86 Where's the Point?

Experiment

Purpose

To measure the focal length of a diverging lens

Setup: <1
Lab Time: >1
Learning Cycle: concept development
Conceptual Level: moderate
Mathematical Level: moderate

Thanks to Herb Gottlieb for his ideas and suggestions for this lab.

Required Equipment/Supplies

low-powered helium-neon laser
diverging lens
sheet of white paper
meterstick
graph paper (if computer is not used)

Optional Equipment/Supplies

computer
data plotting software
printer

Discussion

Parallel light rays are brought to a focus at the focal point of a converging lens. Ray diagrams are useful for understanding this. Parallel light rays are *not* brought to a focus by a diverging lens. Ray diagrams or other techniques are essential for understanding this. In this experiment, you will use a laser to simulate a ray diagram for a diverging lens. Lasers are fun!

Procedure

Set up laser.

Step 1: Carefully (lasers are delicate!) place the laser on a table. Do not point it at any mirrors, windows, or persons.

Observe diverging laser beam.

Step 2: Place a diverging lens in front of the laser. Turn on the laser. Use the sheet of white paper to observe that the beam is very narrow as it comes out of the laser, but after going through the lens, it spreads out into an ever-widening cone.

Step 3: Place the sheet of paper against a book. Hold the paper 5 cm beyond the lens that is in the laser beam. The red spot made by the beam should be in the center of the paper. With a pen or pencil, trace the outline of the red spot. Label the outline "distance 5 cm."

Distance From Lens (cm)	Diameter of Laser Spot (cm)
5	
10	
15	
20	

Data Table A

Step 4: Move the paper 5 cm farther away from the lens, and again trace the outline of the spot that is produced. Label the outline with the new distance. Repeat this procedure, increasing the distance between the lens and the paper by 5-cm intervals, until the spot completely fills the paper.

Step 5: Measure the diameters of the traces of the laser beam on the paper for each position of the paper. Record these diameters and distances from the lens in Data Table A.

Step 6: Plot a graph of the beam diameter (vertical axis) vs. the distance (horizontal axis) between the lens and the paper. Allow room on your graph for negative distances (to the left of the vertical axis.) If available, use data plotting software to plot your data.

Step 7: To find the distance from the lens at which the beam diameter would be zero, extend your line until it intersects the horizontal axis. The negative distance along the horizontal axis is the focal length of the diverging lens. If you are using data plotting software, include a printout of the graph with your lab report.

focal length of lens = _____ cm

Analysis

The focal length of a convex lens is the distance from the lens where parallel light rays are brought to a focus. Why is it impossible to find the focal length of a diverging lens in this manner?

The focal length of a diverging lens cannot be found in the same manner as that of a convex lens, because the parallel light rays never converge to a focus. The focal length of a diverging lens is the distance to the lens from a point *behind* the lens from which diverging light rays *appear* to have originated.