**Lesson Plan**

**COSMOS EDUCATIONAL TOOLKIT: LESSON NAME: Building a solar cooker**

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| **Grade/ Grade Band**: *11* | **Topic:** *Conic Sections and solar cooker* | **Days of project = 1 month** |
| **Brief Lesson Description**: *Through this project, students will use their knowledge of mathematics to construct an apparatus that utilizes the sun’s energy. They will have to refer to their notes from the past semester and conduct research. There are multiple parts to this project based assessment that have specific due dates. The use of a graphing calculator and**desmos.com to create and copy graphs to your report will be used.**TASK: “*You’ve decided to become an engineer who specializes in thermodynamic properties. Your job is to design your own apparatus using conic sections to use the sun’s rays. Your task is to create a mathematical model (conic section) of apparatus that will be tested outside of the classroom at the end of May.” |
| **Specific Learning Outcomes:** *The essential element that students will know after the lesson will be the ability to associate conic sections with a real world application.*  |
| **Narrative / Background Information**  |
| **Prior Student Knowledge Required:** *Students would have just finished the unit on conic sections. They should have a strong spatial ability that would aid in the construction of the apparatus. Being computer savvy and the ability to use online software like Desmos.com would help.* |
| **Problem Solving Practices (Ex: Standards for Mathematical Practice):** *CCLS - Math: G.GPE.3**Category**Expressing Geometric Properties With Equations**Sub-Category**Translate Between The Geometric Description And The Equation For A Conic Section**State Standard:**(+) Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.* | **Main Content Ideas:** *Students will learn through inquiry and discovery that the math concepts they are learning have real applications. We see conic sections in our everyday life but students don’t realize it.* | **Possible Multidisciplinary Concepts:** *You can pull in Physics into this lesson and get more technical with the angle of the sun in relation to the time of the day when the students test their apparatus.*  |
| **Possible Preconceptions/Misconceptions:** *The students may approach this lesson with the understanding that they may not be able to handle the building part. My experience over the last few years are that some students may struggle with the construction but for the most part all the students were successful. In addition, the students were concerned if they don’t melt the chocolate during the testing phase that they fail the project. I always assure the students that you don’t fail, just that you didn’t find the exact location of the focal point.* |
| **LESSON PLAN – 5-E Model**  |
| **ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:** **Phase 1: Mathematical Model: Document #1 on Google Classroom**You will draw a sketch of your design (using some software or taking a picture of your accurate drawing) and uploading it to your google document (Part 1). All measurements should be clearly labeled. You will then find the equation that models your design. Find the equation for the conic section that is associated with your constructed model. Represent all aspects like the vertex, focal point, directrix, and if the conic has it, the latus rectum and co-vertex. You must analyze your mathematical equation in terms of algebraically, graphically and logically. Explain why you believe that this mathematical model will be functional.* You will use a cardboard box. Try not to exceed: width < 12 inches, length < 20 inches, height < 10 inches. If larger, remember that it needs to be portable. A good example of this dimension is starting with a box from a case of paper. Smaller would be a shoe box which may be too small. Our school throws out boxes every day.
* The **drawing** of your design must have all the labels, titles, and different views. A recommendation is using a set scale or legend (ie: ¼” = 1 foot scale). The reason for doing this is to aid you in your construction.

Be aware how you present your information and how clear your information comes across does matter.**Questions to ponder:*** Would a particular color aid in absorption of the sun rays?
* Is it better to have your conic with an open design verse putting up walls around your design?

**Phase 2 : Construction and Testing: Document #2 on Google Classroom***Sun Collector Design: Your job is to design your own sun collector that uses conic sections.**To complete this task, follow these steps:*  * The apparatus will be designed and built by you. Be creative and not copy an exact design that you find on the internet. This can be researched.
* The apparatus must be functional. This is your goal.

Materials: (You could share materials with your friends. Cost to build should be minimal.) * You will need a roll of aluminum foil. No creases.
* Clear packing tape as to not hinder the sun's rays.
* Optional: Foam (to be placed as a structure under your conic shape if desired).
* Glue (hot glue or regular glue stick). I have hot glue if you need to borrow.

Construction:1. List all materials that you used for the construction.
2. You will have to make some type of platform at the focal point that will be strong enough to hold something to test. You will be testing something no heavier than an iphone. A platform should not be bigger than 3 by 3 inches. Keep in mind that you don’t want shadows. A platform that is adjustable would be helpful. Structure is important.

DIRECTIONS for Part 2:1. You will submit a document with the time-line of the construction with pictures.
2. Find the new equation for the constructed model and all new measurements. Your actual model will most likely differ from your mathematical model. This needs to be indicated.
3. Submit a picture timeline of your construction. When you take pictures of your design, a suggestion is to take pictures that are parallel to you and not at an angle. This will distort the picture.

COSMOS:Students will bring in their apparatus to be tested. Using the light probe sensor along with the COSMOS equipment students will find their focal point. The light probe sensor will be used to test the light sensitivity and strength associated with the distance from where you are holding the sensor. The thought is to use this tool to detect the sweet spot where the focal point is located. Then the students can compare their initial design, actual construction and a more accurate test with a light sensor. The students will give the percent error and discuss what that value means to them.   **Phase 3: Test Analysis/Conclusion: Document #3 on Google Classroom**This is your final report. Place all relevant information in this section. Do NOT refer the person back to part 1 and part 2.1. Paste pictures that you will use to refer to. Do not add pieces that are irrelevant to your analysis.
2. Compare your mathematical model with your actual design. How close were you to your prediction?
3. Compare your conic section with your group’s. Whose conic section (circle, ellipse, parabolic and hyperbola) was more efficient?
4. Add results of timed experiment. Did this time reflect the effectiveness of your design, or the fact that it was already hot outside? Explain.
5. What time of the day did you test your solar cooker? Was this a good time of the day to test? Why or why not.
6. Do you feel that you were successful at executing your design? Why or why not?
7. What alterations can you do to your design to better improve its efficiency? Use evidence and explain.
8. Share some challenging tasks you faced while executing your project and what was your approach in solving them?
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| **EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:** * *Possible Transmission devices: Computer program and COSMOS equipment.*
* *Other equipment may be used.*
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| **EXPLAIN: Concepts Explained and Vocabulary Defined:** **Key Vocabulary:**  |
| **ELABORATE: Applications and Extensions:** *An extension would venture into some of the other examples that were shared above in the multidisciplinary concept section.* |
| **EVALUATE:** **Formative Monitoring (Questioning / Discussion):** **Summative Assessment (Quiz / Project / Report):**  |
| **Elaborate Further / Reflect: Enrichment:**  |