

# Three Lasers Converging at a Focal Point : A Demonstration

## Overview

In this activity, students will see how we can use the property of refraction to focus parallel rays of light. Students will observe how a convex lens can cause parallel rays of light to converge.

## Students Will Learn...

- ◆ A convex lens can cause parallel rays of light to converge.
- ◆ The point at which parallel light rays meet is called the focal point.
- ◆ The distance from the lens to the point where the light rays meet is called the focal length.

## What You Need

*For the class:*

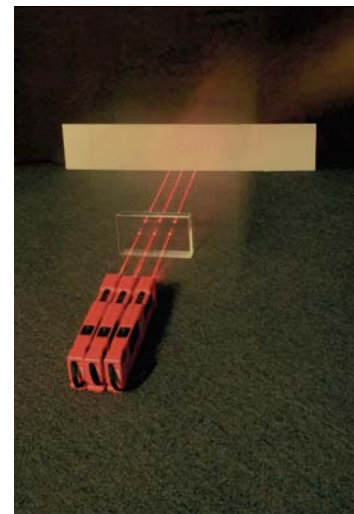
- ❑ 3 laser pointers
- ❑ 1 acrylic block
- ❑ 1 velum screen or a wall
- ❑ 1 large positive lens
- ❑ mister

*For each student:*

- ❑ Copy of “STUDENT HANDOUT: Which Laser Produced Which Spot?”

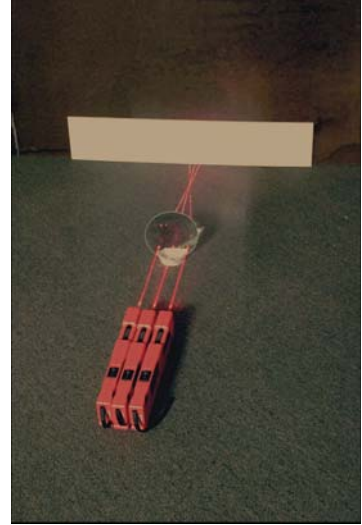
## Getting Ready

1. Clear a space on a table. Set up three lasers next to each other so they will produce parallel beams of light. The lasers need to be close together so they all pass through the lens. There are two ways to accomplish this. One is to not use the supports and use a rubber band to hold the lasers together as shown in the diagram above. The second technique is to stagger the lasers and use the supports. Put the laser on the right in front, then the laser in the middle set slightly back, and the laser on the left back further still. The most important thing to remember is that the beams must be parallel. It does not matter if one laser is closer to the lens than the others.
2. Set up a velum screen several feet away from the lasers (or alternately, have the lasers project onto a wall or other vertical surface).
3. Make a holder for the large positive lens. Cut the bottom off a Styrofoam cup so that the lens will sit in the cup. You may want to cut small notches in the side of the cup to make the lens more stable.



### GO: Three Lasers Converging at a Focal Point

1. Shine the lasers through the piece of acrylic block and onto the velum screen. The three beams need to be shining at normal incidence to the block so that the beams go straight through and hit the target producing three spots. Ask the students which spot on the screen corresponds to which laser and have them fill out their worksheet. In this case: the laser on the left produces the spot on the left, the center laser corresponds to the center spot, and the laser on the right corresponds to the spot on the right.
2. Slowly rotate the block so that the lasers now hit the block at an angle. Ask the students to describe what is happening to the spots.
3. Now replace the glass block with the positive lens. Two things to note here: The center laser beam needs to go through the center of the lens, and the set up should have the screen placed at a distance away from the laser such that the three spots are similar in appearance as they were for the glass block. Again, ask the students which spot, corresponds to which laser. This time the left laser produces the spot on the right and the right produces the spot on the left. The center beam is unchanged. Ask the students what is different.
4. You can use the screen or a spray of water from the mister to show the path of the three beams. Alternately, you can turn off the lasers one at a time and see which spot disappears. Ask the students for the name of the point where the three beams touch [focal point]. Explain that the beams are parallel, just like rays from an object at infinity, and they come to a focus at a distance that is equal to the focal length of the lens. (See the note in the sidebar of this page.)



**NOTE:** This is a place in the module to make it clear to the students that the focal point of a lens is a property of the lens and it DOES NOT change. Images are formed where rays are in-focus, which is NOT necessarily where the focal point of the lens is.

### What's Really Happening Here...

A converging lens, sometimes called a positive lens (due to the fact that it has a positive focal length) is capable of focusing parallel light rays down to a single point, called the focal point. You will notice that a converging lens has a curved surface and is thick in the middle and thin at the edges. Light rays that pass through the center of the lens will not change direction. Light rays that hit away from the center of the lens have a different angle of incidence. Therefore, they are refracted and will change their direction of travel. The shape of a converging lens causes all incoming parallel light rays to converge to a single point.



The converging lens can focus incoming light rays that are not parallel as well. These light rays will not converge at the focal point. For more information, see “Finding the Focal Length Using a Distant Object: What’s Really Happening Here...”

**Going Further**

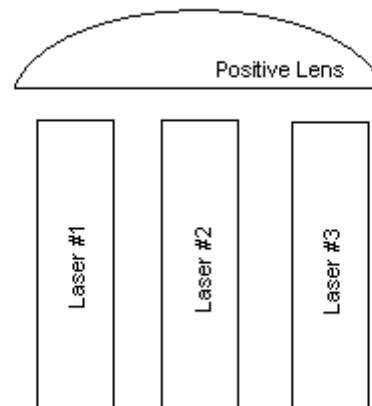
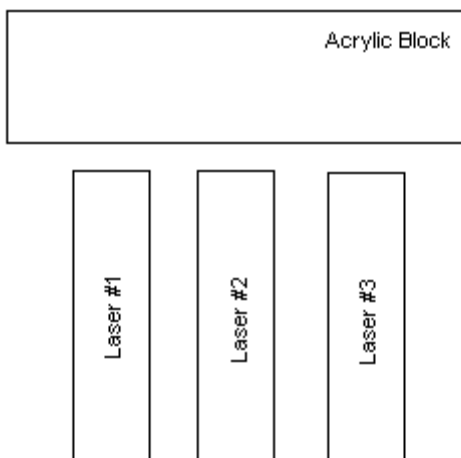
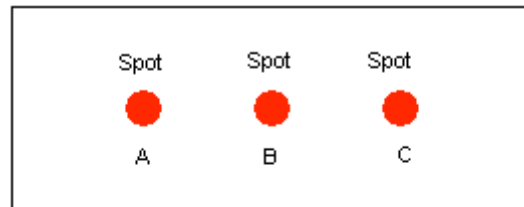
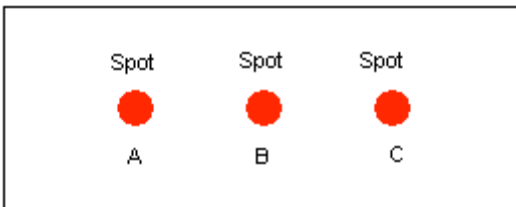
Can students find other materials in the classroom that can be used to create a focal point.



# STUDENT HANDOUT: Which Laser Produced Which Spot?

## What To Do

1. Predict where you think the path that the laser beams will follow by drawing lines from the end of the lasers to the labeled spots.
2. Observe your instructor's demonstration. Then answer the questions on the next page.



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3. What happens to the beams of light from the three lasers as the beams go through a block of acrylic (left picture)?
  
4. What happens to the beams of light from the three lasers as the beams go through a large lens (right picture)?
  
5. In the table below, indicate which spot (A, B, or C) is created by Laser #1, 2, or 3 when passing through the acrylic block.

Laser #	Through Acrylic Block	Through Large Lens
	Spot	Spot
1		
2		
3		

6. In the table above, indicate which spot (A, B, or C) is created by Laser #1, 2, or 3 when passing through the large lens.
  
7. Why do the laser beams act differently when they travel through an acrylic block and a lens?

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