LIPSCOMB UNIVERSITY | Ayers Institute for Teacher Learning & Innovation

Standards-Aligned Lesson Plan

High School Physics: Witness Walls (Nashville, TN)

Developed in partnership with the Metropolitan Nashville Arts Commission.

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Planning and Presenting a Science, Social Studies, or Technical Subject/Fine Arts Lesson Based on TN Academic Standards

Physics
Grades 11-12

Section I: Planning

Overview: This section focuses on the elements to consider when planning for a content-specific lesson with TN Academic literacy standards embedded, such as Content Standards, State Performance Indicators, and CCSS Literacy for the Technical Subjects. Other elements to plan include clear learning targets, task objectives, new learning for students, anticipated learning challenges, scaffolding, opportunities for differentiation, ways to prompt student thinking through assessing and advancing questions, instructional strategies to be used in the lesson, and materials and resources.

Lesson Topic: Optical Illusions	**Time Frame/Lesson Length: 2 class periods**

Content Standard	**State Performance Indicators**	**CCS Literacy Standards**	**Assessments (Please describe the specifics of the assessment)** ✓ **Formative** ➢ **Summative**
• CLE 3231.4.3 Explore the optics of lenses • CLE 3231.4.4 Analyze the optics of mirrors	• SPI.3231.4.5 Identify the properties of light related to reflection, refraction, diffraction, and interference of light waves • SPI.3231.4.6 Using light ray diagrams, identify the path of light using a convex lens, a concave lens, a plane mirror, a concave mirror and a convex mirror.	• CCSS.ELA-LITERACY.RST.11-12.3 Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text. • CCSS.ELA-LITERACY.RST.11-12.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 11-12 texts and topics.	✓ Formative - Comprehension questions during the guided reading section - Monitoring during lab stations ➢ Summative - 5 question assessment - Final Product

Planning Element	**Description**
Clear Learning Targets	• Students will be able to distinguish the different properties of light • Students will be able to complete optical labs with appropriate steps

	• Students will be able to use different diagrams (such as the *Witness Walls*) to demonstrate the path of lights with different mirrors • Students will be able to identify the different meanings of domain specific language in text
Task Objectives (steps to reach mastery of clear learning targets)	• Students will be able to look at the *Witness Walls* piece and describe the different optical illusions taking place, created by the convex and concave images.
New Learning	• The different properties of light • The different types of mirrors • The different types of lenses • The significance of the *Witness Walls* piece
Anticipated Learning Challenges	• Students will have a difficult time getting rid of misconceptions. Any time there is a concept in science that students interact with on a daily basis, there are always many misconceptions that have already formed.
Scaffolding opportunities (to address learning challenges)	• Students that are having a difficult time understanding the concepts will be put in a small remediation group with a peer leader.
Opportunities to Differentiate Learning (explain how you address particular student needs by differentiating process, content, or product)	• The websites in the interactive reading sections can be adjusted to different websites on students reading levels or the questions from the reading can be adjusted. • The product can be adjusted to meet the students' needs. The product can be less open-ended and provide guided questions for students who need the scaffolding.
Questioning: Planning to Illuminate Student Thinking	*Assessing questions:* • What are the similarities and differences between concave and convex lenses? • What is the difference between a lens and a mirror? • What ability of glass allows us to magnify, or make things larger? • How do light waves act when they hit a smooth or shiny surface? *Advancing questions:* • What effect does changing the distance between the lens and the object viewed have on the orientation and size of the image produced using a convex and a concave lens? • What are some real world examples of the following: concave mirror, convex mirror and concave lens? • Why do convex and concave mirrors make some images more powerful?
Instructional Strategies	• Accountable Talk- During all stations, but particular during the mini-labs. • Text-Based Questions- Station #2- The questions come directly from the information that has been read. • Problem- Based Learning- in the Putting it all Together activity. The students receive a

	problem that they must solve.
Materials and Resources	Spoon, water, mirrors, glass test tube, stopper, ruler, index card, Witness Wall picture, Explore Learning account, computer access, flashlight, modeling clay, protractor, construction paper, flashlight

Section II: Presentation

Overview: This section focuses on the steps involved in presenting the lesson. The lesson presentation is divided into segments, such as "Framing the Lesson," "The Texts and Task," "Sharing, Discussing, and Analyzing" and "Closing the Lesson," and "Extending the Learning." For each of these lesson elements, there is an explanation of the procedure, teacher actions, and student outcomes.

🔔 **Framing the Lesson** (15 min)		
Detailed Procedure	**Teacher Actions**	**Student Outcomes**
• Intro Activity- Spoons and Images – See Handout • The students will use spoons to look at different images of the Civil Rights Movement and of Walter Hood's *Witness Walls*. During the activity, students will gain the basics on how curved surfaces reflect light. Students will begin to discuss the Nashville Civil Rights Movement as they look at the pictures.	• Teacher must have spoons and different graphic images of the Civil Rights Movement in Nashville for each group (see appendices). Before the class begins the intro activity, the teacher should have a short discussion about the Nashville Civil Rights Movement Pictures. This discussion should activate students' prior knowledge on the subject. During the activity, the teacher should walk around and monitor students' answers to the intro activity. Teacher should listen for misconceptions that need to be addressed before students move on to the stations.	• The basic expectation is for students to see that different types of mirrors reflect different images. The students should also have some real world examples where different mirrors are used. The students should take away some background knowledge of the Nashville Civil Rights Movement.
🖋 **Exploring the Texts and Task** (2 hours and 15 minutes (over two days)		
Detailed Procedure	**Teacher Actions**	**Student Outcomes**
• The lesson will consist of three stations that will take approximately 45 minutes each. • The stations are designed to give students an in-depth overview of mirrors, lenses, and how they work. • Station 1- Explore Learning- It gives the students real images to look at as they	• Station #1- The teacher will make sure that the classroom has computers with internet. The teacher should have set up a free account with Explore Learning, so that students could have the password to get on the virtual lab. Teacher should make sure that all students are following the directions on the virtual lab	• Station #1- Students should have a deeper understanding of concave and convex mirrors. • Station #2- Students should be able to explain the difference between key terms- Refraction and reflection, concave and convex, and the different

study mirrors. • Station 2- This station gives students basic knowledge and vocabulary. They will read information from the computer (similar to a webquest) and answer questions. The students will also make a foldable as visual representation between the key terms. • Station 3- Mini-Labs. The mini-labs are designed for students to discover misconceptions on their own.	• Station #2- Teacher should make sure that students are understanding the material. Teacher should check and make sure that students have correct information on their handout and in their foldable. • Station #3- Teacher should listen to the accountable talk among the groups to ensure that misconceptions are being addressed. Teacher should ask probing questions to make the students go deeper with the simple materials.	types of mirrors. This station provides the basic background knowledge for all of the information in the unit. • Station #3- Students should get hands-on experience with the different lenses and mirrors. This station should address misconception that the students have by allowing them to observe the phenomena.
☺ **Sharing, Discussing, and Analyzing** (45 minutes)		
Detailed Procedure The students will complete a Putting it All Together activity that will sum up the different types of mirrors and lenses. The students will pick what type of lenses that they think are the best for the Witness Wall.	**Teacher Actions** • Teacher should group the students by ability level during this portion of the lesson. By grouping by ability teacher can differentiate the products and scaffold the problem if necessary.	**Student Outcomes** • Students should gain a deep understanding of the *Witness Walls* and the science behind the design. Students should be able to relate the design to what makes *Witness Walls* such a dynamic exhibit.
☐ **Closing the Lesson** (15 minutes)		
Detailed Procedure • The students will complete a five question assessment.	**Teacher Actions** • Teacher will distribute the assessment. Even though the assessment is summative in nature, the results will guide the teacher's next steps in teaching.	**Student Outcomes** • At least 80% of students should exhibit mastery of the information.
🕮 **Extending the Learning** • To extend the learning, students could make their own witness wall for the school. It would be built on the same principles from the artist. The witness wall would have to include at least one concave, convex, and plane mirror.		

Appendices (attach resources used, such as handouts, etc…):

Intro Activity- Spoons and Images

Optics Stations Directions/Handouts

- Station 1- Explore Learning Activity

- Station 2- Interactive Reading and Foldable
- Station 3- Concave and Convex Lenses/Mirror Mini- Labs

Putting It All Together Activity- Through the Lens

Physics Lesson: *Witness Walls* Intro Activity- Spoons and Images

Using a shiny spoon, answer the following questions.

1. Look at your image on the curved inside of the spoon. This is like a concave mirror.
Hold the spoon about arm's length away and slowly move it in towards your face.
What do you notice about your image? Does the image change? Is your reflection upside down or right side-up? Is it smaller or larger than your face? Explain.

_____
_____
_____

2. Now look at your image on the curved outside of the spoon. This is like a convex mirror. Hold the spoon about arm's length away and slowly move it in towards your face. What do you notice about your image? Does the image change? Is your reflection upside down or right side-up? Is it smaller or larger than your face? Explain.

_____
_____
_____

3. Using one of the pictures of the Civil Rights Movement, look at the picture from the curved side of the spoon and the curved outside of the spoon. What do you notice about the image (explain from the curved side of the spoon and the curved outside of the spoon)? What type of mirror best depicts the image? Explain.

_____
_____
_____

4. Using another one of the pictures of the Civil Rights Movement, look at the picture from the curved side of the spoon and the curved outside of the spoon. What do you notice about the image (explain from the curved side of the spoon and the curved outside of the spoon)? What type of mirror best depicts the image? Explain.

_____
_____
_____

5. Give an example of when one may need to use a concave mirror.

---

6. Give an example of when one may need to use a convex mirror.

7. Using the pictures and background knowledge of the Nashville Civil Rights Movement, why is it important to look at images from different angles?

8. What stood out to you from the Nashville Civil Rights pictures? Explain?

9. Compare and Contrast the Nashville Civil Rights Movement with things currently going on in Nashville?

10. What questions do you still have about concave and convex mirrors? What do you still have about the Nashville Civil Rights Movement?

Images for Intro Activity


"I came to Nashville
not to bring inspiration,
but to gain inspiration from the
great movement that has taken
place in this community."
-Martin Luther King Jr.


SCHOOL

Name: _____ Block: _____

Group Members: _____ _____

Optics Stations

Instructions: READ ALL OF THESE INSTRUCTIONS BEFORE YOU GET STARTED! Be aware of your time and don't spend too much time at one station

- **STATION 1 – Concave and Convex Mirror Virtual Lab -** Each member should complete their own lab sheet. You will use the classroom computers or your personal technology to go to the explorelearning website and complete the Gizmo (Virtual lab) on Ray Tracing (Mirrors).
    - www.explorelearning.com

- **STATION 2 – Interactive Reading/Foldable:** Find a quiet place to read over the information in the packet and answer the questions along the way. When your group is done, you will complete a foldable of the key terms in the lesson. You will need construction paper and copy paper.

- **STATION 3– Concave and Convex Lenses/Mirror Mini Labs:** Follow closely the directions in the packet. All materials are provided for you.

- ***When you finish everything, turn all assignments in, stapled together with this form. This paper should be on the front with the other assignments attached.***

Name: _____ Date: _____

Station 1- Virtual Lab-Student Exploration: Ray Tracing (Mirrors)

www.explorelearning.com

Vocabulary: concave mirror, convex mirror, focal point, magnification, real image, reflect, virtual image

Prior Knowledge Questions (Do these BEFORE using the Gizmo.)
For these questions, it would be helpful to have a metal spoon on hand. If you don't have one, try to imagine looking at yourself in a spoon.

1. Look at yourself in the front of the spoon (the side where the food sits). What do you see?

   _____

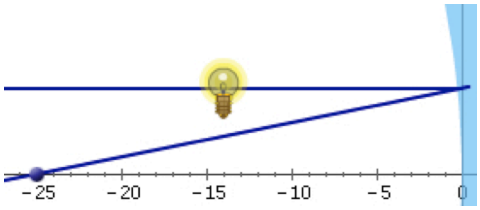
   The front of a spoon is an example of a **concave mirror**.

2. What do you see when you look at yourself in the back of a spoon? _____

   _____

   The back of a spoon is an example of a **convex mirror**.

Gizmo Warm-up
The *Ray Tracing (Mirrors)* Gizmo™ shows a side view of a light bulb positioned to the left of a mirror. Light rays passing from the light bulb to the mirror are shown.



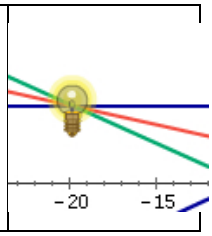
To begin, select the **Concave mirror**. Turn on **Colorize lines**. Under **Show lines**, turn off the **Central line** and the **Line through focal point** so that only the **Parallel line** is showing.

1. The blue dot in front of the mirror is the **focal point** of the mirror. Move the light bulb on the left around. What is always true about the ray that is **reflected** from the parallel ray?

   _____

2. Turn off the **Parallel line** and turn on the **Line through focal point**. Move the light bulb around. What do you notice about the reflected ray in this situation?

   _____

Activity A: **Real and virtual images**	Get the Gizmo ready: • Check that the **Concave mirror** is selected. • Turn on the **Parallel line**, **Central line**, and **Line through focal point**. • Place the light bulb above -24 on the central axis, with the focal point at -12.	

Introduction: A concave mirror is also called a "converging mirror" because it reflects light rays into a point. A **real image** is formed where the reflected light rays converge at a point. Unlike a **virtual image** that forms behind a mirror, a real image can be projected onto a screen.

Question: How do mirrors create real and virtual images?

1. Observe: In its current configuration, the distance from the light bulb to the focal point is slightly more than 12 units. The distance from the focal point to the mirror is exactly 12 units.

   A. What do you notice about the size of the light bulb's image? _____

   _____

   B. What do you notice about the orientation of the light bulb's image? _____

   _____

2. Investigate: Complete each action described in the table below, and state how that action affects the image.

Action	Effect on image
Move the light bulb to the left.	
Move the light bulb to the right.	
Move the focal point to the left.	
Move the focal point to the right.	

3. Analyze: Examine the results recorded in your table.

   A. In general, how do the size and position of the image change when the distance between the light bulb and the focal point increases?

   _____

   B. In general, how do the size and position of the image change when the distance between the light bulb and the focal point decreases?

   _____

(Activity A continued on next page)

Activity A (continued from previous page)

4. Explore: Move the light bulb to -10 and the focal point to -20. What do you notice about the image when the light bulb is between the focal point and the mirror?

   _____

   The image is virtual because no light rays are focused there. This virtual image is what an observer would see looking into the mirror. The dashed lines represent the direction that an observer would perceive the reflected light was traveling from.

5. Investigate: Select a **Convex mirror**, and turn off the **Original light lines** and the **Apparent light lines**. Move the light bulb back and forth (but keep it close to the central axis).

   A. What do you notice about the three lines reflected from the convex mirror?

   _____

   B. Is the image of the light bulb a real image or a virtual image? Explain. (Hint: Recall that a real image is formed where actual light rays are reflected.)

   _____

   C. Move the light bulb back and forth. No matter where the light bulb is located on the central axis, what is always true about size of the image?

   _____

6. Apply: Which type of mirror would you use for the following applications, and why?

   A. Cooking a hot dog: _____

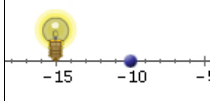
   _____

   _____

   B. Surveillance in a convenience store: _____

   _____

   _____

Activity B: **The mirror equation**	Get the Gizmo ready: • Select the **Concave mirror**. • Move the light bulb to -15 and the focal point to -10. • Turn off all lines, and turn on **Show ruler**.	

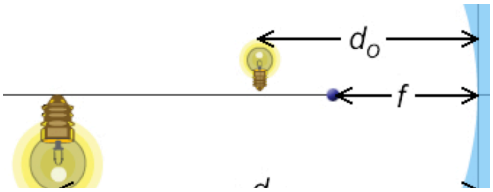
Question: How is position of the image related to the position of the object and the focal length of the mirror?

1. Measure: In this activity, you will measure the relationships between several values:

   d_o: Distance between object and mirror

   f: Distance between focal point and mirror

   d_i: Distance between image and mirror

   What are the current values of each of these variables? (Note: You can use the ruler to measure d_o and d_i.)

   d_o = _____ f = _____ d_i = _____

2. Gather data: Measure d_i for each of the following values of d_o and f. For the last two rows of the table, use your own values of d_o and f.

d_o	f	d_i	$\frac{1}{d_o}$	$\frac{1}{d_i}$	$\frac{1}{f}$
15	10				
25	10				

3. Calculate: Find the reciprocal of each value and fill in the last three columns of the table.

4. Analyze: For each row of the table, find the sum of $\frac{1}{d_o}$ and $\frac{1}{d_i}$. Record these values here:

   _____ _____ _____ _____

   What do you notice? _____

   _____

(Activity B continued on next page)

Activity B (continued from previous page)

5. Make a rule: Express the relationship between $\frac{1}{d_o}$, $\frac{1}{d_i}$, and $\frac{1}{f}$ as an equation.

   =

   This equation is called the *mirror equation*. For the spherical mirror shown in this Gizmo, the equation works well so long as the object is close to the central axis.

6. Practice: You place a light bulb 8 cm in front of a concave mirror. You then move a sheet of paper back and forth in front of the mirror. The image of the light bulb focuses on the paper when the paper is 12 cm in front of the mirror.

   What is the focal length of the mirror? _____

   Show your work:

7. Practice: A light bulb is placed 20 cm in front of a concave mirror with a focal length of 8 cm.

   How far from the mirror will the image of the light bulb be focused? _____

   Show your work:

8. On your own: Does the mirror equation work for a convex mirror? Use the Gizmo to find out and describe your findings below. (Hint: In this situation, d_i and f are negative.)

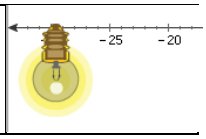
   _____

   _____

   _____

   _____

   _____

Activity C: **Magnification**	Get the Gizmo ready: • Check that the **Concave mirror** is selected. • Move the light bulb to -15 and the focal point to -10.	

Introduction: Mirrors are often used to change the size of an image. The **magnification** of an image is equal to the ratio of the image height to the object height. Some mirrors, such as the mirrors in reflecting telescopes, produce images that are greatly magnified. Other mirrors, such as the mirrors in side-view mirrors on cars, produce images that are reduced in size.

Question: What determines the magnification of an image?

1. Measure: What are the current values of these variables?

   d_o = _____ f = _____ d_i = _____

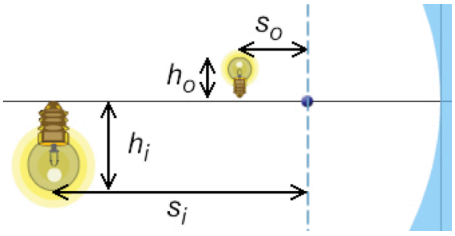
2. Measure: In addition to the variables you explored in the previous activity, you will investigate several others. Measure each of these variables and list their values below.

   h_o: Object height

   h_i: Image height

   s_o: Distance from object to the focal point

   s_i: Distance from image to the focal point



   h_o = _____ h_i = _____ s_o = _____ s_i = _____

3. Gather data: Use the values above to fill in the first row of the table. Then run your own experiments to fill in the last two rows.

d_o	f	d_i	h_o	h_i	s_o	s_i	$\frac{d_i}{d_o}$	$\frac{h_i}{h_o}$	$\frac{f}{s_o}$	$\frac{s_i}{f}$
15	10	30					2.0	2.0	2.0	2.0

4. Calculate: Calculate the given ratios to fill in the last four columns of the table.

5. Analyze: What do you notice about the four ratios? _____

   _____

(Activity C continued on next page)

Activity C (continued from previous page)

6. Make a rule: The magnification of an image is equal to the ratio of the image height to the object height. Using the ratios from the table on the previous page, write three equations that could be used to calculate magnification:

$\frac{h_i}{h_o} =$ $\frac{h_i}{h_o} =$ $\frac{h_i}{h_o} =$

7. Manipulate: If $\frac{f}{s_o} = \frac{s_i}{f}$, what is true about the product of s_o and s_i? _____

   Use the data you collected on the previous page to confirm that this relationship holds.

8. Practice: A candle is placed 14 cm in front of a concave mirror. The image of the candle is focused on a sheet of paper that is exactly 21 cm in front of the mirror.

   A. What is the magnification of the image? _____

   B. What is the focal length of this mirror? (Hint: Use the mirror equation.) _____

   Show your work:

9. Practice: A candle is placed 9 cm in front of a concave mirror with a focal length of 6 cm.

   A. How far from the mirror will the image be located? _____

   B. What is the magnification of this image? _____

   Show your work:

10. Challenge: When an object is between the focal point and a concave mirror, s_o is negative. What other values must be negative for your equations to still work? (Hint: The distance between the focal point and the lens (f) is always positive for a concave mirror.)

    _____

    _____

Name: _____ Block: _____

Station 2: Interactive Reading and Foldable

To complete this assignment, you will travel to different websites to read and look at diagrams in search of answers. Make sure to take your time to carefully find each answer!

Venture to http://www.mysciencesite.com/optics.html

Click under "To reflection and refraction p.3"

1. Light can be _____
2. Why are you able to see the tree?

_____

_____

3. Reflection involves what 2 rays?_____
4. The line perpendicular to the surface of reflection is _____
5. Reflection from a smooth, mirror-like surface is called _____
6. _____ is how we see illuminated objects.
7. The Law of Reflection states

_____

8. How does Refraction occur? _____

9. When light enters a denser medium the ray _____ and when it enters a rarer medium it is bent _____.

10. What happens to light when it passes through water?

_____

Click NEXT under "To mirrors, lenses and your eyes p.4"

11. The image you see in a mirror is a

_____

12. A virtual image is the _____size and shape as the object being reflected.

13. What are the 2 types of curved mirrors? Explain their differences.

_____

_____

14. What is a lens? Define the 2 types. (Drawing a picture always helps too!)

_____

_____

_____

_____

15. The lens of your eye is a _____

16. Where is the image focused onto?

_____

Take a look at the pictures of the eyes and answer the following questions.

17. Farsighted focuses _____ and is corrected with a _____ lens.

18. Near sighted focuses _____ and is corrected with a _____ lens.

19. What is your eye compared to? Why?

_____

_____

Click NEXT under "To optical illusions p.5"

Optical Illusions play tricks on our eyes….

20. How many legs does the elephant have? _____ How many faces do you see? _____

Part 2- Foldable

- Directions for Foldable on light and optics- Please use your book, notes, and other resources to complete foldable.

Direction to make a flipbook:

1. Take the three sheets of paper. Place them vertically on your desk.

2. Pull each sheet down. The top edges should be about one to two centimeters from the top of each page

3. Hold the paper. Fold the entire stack. The bottom edge should be about one to two centimeters below the top edge.

4. Turn the folded pages and staple the top.

Your flipbooks are now ready to use. It should look like the example below.

staple	staple	staple
Your Name Block Date		
Mirrors		
Lenses		
The Eye		
Optical Technology		

1. Must include the four main concepts (and must be colored):
    A) Mirrors
    B) Lenses
    C) The eye
    D) Optical technology

A. Mirrors must include the following with drawings:
    a. flat mirrors
    b. concave mirrors
    c. convex mirrors
    d. Law of Reflection

B. Lenses must include the following with drawings:
    a. concave lenses
    b. convex lenses

C. The eye must include:
    a. diagram of the eye and label the structures
    b. Explanation of how we perceive images

D. Optical technology must include:
    a. how optics are used each day
    b. examples of optical tools with drawings

Name: _____ Block: _____

Station 3- Concave and Convex Lenses/Mirror Mini- Labs

Mini- Lab #1- Forming an Image with a Lens

Procedure

1. Fill a glass test tube with water and seal it with a stopper.
2. Write your name on a 10-cm_10-cm card.
Lay the test tube on the card and observe the appearance of your name.
3. Hold the test tube about1 cm above the card and observe the appearance of your name through it again.
4. Observe what happens to your name as you slowly move the test tube away from the card.

Analysis

1. Is the water-filled test tube a concave or a convex lens?
2. Compare the images formed when the test tube was close to the card and far from the card.

Mini- Lab #2- Image Formation By a Convex Lens

- The type of image formed by a convex lens, also called a converging lens, is related to the distance of the object from the lens. This distance is called the object distance. The location of the image also is related to the distance of the object from the lens. The distance from the lens to the image is called the image distance. How are the image distance and object distance related for a convex lens?

Procedure

1. Design a data table to record your data. Make three columns in your table: one column for the object distance, another for the image distance, and the third for the type of image.

2. Use the modeling clay to make the lens stand upright on the lab table.

3. Form the letter *F* on the glass surface of the flashlight with masking tape.

4. Turn on the flashlight and place it 1 m from the lens. Position the flashlight so the flashlight beam is shining through the lens.

5. Record the distance from the flashlight to the lens in the object distance

6. Hold the cardboard vertically upright on the other side of the lens, and move it back and forth until a sharp image of the letter *F* is obtained.

7. Measure the distance of the card from the lens using the meter stick, and record this distance in the Image Distance column in your data table.

8. Record in the third column of your data table whether the image is upright or inverted, and smaller or larger.

9. Repeat steps 4 through 8 for object distances of 0.50 m and 0.25 m and record your data in your data table.

Analyze Your Data

1. Describe any observed relationship between the object distance, and the image type.

2. Identify the variables involved in determining the image type for a convex lens.

Conclude and Apply

1. Explain how the image distance changed as the object distance decreased.

2. Identify how the image changed as the object distance decreased.

3. Predict what would happen to the size of the image if the flashlight were much farther away than 1 m.

Mini- Lab #3- Reflection from a Plane Mirror

1. With the scissors, cut a slit in the construction paper and tape it over the flashlight lens.

2. Place the mirror at one end of the unlined paper. Push the mirror into lumps of clay so it stands vertically, and tilt the mirror so it leans slightly toward the table.

3. Measure with the ruler to find the center of the bottom edge of the mirror, and mark it. Then use the protractor and the ruler to draw a line on the paper perpendicular to the mirror from the mark. Label this line *P*.

4. Draw lines on the paper from the center mark at angles of 30°, 45°, and 60° to line *P*.

5. Turn on the flashlight and place it so the beam is along the 60° line. This is the angle of incidence. Measure and record the angle that the reflected beam makes with line *P*. This is the angle of reflection. If you cannot see the reflected beam, slightly increase the tilt of the mirror.

6. Repeat step 5 for the 30°, 45°, and *P* lines.

Conclude and Apply
Infer from your results the relationship between the angle of incidence and the angle of reflection.

Create- Make a small poster that shows your measured angles of reflection for angles of incidence of 30°, 45°, and 60°. Write the relationship between the angles of incidence and reflection at the bottom.

Name: _____ Block: _____

Through the Lens

Putting it All Together: Using technology resources, develop a solution to the following problem.

- In an imagined scenario of the *Witness Walls* art piece production phase, one of the depicted images of a leader in the Nashville Civil Rights Movement has his back to the audience (meaning, an image of his back is facing those who walk by the *Witness Walls* installation) as he is looking in a mirror. You should come up with a cost efficient way to recreate a witness wall using one of the pictures from the intro activity with spoons or a picture from the Nashville Civil Rights Movement. Please use your knowledge of lenses and mirrors to depict this situation.

- Here are a few things to consider when you are coming up with a solution to the problem:
  - His character feels like his "world is turned upside-down, " due to the Movement. Walter Hood would like the audience to be able to see this leader's face reflected upside-down in the mirror. Walter Hood has a variety of curved and flat mirrors in various sizes. Is there a way to produce an upside-down image? What are the best type of mirrors/lenses to use?
  - What solutions would you recommend to Mr. Hood that will be both time- and cost- efficient in solving these problems?
  - Your plan should not only include solutions to the problems, but also should describe HOW and WHY your solution will work.
  - Through your written plan, it is your job to convince Mr. Hood that your solutions are worth the time and energy investment.

Name/Group: _____

Project: _____

Date: _____ Period: _____ Total Points: _____

Putting It All Together Rubric

Knowledge of Content	Has a lack of understanding of types and functions of the different types of mirrors and lenses. 2 4 6	Shows some understanding of types and functions of the different types of mirrors and lenses. 8 10 12	Shows a good understanding of types and functions of the different types of mirrors and lenses. 14 16 18	Shows a full understanding of types and functions of the different types of mirrors and lenses. 20
Function of Model	Model would work poorly and group has a lack of understanding of the scientific principles underlying the construction. 2 4 6	Model would work fairly well and group has a good understanding of some scientific principles underlying the construction. 8 10 12	Model would work well and group has a good understanding of scientific principles underlying the construction. 14 16 18	Model would work very well and group has excellent understanding of scientific principles underlying the construction. 20
Organization	No evidence of planning. 2 4 6	Some evidence of planning but not always logical**.** 8 10 12	Well planned and follows a logical sequence. 14 16 18	Extremely well planned and has a smooth transition. 20
Oral Communication	Does not speak loudly enough to be understood. 2 4 6	Does not speak loudly and/or does not maintain eye contact. 8 10 12	Speaks loudly and maintains eye contact. 14 16 18	Speaks loudly and commands audience's attention. 20
Multimedia	Distracts audience from content and purpose. 2 4 6	Does not distract audience from content and purpose. 8 10 12	Supports content and purpose. 14 16 18	Greatly enhances content and purpose. 20

Additional comments:

Name: _____ Block: _____

Optics Assessment

1. Contrast the differences between the surfaces of the following types of mirrors: plane, convex, concave.

2. Diagram how light rays are reflected to form an image in a convex mirror.

3. How are concave mirrors used?

4. List at least three mirrors you see in everyday life. Describe how they are used. Identify each one as a plane, concave, or convex.

5. Describe the difference between a lens and a mirror.