**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](http://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**](http://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.

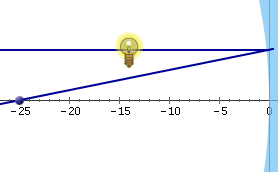
1. Look at yourself in the front of the spoon (the side where the food sits). What do you see?

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

1. 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?

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

1. 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. | RayTracingMirrorsSE2 |

**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.
2. What do you notice about the size of the light bulb’s image? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. What do you notice about the orientation of the light bulb’s image? \_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. 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. |  |

1. Analyze: Examine the results recorded in your table.
2. In general, how do the size and position of the image change when the distance between the light bulb and the focal point increases?

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

1. 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)**

1. 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.

1. 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).
2. What do you notice about the three lines reflected from the convex mirror?

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

1. 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.)

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

1. 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?

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

1. Apply: Which type of mirror would you use for the following applications, and why?
2. Cooking a hot dog: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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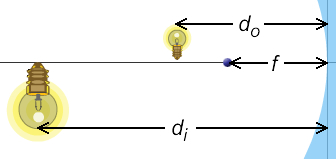
1. Surveillance in a convenience store: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

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| **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**. | RayTracingMirrorsSE3 |

**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:

*do*: Distance between object and mirror

*f*: Distance between focal point and mirror

*di*: Distance between image and mirror

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

*do* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *f* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *di* = \_\_\_\_\_\_\_\_\_\_\_\_\_

1. Gather data: Measure *di* for each of the following values of *do* and *f*. For the last two rows of the table, use your own values of *do* and *f*.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ***do*** | ***f*** | ***di*** |  |  |  |
| 15 | 10 |  |  |  |  |
| 25 | 10 |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

1. Calculate: Find the reciprocal of each value and fill in the last three columns of the table.
2. Analyze: For each row of the table, find the sum of  and . Record these values here:

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

What do you notice? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(Activity B continued on next page)Activity B (continued from previous page)**

1. Make a rule: Express the relationship between , , and 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.

1. 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:

1. 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:

1. 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, *di* and *f* are negative.)

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

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

|  |  |  |
| --- | --- | --- |
| **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. | RayTracingMirrorsSE5 |

**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.

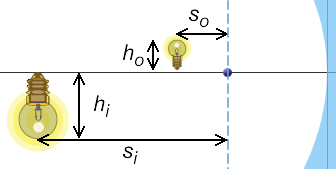
**Question: What determines the magnification of an image?**

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

*do* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *f* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *di* = \_\_\_\_\_\_\_\_\_\_\_\_\_

1. 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.

*ho*: Object height



*hi*: Image height

*so*: Distance from object to the focal point

*si*: Distance from image to the focal point

*ho* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *hi* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *so* = \_\_\_\_\_\_\_\_\_\_\_\_\_ *si* = \_\_\_\_\_\_\_\_\_\_\_\_\_

1. 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.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***do*** | ***f*** | ***di*** | ***ho*** | ***hi*** | ***so*** | ***si*** |  |  |  |  |
| 15 | 10 | 30 |  |  |  |  | 2.0 | 2.0 | 2.0 | 2.0 |
|  |  |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |  |

1. Calculate: Calculate the given ratios to fill in the last four columns of the table.
2. Analyze: What do you notice about the four ratios? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

**(Activity C continued on next page)Activity C (continued from previous page)**

1. Make a rule: The magnificationof 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:

= = =

1. Manipulate: If  = , what is true about the product of *so* and *si*? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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

1. 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.
2. What is the magnification of the image? \_\_\_\_\_\_\_\_\_\_\_
3. What is the focal length of this mirror? (Hint: Use the mirror equation.) \_\_\_\_\_\_\_\_\_\_\_

Show your work:

1. Practice: A candle is placed 9 cm in front of a concave mirror with a focal length of 6 cm.
2. How far from the mirror will the image be located? \_\_\_\_\_\_\_\_\_\_\_
3. What is the magnification of this image? \_\_\_\_\_\_\_\_\_\_\_

Show your work:

1. Challenge: When an object is between the focal point and a concave mirror, *so* 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**](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.