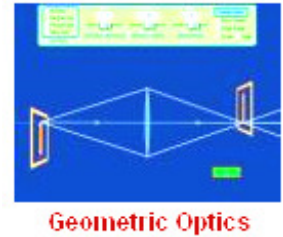


Ray Optics PhET Lab

Introduction:

When you hold your glasses far away from your face, what do you see? If you look through a magnifying glass and move it away from your face, something odd happens as you look through the moving lens. The light that reflects off images and passes through a lens before it arrives at your eye can be simulated as a series of rays. In this lab, you will investigate lens optics using the 3-ray system (parallel-focal, focal-parallel, central). Remember, the *real* focal point of a lens is *behind* the lens. The lens we will use in this simulation is a thin double-convex lens.

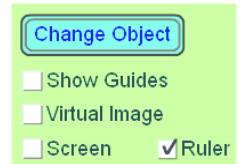


Important Formulas: $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ or $\frac{1}{f} = \frac{1}{p} + \frac{1}{q}$ $\frac{1}{f} = (n-1)\frac{2}{R}$ $m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$ or $m = \frac{h_i}{h_o} = \frac{-q}{p}$

Please note that in some texts, the object's distance is given by "p" and the image's by "q"

Procedure: *PhET Simulations* → *Play With Sims* → *Light and Radiation* → *Geometric Optics* Run Now!

- Take some time and familiarize yourself with the simulation. You are able to move the object and the lens and change the characteristics of the lens. During this lab, be sure to always anchor your image on the principal axis. The pencil's eraser works well for this.
- Click Principal rays to draw the rays using the 3-ray system you learned in class.
- Move the object towards the lens. What happens to the image formed on the other side of the lens?



- As you move the object inside the lens' focal point something odd happens. Rays that don't meet **diverge**. Does this mean no image will be formed? _____ Where is the image? _____
- Click on "Virtual Image." How are a real image and a virtual image similar? _____ How are they different? _____

- Click on the ruler. You will need to make several measurements during the lab. You may, if you wish, leave your measurements in **cm** when using the formulas given above.

- Set the lens's refractive index (n) to 1.8 and the radius of curvature (R) to 0.7m. Use the appropriate equation above to solve for the focal distance (f). $f = \underline{\hspace{2cm}}$



(Measure the focal distance to confirm your answer.)

- Using the focal distance you just found, complete the table below and check your work in the simulation.

focal distance (f)	distance object (d _o)	distance image (d _i)	magnification (m)
	120. cm		
	90. cm		
	60. cm		
	30. cm		
	15 cm		

Graded 1/2 point each

- Repeat the previous exercise, but with a very different lens with the following characteristics: $R = 80\text{cm}$, $n = 1.25$



WATCH YOUR SIGNS Real images' d_i should be + / - while virtual images should be + / -

focal distance (f) distance object (d_o) distance image (d_i) magnification (m)

solve for this first	120. cm		
	90. cm		
	60. cm		
	30. cm		
	15 cm		

Conclusion Questions and Calculations: 1/2 point each

- Images found behind a lens are *real* / *virtual* images that will be *upright* / *inverted*.
- As the radius of curvature of the lens increases, the focal point of that lens becomes *closer to* / *further away from* that lens.
- As the refractive index of the lens increases, the focal point of that lens becomes *closer to* / *further away from* that lens.
- What advantage does a larger lens have over a smaller lens (all other characteristics being equal)?

- What was the focal distance (f) when the radius of curvature was .70 and index of refraction was 1.8? _____
- Calculate the radius of curvature of a lens with a focal distance of 40. cm and an index of 1.2. _____
- An object placed 35cm away from a lens projects a real image .55m behind the lens. What is this lens' focal distance?

- What is the lens' magnification? _____
- An object 20. cm to the left of a **convex lens** is 1.0 m in height. What is the height and location of its image if the lens has a magnification of **-2.0**? _____ m and _____ cm on the *left* / *right* side of the lens
- Imagine you are nearsighted (can only see close objects clearly and far objects are blurry). At your last eye doctor's appointment, your optometrist tells you that she will need to **increase** your prescription because as it turns out light is focusing "too soon" or in front of your retina. You respond, "Obviously, I will need a *converging* / *diverging* lens with a *higher* / *lower* focal distance."