Laboratory Investigation Name ______________________________

Physics@Frisch: Form L9.3A Date ____________________ Period _____

Mirrors, Lenses, and Images

PROBLEM

How do mirrors and lenses form images?

INTRODUCTION

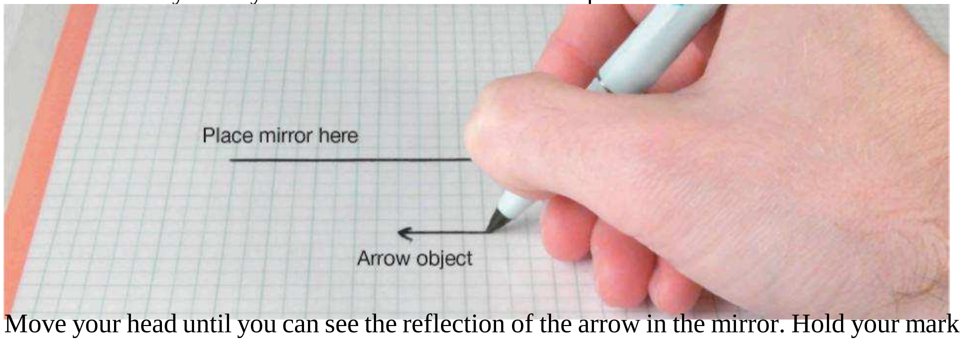
A lens uses the refraction of light to bend light rays to form images. A mirror also forms an image but with reflected light instead of refracted light. When you see something in a plane mirror, the light rays are reflected. The reflected rays appear to come from somewhere behind the mirror. You see a *virtual image* in the mirror because your brain "sees" where the light rays *appear* to come from instead of where they actually come from. Like a prism, a lens bends light. Because the shape of a lens is curved, rays striking different places along the lens bend different amounts. The laser allows us to follow the path of the incident and refracted rays. Rays that approach a lens *parallel to the axis* meet or appear to come from a point called the *focal point*. The distance between the center of the lens and the focal point is called the *focal length*. In this investigation, you will: use the laser flashlight to trace light rays from a lens to determine its focal length; show how ray diagrams are used to predict where images form with lenses and mirrors.

MATERIALS *(per group)*

Dark blue (concave) lens; Laminated graph sheet; Laser flashlight; Light blue (convex) lens; Mirror; Meter stick; Water-soluble marker

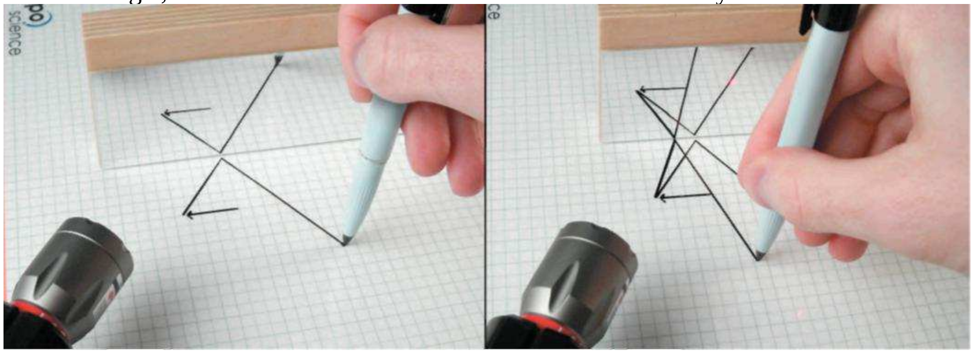
PROCEDURE

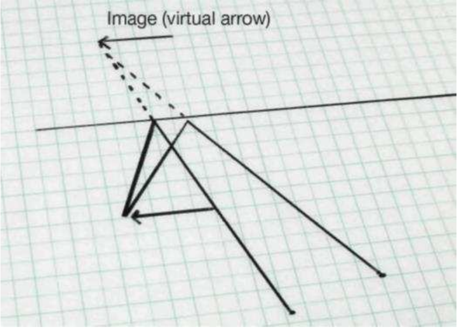
1. Draw a line with a water-soluble marker on the laminated graph sheet where you will place the mirror. Place the reflecting surface of the mirror along this line. Draw a 1-cm-long arrow on the graph paper about 3 cm away from your line. The arrow should be parallel to the line.



2. Move your head until you can see the reflection of the arrow in the mirror. Hold your marker straight up with the point on the tip of your arrow. Use the marker to set the laser beam so it passes right over the tip of your arrow, and hits the mirror. *CAUTION: Never look directly into a laser beam. Some lasers can cause permanent damage to your eyes.*

3. Trace the laser beam using the index card technique you learned in the previous investigation. Trace the incident and reflected beams. Move the laser so the beam passes over the tip of your arrow from a different angle, but still hits the mirror. Trace this second beam as you did the first.





4. Remove the mirror and use a ruler to extend the two reflected rays. They should meet in a point on the other side of the line from where the real arrow is. The meeting point for the reflected rays is where you see the image of the tip of the arrow. The image forms where all rays that leave the same point on an object meet together again. Measure the distances of the arrow and the image of the arrow from the mirror. Record your results below.

5. Divide your laminated graph sheet in half horizontally. You will use the top half to experiment with the light blue (convex) lens, and the bottom half will be reserved for the dark blue (concave) lens.

6. Place the laser on the edge of the laminated graph sheet and shine the laser so it follows a horizontal grid line across the paper. Place the light blue lens 10 cm to the right of the laser with the slot facing up. Line the lens up vertically using the grid lines on the graph paper. It is important that the beam is perpendicular to the lens. Make sure the beam of the laser is lined up with the middle of the lens. There are lines on the side of each lens indicating the middle of the lens.

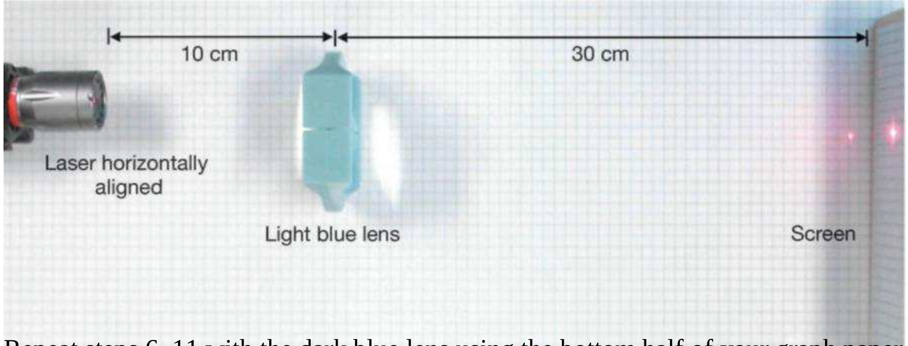
7. Trace around the base of the lens so it can be removed and put back in place in case you need to move it to complete ray tracing.

8. Shine the laser through the lens so the beam passes off-center, almost at the very outer edge of the lens. Trace the incident and refracted rays. Be sure to always carefully mark the points that the beam exits the laser, enters the lens, exits the lens, and then hits the block. Connect all these points to see the path of the beam.

9. Realign the laser with a different horizontal grid line parallel to the original beam and closer to the center of the lens. Again, trace the path of the beam before and after it passes through the lens.

10. Realign the beam so it passes directly through the center and trace the beam again.

11. Trace two more beams passing through the lens on the other side of the center of the lens for a total of five beams. Label the beams 1–5 on both sides of the lens. Note whether the rays converge or diverge. If the rays diverge, extend them back to the point they appear to come from in front of the lens. Mark the focal point on the ray diagram. Measure the focal length of the lens. Record the result below.



12. Repeat steps 6–11 with the dark blue lens using the bottom half of your graph paper.

OBSERVATIONS

Distance from Device		
Device	**Distance to:**	**Distance Measured (*cm*)**
Mirror	Object (arrow)	
	Image	
Light blue (convex) lens	Focal point	
Dark blue (concave) lens	Focal point	

CONCLUSIONS

1. How does the distance of the arrow in front of the mirror compare to the distance of the image behind the mirror? Does this agree with your expectations? ____

2. Describe the paths of the rays before and after they traveled through the light blue lens. Include the words *refract*, *converge*, and *diverge* in your description. ____

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3. Describe the paths of the rays before and after they traveled through the dark blue lens. Include the words *refract*, *converge*, and *diverge* in your description. ____

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4. What type of lens is a converging lens, concave or convex? ____

5. What type of lens is a diverging lens, concave or convex? ____

6. What type of image is formed by a plane mirror? ____

7. Which type of lens(es) can form a real image? Explain. ____

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