Jeff
   20. Water rocket launcher- Provided by Jeff
   21. 15 Printouts Evaluating Your Rocket (attached)
   22. 1 Scientific Calculator
   23. 24 Washers
   24. Paper Towel Roll
   25. Printed protractor
   26. Pitcher or bucket to hold water - A cup (only if a bucket is used)
2. **TEACHER CONTENT KNOWLEDGE**
   1. When teaching the lesson the teacher must know about rockets. Rockets are used for various things such as sending astronauts into space, launching satellites, and sending probes other places. Rockets work in space by Newton’s third law of motion; for every action there is an equal and opposite reaction. The rockets exhaust pushes on the rocket and the rocket pushes on the exhaust. The engine runs on fuel, which is then turned into hot gas. The hot gas pushes on the rocket causing the rocket to go. However, one interesting thing about the rocket and its engine is that it does not need air like other engines. Today, new rockets are being designed that will model more of the original rocket look: tall, thin, and round. These rockets are expected to be taking astronauts to space and supplies to the International Space Station, as well as eventually taking people to Mars.
   2. Even though this lesson is based on student exploration, the teacher should be knowledgeable about what the requirements are to make a rocket that works. The students can make changes to better the rocket, but there are aspects that are necessary to make the rocket function correctly. To build a rocket you need to:
      1. Start with a base for the rocket (Plastic bottle, PVC pipe, etc.) that is free of labels.
      2. Make 3-5 stable fins
      3. Add a payload (weight) to the end of the rocket for weight
      4. Add a nose cone
      5. Pick an amount of water for inside of the bottle
      6. Launch!
3. **Resources**
   1. **NASA | What Is a Rocket? Sandra May (Sep. 8th, 2015)**
      1. <http://www.nasa.gov/audience/forstudents/k-4/stories/nasa-knows/what-is-a-rocket-k4.html>
   2. **Exploratorium | Height Site: Making Your Inclinometer. (2015)**
      1. <https://www.exploratorium.edu/math_explorer/howHigh_makeInclino.html>
   3. **www.water-rockets.com| What Is the Best Fin Shape, Size and Placement. (Dec 11 2009)**
      1. <http://www.water-rockets.com/article.pl?121,0>
4. **DESCRIPTION OF YOUR LESSON**

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| --- |
| **ENGAGE:**   * Students will present their presentations from the previous week. The whole class will settle back into their seats in the classroom and each group will give presentations over their chosen topic.   + Why did you choose the topic you did?   + How do you think astronauts and scientists are able to figure this out?   + What tools or technologies do you think would be helpful when learning about this topic? |
| **EXPLORE:**   * Students will be creating their own rocket out of either a 2-liter bottle or 16 oz. bottle. They will get to design their rocket by adding wings onto it, a nose to help the rocket go straight and so on. This will represent space rockets that have been taken to space. While building their rocket, they will need to think of different aspects of their rocket. Each of the teachers will be assigned to a group to monitor and assist in the building process. Each teacher will ask their group members questions, such as:   + What can you do to make the rocket go straight up in the air?   + Why did you pick these materials?   + Why did you choose to design the rocket this way? * Students will have trial launches to test their rockets. From there, the students can make modifications to their rocket. After each launch each teacher should ask students questions such as:   + What do you think you need to change about your rocket?   + What materials do you need to make this change?   + How do you expect that this change will affect your rocket? |
| **EXPLAIN:**   * Once we go to outside to test the rockets in front of their table group. Students will explain what:   + What materials they used for building   + The reason behind why they chose the materials   + Problems that arose during the building process and how they fixed them * The teachers will measure the height of the rocket by using the inclinometer made prior to the lesson. Once the angle is measured, the teachers will quickly calculate the height of their rocket by using the equation a/sin (A) = b/sin (B) = c/sin (C) (where a, b, c are sides and A, B, C are angles)   + The teacher measuring will stand 100 ft. from the rocket being launched (this is the D in the equation).   + A useful website to calculate the height using the law of sine is:     - http://www.calculatorsoup.com/calculators/geometry-plane/triangle-theorems.php |
| **ELABORATION:**   * After each student launches their rocket, the teacher will ask students:   + Did your rocket go as planned?   + What would you change if you had the opportunity to make additional changes?   + What resources do you wish you had to use while you were building?   + What process do you think astronauts go through to build rockets since they cannot launch them and make revisions? * By having the students explain the reason and process behind their rocket, they begin to think and reflect on their experience with the rocket. |

1. **EMBEDDED FORMATIVE ASSESSMENT (the 5th “E”)**
   1. After students present their group research, the groups will be asked questions about their research to get them thinking how astronauts are able to figure out information about these phenomenon topics and what tools they need to be able to collect this information.
   2. During the building of the rockets, the teachers will ask the students questions about their process and justification of material choices. This will help the teacher to understand if any adjustments need to be made during the lesson. If the lesson is too easy they will need to gear up and if the lesson is too hard they will need to gear down.
   3. When the students are launching their rockets, the teachers will be asking questions that will require students to think about their process of building the rocket. They will also have to assess themselves using the worksheet to decide if their rocket fit the requirements to be a viable rocket design. Finally, the students will have to think about what things they would still change as well as things that they wish that they could have done from the beginning.
2. **Gearing Up/ Gearing Down**
   1. **Gearing up**
      1. To make this lesson more challenging for students, the teacher may add on different variables to consider such as how weight, air pressure (in the bottle), and measuring the height of their rocket by making their own inclinometer.
   2. **Gearing down**
      1. To make this lesson less challenging for students, the teacher may decide to provide the class with an effective model for the students to look at.

Handouts



**Station Directions**

Station 1: Black holes

* Step 1: Watch this video:



* Step 2: Complete this simulation:



* Step 3: Do black hole activity (directions from station leader)

Station 2: Eagle Nebula

* Step 1: Complete this simulation



* Step 2: Prezi about Eagle Nebula



Station 3: Living in Space

* Step 1: Discussion about changes to your body in space
  + What do you think happens when you go in space
  + What parts of your body are affected?
* Step 2: Do the Human Body Simulation



Station 4: Types of Stars

* Step 1: Complete the balloon activity (instructions from station leader)
* Step 2: Watch this YouTube video



Station 5: Galaxies

* Step 1: Make Your Own Galaxy (station leader will give instructions)
* Step 2: Galaxy Simulation and Information



**Evaluating Your Rocket**

**Questions: Circle your answer:**

1. Did the rocket go straight? yes no
2. Was the rocket durable? yes no
3. Was your design thoughtful and creative? yes no
4. Did your rocket do what you expected it to do? yes no
5. How high did your rocket go? \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_­\_\_\_
6. Observe and describe what happened inside the bottle once it landed: \_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Evaluating Your Rocket**

**Questions: Circle your answer:**

1. Did the rocket go straight? yes no
2. Was the rocket durable? yes no
3. Was your design thoughtful and creative? yes no
4. Did your rocket do what you expected it to do? yes no
5. How high did your rocket go? \_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_­\_\_\_
6. Observe and describe what happened inside the bottle once it landed: \_\_\_\_\_\_\_\_\_\_\_

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_