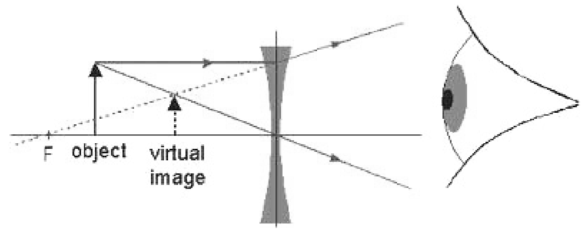
Name: David Gutierrez | Group Members: Claire Zhou, Yash Desai, Alvaro Espinoza, Kenneth Lin

LAB 15. RAY OPTICS: IMAGES OF CONCAVE LENSES

AP PHYSICS II

Driving Question | Objective



If a virtual image is the result of intersecting non-real refracted light rays, how can you determine its location without being able to project the image itself onto a screen?

You will attempt to determine the location of a virtual image using methods of parallax and multi-lens optics.

Conduct Your Experiment

Before going into this experiment, it is necessary to review basic optics properties. When dealing with multiple lenses, it would make sense that the light from the object passes through the first lens and forms an image (real or virtual). It is this image that the second lens "sees", not the original object. So in application, we can treat the image of the first lens as the object of the second lens.

Object 1 → Lens 1 → Forms Image 1 Image 1 = Object 2 → Lens 2 → Forms Image 2

Materials and Equipment

- Light Source
- Optics Bench
- -150 mm lens
- +200 mm lens
- Viewing Screen

Experimental Design

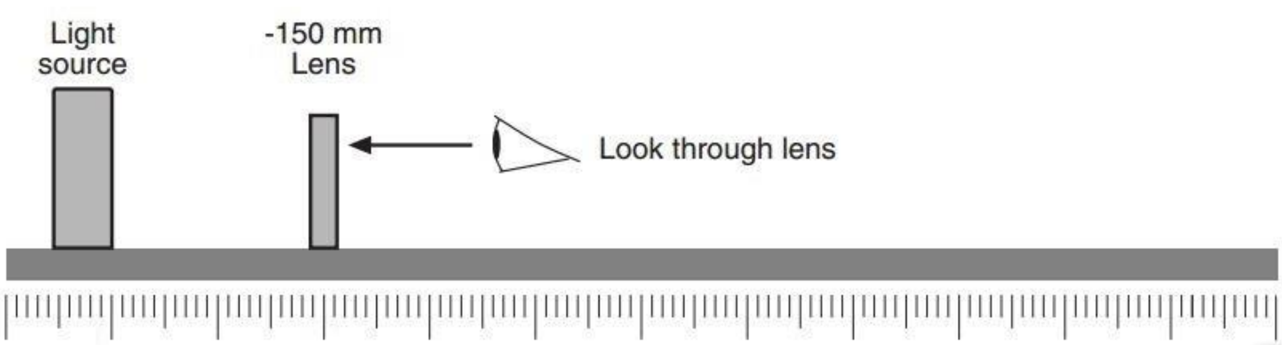
1. Place the light source (image side) somewhere near the beginning of the bench, but not at the 0 cm mark (example: 10 cm or 15 cm).

   Chosen Light Source Position: 10 cm

2. Place the -150 mm lens on the bench at a position greater than 150 mm, but less than 300 mm away from the light source.

   Chosen f = -150 mm Lens Position: 40 cm

3. Record the object distance d_{o1} in Table 1 on page 35.

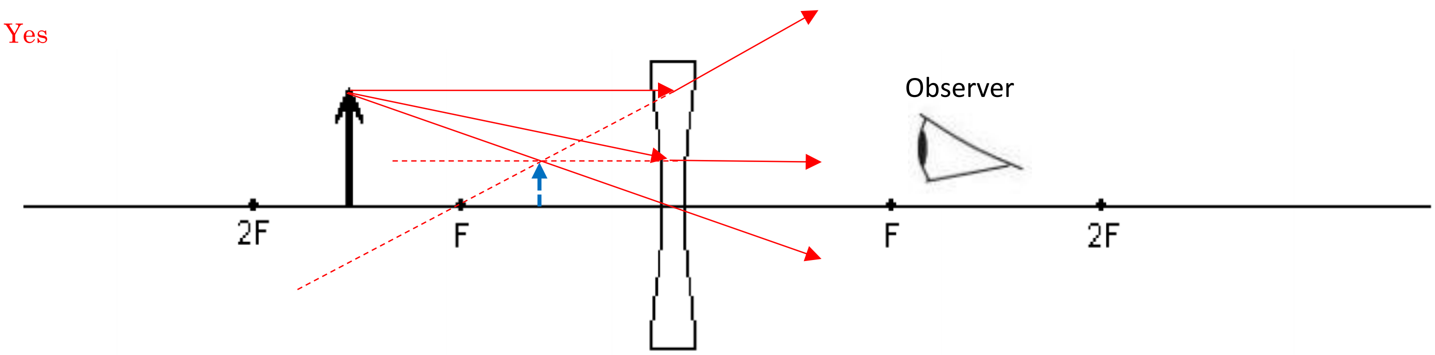


4. Looking through the lens toward the light source, describe the image. Is it upright or inverted? Smaller or Larger? It is smaller and upright.

5. Is the image closer or farther to you than the object? Is the image real or virtual? How do you know? The image is closer due to the parallax effect. The image virtual because the lens is concave

6. Using what you know about ray tracing at this point, does the location of the image match your prediction?

Yes



7. Does your Ray Trace Diagram confirm your hypothesis of the relative location of the image with respect to the object from Procedure #5? Yes

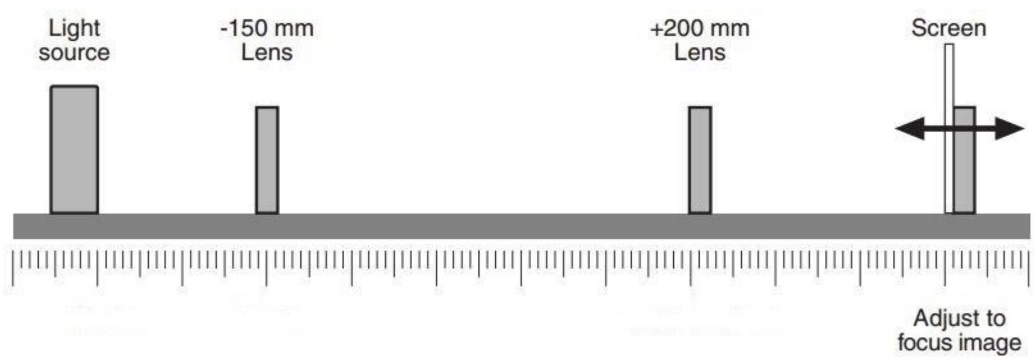
Now that you have an *approximate* location of the image, we will be attempting to find the *exact* location experimentally.

8. Place the +200 mm lens on the bench anywhere a distance greater than 200 mm from the -150 mm lens.

9. Record the +200 mm lens position: 70 cm

10. Place the viewing screen behind the +200 lens and slide the screen to a position where a clear image is formed on it.

11. Record the screen position: 110 cm



12. Is the image you see on the screen real or virtual? How to you know?

Real because convex images are always real.

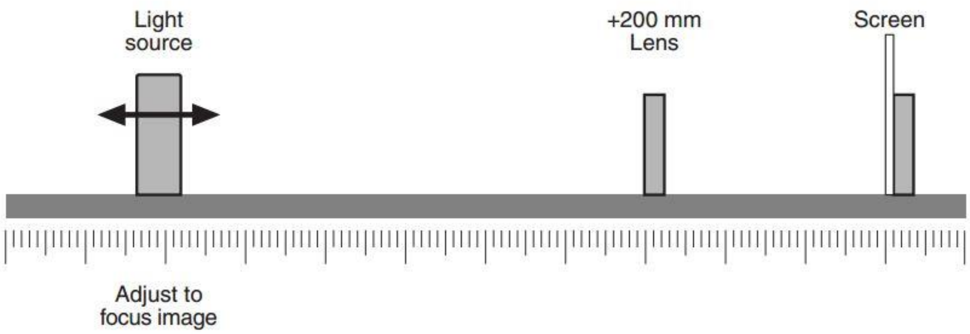
13. The image you see on the screen is the "*image*" from the +200 mm lens. But what acts as the +200 mm lens' "*object*"?

The image of the concave lens.

14. Remove the -150 mm lens from the bench. What happens to the image on the screen?

The image becomes blurry and defocused

15. While leaving the +200 mm lens and Screen in place, attempt to get your image back by moving the light source around to a new position.



16. Once you have formed a clear image on the screen, record the new position of the light source: 29.5cm

Analysis

We will be making a comparison between the experimental image distance and calculated image distance.

1. How do you think this new position of the Light Source compares to the position of the virtual image formed by the -150 lens. Why?

The positions should be the same because the focal length of the convex length does not change.

2. Record the distance between the chosen position of the -150 mm lens (Procedure #2) and the position of the light source from Procedure #16 as d_{i1} Experimental.

-150 mm was 40 cm and the light source was -10.5 cm.

3. Calculate the virtual image distance d_{i1} (the distance between the f = -150 mm lens and the virtual image) using the Thin Lens Formula $\frac{1}{f} = \frac{1}{d_{o1}} + \frac{1}{d_{i1}}$. Record this value in the table below for d_{i1} Theoretical.

1/-15 = 1/29.5 + 1/di   di = -9.9 cm

4. What do you notice about the sign of d_{i1} Theoretical? What do you think this means?

It’s negative this means there is a positive magnification and the image is not inverted

5. Calculate the magnification and record it in Table 1 below. $M_1 = -\frac{d_{i1}}{d_{o1}}$ using your experimental values.

Table 1: Negative Lens Info.

d_{o1}	29.5 cm
d_{i1} Experimental	-10.5 cm
d_{i1} Theoretical	-9.9 cm
M_1	.356

Analysis

❓ 1. How do you know that the final position of the light source is identical to the position of the virtual image when the negative lens was on the bench?

They both must be at the focal point so that the projected image remains focused.

❓ 2. In step 5, you predicted the position of the virtual image relative to the light source. Was your prediction correct?

Yes, my prediction was correct.

❓ 3. Is M_1 positive or negative? How does this relate to the appearance of the image?

M_1 is positive. This means that the image appears upright.

❓ 4. Calculate the % error of the calculated and measured position of the virtual image.

6.06%

Save this file as a PDF (NOT WORD!) document for submission.