GYSTC
GEORGIA YOUTH SCIENCE & TECHNOLOGY CENTERS

Title: Homemade Projector STEM Challenge

Estimated Time: 2 periods

Core Ideas (GSE Standard and elements):

S4P1. Obtain, evaluate, and communicate information about the nature of light and how light interacts with objects.

a. Plan and carry out investigations to observe and record how light interacts with various materials to classify them as opaque, transparent, or translucent.

b. Plan and carry out an investigation using everyday materials to explore examples of when light in refracted

or

S8P4. Obtain, evaluate, and communicate information to support the claim that electromagnetic (light) waves behave differently than mechanical (sound) waves.

d. Develop and use a model to compare and contrast how light and sound waves are reflected, refracted, absorbed, diffracted or transmitted through various materials.

g. Develop and use models to demonstrate the effects that lenses have on light (i.e., formation an image) and their possible technological applications.

Literacy Connections: Books	**Literacy Connections: Close Reads**
All About Light, Lisa Trumbauer All About Light and Sound, Connie Jankowski	Lots to Learn About Lenses Close Read
Science and Engineering Practices: **Asking Questions and Defining Problems:** Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. **Developing and Using Models:** Develop a diagram or simple physical prototype to convey a proposed object, tool, or process.	**Crosscutting Concepts:** **Systems and System Models:** A system is a group of related parts that make up a whole and can carry out functions its individual parts cannot. **Structure and Function:** Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used.

STEM Challenge Overview:

This STEM Challenge provides an excellent chance for students to apply what they have been learning about light and lenses. Their job is to create a homemade projector that uses a simple magnifying glass to project a cartoon from a Smart Phone.

Ask	If possible, pass out magnifying glasses and let them zoom in on a few of their favorite objects. As they do so, have them **ask** questions about lenses and their ability to maneuver light. Have them read the ***Lots to Learn about Lenses*** article to prepare them for the upcoming STEM Challenge. Briefly discuss the article and highlight key ideas.
Imagine/Brainstorm	Students **brainstorm** ideas that could serve as possible solutions for constructing each part of their projector. After doing so, they should consider

	the strengths and weaknesses of each idea before deciding on which idea they think will provide the best solution.
Plan/Design	Students **plan** an organized approach to solving their problem. This may include a **design** (sketch) of the projector and/or a procedure as well as a list of any additional materials they may need to solve the problem.
Create/Test	Students follow their plan, modify their projector and **create** a potential solution to their problem (a functioning projector). Once it is created, students **test** their solution in a measureable way to evaluate the effectiveness of their solution.
Improve	After discussing and evaluating their results, students improve their solution and re-test if possible.

Teacher Notes:

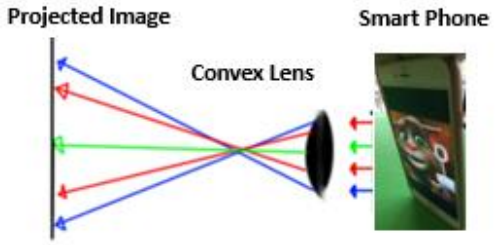
This STEM Challenge provides an excellent chance for students to apply what they have been learning about light and lenses. Their job is to create a homemade projector that uses a simple magnifying glass to project a cartoon from a Smart Phone. Have students read the article, ***Lots to Learn about Lenses,*** and highlight key ideas from the article that warrant additional emphasis. It is recommended that you also discuss the two main types of lenses. **Convex** (or converging) lenses make light rays converge (come together) at the focal (focus) point. Convex lenses are thicker in the center than they are at edges. **Concave** (or diverging) lenses make light rays spread out. They are thicker at the edges and thinner in the middle.

You may also choose to consider how lenses can be used by themselves or in combination with other lenses. Single lenses are used in eyeglasses, contact lenses, magnifying glasses, and viewfinders. Often, lenses are combined together to make a compound lens. Compound lenses are used in instruments like cameras, binoculars, microscopes, and telescopes.

Lenses are often used to magnify objects that are either very small (microscope) or very far away (telescope). As might be expected, some lenses magnify the apparent size of an object much more than others. For middle school students, it is appropriate to explore the importance of focal length. This is the measurement that indicates the power of a lens. The shorter the focal length, the more powerful the lens.

While there are lots of cool man-made lenses, our eyes contain what many consider to be the most amazing lenses of all. If you haven't discussed these lenses yet, they can easily be incorporated into this exploration. Unlike most lenses, our lenses are flexible and can change shape instantly thanks to tiny, but powerful, muscles that can contract and relax in a moment. This means you can go from focusing on the book your reading to searching for shooting stars in the sky in a flash.

In this STEM Challenge, students create a homemade projector using a simple magnifying glass to project a cartoon from your Smart Phone. The light from the Smart Phone is refracted inward by the convex lens provided the magnifying glass. You might need to take some time to introduce the concept of a ray diagram (below) where the diagram traces the path that light takes in order for a person to view an image of the object.



In preparation for this challenge, you need collect enough shoeboxes so that you have one for each group of 3-4. If boxes are low in supply, similar boxes can be purchased cheaply from any Dollar Store. As the instructor, you can decide whether to take an open-ended or guided-inquiry approach. The projector will work in a variety of orientations and a lots of different approaches can be used to construct a functional phone holder. A second magnifying glass can also be added to improve resolution but this requires there be lots of them at your disposal.

In wrapping up the challenge, have students discuss what techniques they used to design their projector and maximize the resolution. Have them discuss possible improvements and even redesign and retest as time permits. With respect to crosscutting concepts, the projector provides an excellent example the relationship between structure and function where, in this case, the shape and structure of the lens determines many of its properties and functions. The components and design of the projector also act as a system where the parts of system work together to accomplish the overall goal of being a functional projector.

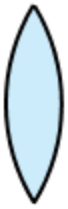
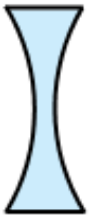
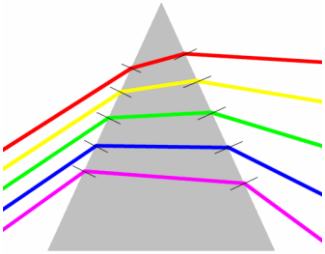
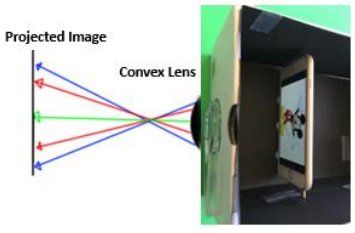

Alternative box and orientation

Materials Needed per Group:

Shoebox or similar sized box
Magnifying glass
Cell phone (if needed students can take turns with one or two)
Scissors
Tape (scotch)
Piece of clay, playdoh, or poster putty (Dollar Store)
Black paper for lining box (alternatively kids can paint the box black).
Some of the following:
Skewer stick, straw, paper clip, popsicle stick


Materials needed for STEM Challenge

Vocabulary Cards:

lens **a transparent object with curved sides** 	**convex** **a lens that causes light to converge (come together)**  bi-convex
concave **a lens that causes light to diverge (spread apart)**  bi-concave	**complex lens** **a group of two or more simple lenses that work together** 
refraction **bending of light as it passes from one object into another** 	**engineer** **to design, build, and improve things** 

Homemade Projector STEM Challenge:

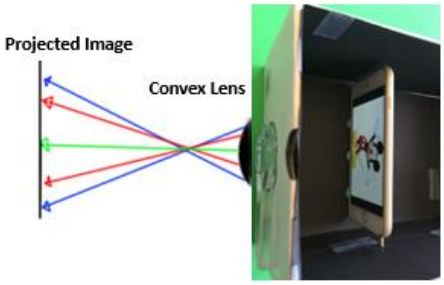
Can you create a functional projector using a magnifying glass, Smart Phone, and your knowledge of lenses and the refraction of light?

Constructing your Projector Box:

1. Trace the outer edge of your magnifying glass using a pen or marker.
2. Cut out the hole and remove.
3. Tape black paper to the inside of your box.
4. On the outside, or inside, of the box tape the magnifying glass over the hole.

Attaching your Smart Phone and Setting the Focus:

1. When placing your phone inside the box, some of the light from your screen will travel through the lens where it will be refracted and bent inward. The projected image will be upside down.



2. To test your projector, turn off the lights and project a photo onto a bare white wall or white projector screen. A piece of white poster board also works well.
3. Move your phone within the box and the position of the projector in relation to the wall until you the image comes into the clearest focus possible.
4. Once the best position is determined, build a holder to keep your cell phone in place. You can use items such as clay, playdoh, paperclips, skewer sticks and straws.
5. To use your projector, set a photo album from your phone on play or choose a cartoon or animation (make sure it is school appropriate).
6. For highest quality viewing, turn the screen brightness all the way up and close (or place a lid) on the top of the box
7. If time permits, decorate the outside of your box to make it more personalized and artistic.

Evaluating and Improving:

8. As a group, discuss how you were able to construct your projector and explain how the magnifying glass and bending of light was involved.
9. As a group, evaluate the effectiveness of your design and discuss how you would change your design moving forward to improve the performance of your projector. If time permits, make these improvements and re-test.
10. As a group, discuss one or two crosscutting concepts from this exploration that could be used to broaden your understanding of science and engineering.