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Laser Optics Kit
#LSOPT7

Warning:

- **Not a toy; use only in a laboratory or educational setting.**
- **California Proposition 65 Warning: This product can expose you to chemicals including nickel, lead, and styrene, which are known to the State of California to cause cancer, birth defects, or other reproductive harm. For more information go to www.P65Warnings.ca.gov.**

Introduction

Lasers are an ideal tool for demonstrating the various behaviors of light. They differ from light sources like light bulbs or the sun, which produce light of many different wavelengths and in all directions, because their wavelengths are **spatially coherent,** essentially meaning that the individual wavelengths in the laser are focused tightly into a narrow beam. This quality of lasers makes them ideal for demonstrating behaviors of light such as **reflection** and **refraction. Reflection** describes light when it bounces off of a surface, and **refraction** describes light when it passes through a new material causing it to change its speed and direction.

This kit will allow you to visually explore reflection and refraction using a laser box that can produce a single beam, three parallel beams, or five parallel beams .

Components

1. Storage Case
2. Laminated Protractor and Ruler
3. Magnetic Protractor and Ruler
4. Quick Reference Sheet
5. Laser Ray Box
6. Refraction Tank (60mm)
7. Cleaning Cloth
8. Mirror
9. Bi-convex Acrylic Shape
10. Isosceles Triangle Acrylic Shape
11. Rectangular Acrylic Shape
12. Power Cord
13. Bi-concave Acrylic Shape
14. Semi-circle Acrylic Shape
15. Trapezoid Acrylic Shape

How to Use

Your laser optics kit contains a variety of components that you can use to experiment. Each piece in the kit can be used in combination with others to manipulate your lasers. Page 2 of this guide will be referenced to call out each piece when necessary. How you use your kit is up to your imagination, but the following instructions will provide you with a baseline understanding of each piece's use:

Using Your Laser Ray Box

1. Gather your laser ray box (**#5**) and its power cord (**#12**).
2. Plug your power cord into a wall outlet, and then plug its other end into to port on your laser ray box.
3. Press the small red switch in the bottom left corner of the face of the box to turn it on. **(Caution:** Pay attention when turning your laser ray box on to make sure it is not pointing in the direction of anyone's eyes. Lasers can cause damage to eyes.**)**
4. Use the silver toggle switch on the box to choose how many lasers your box produces. The upright, center position of the switch will produce a single laser from the middle of the box. When the switch is toggled up towards the top of the box, the middle three lasers will turn on. When it is toggled down towards the bottom of the box, all five lasers will turn on. All lasers on the box are parallel and equally spaced apart. Using the single beam will allow you to easily measure specific angles of refraction and reflection. The multi-laser settings are useful for visually comparing the paths the lasers take when they come into contact with different shapes and angles.

Using You Acrylic Shapes

1. Chose which shape(s) (**#6, #9, #10, #11, #13, #14, #15**) you wish to use to obstruct your laser's path.
2. Clean your shape(s) with your cleaning cloth (**#7**) to make sure any smudges and dirt don't affect your lasers.
3. Place your shape down onto your workstation with its frosted side in contact with the table. This will allow you to see the laser pass through the shape.

Using Your Mirror

1. Decide how you want to configure your kit's flexible mirror (**#8**). Using the two posts on either side of the mirror, you can choose whether you want a flat reflecting surface, a concave reflecting surface, or a convex reflecting surface. For a flat surface, make sure the notches in the posts that hold your mirror are facing each other, and then tighten the mirror into position using the tightening screws on the underside of the posts. For a concave or convex surface, twist the posts until the notches on the posts both angle upwards so that the mirror held between them has an even curve, and then tighten the screws on the posts. **(Note:** Do not bend your mirror too harshly, as you can cause permanent damage to it.**)**
2. Clean your mirror with your cleaning cloth (**#7**) to make sure any smudges and dirt don't affect your lasers.

Experimenting with Your Mirror and Shapes

1. Turn your laser box on. Determine if you will be measuring specific angles or comparing laser paths in relation to where they come in contact with the shape(s) you chose.
2. Use your quick reference sheet (**#4**) to help you determine how you want to watch your laser(s) behave according to the obstructions you place in front of them.
3. Experiment with using multiple shapes and your mirror to see what paths you can make your laser(s) take.
4. Place your protractors and rulers (**#2 and #3**) beneath your shapes if you wish to measure the effects different shapes have on your lasers' paths.

How to Measure Refractive Indices with Snell's Law

Your kit, in addition to being a great tool for visualizing reflection and refraction, is also equipped to teach the principle behind refraction known as **Snell's Law.** Refraction is the change in the direction of a wave due to it changing phase velocity when passing through a new material. This phenomena takes place with any waves passing through two different media. It is accurately measured and predicted by **Snell's Law**, which mathematically links the **indices of refraction** of the two substances a wave passes through with the **angles of incidence and of refraction.** Below you will read how to use your kit to learn this principle:

1. Locate your semi-circle acrylic shape (**#14**) for this experiment. This shape will allow you to find the refractive index of the acrylic used in your kit.

2. Place the midpoint of the flat edge of your shape onto the center of one of your kit's protractors.

3. Turn your laser ray box on with it set to project a single laser beam.

4. Using the illustration below as a guide, shine your single laser beam onto the midpoint of the flat edge of your shape.

5. Calculate the refractive index of the acrylic in your shape ($\mathbf{n_2}$) using Snell's Law.

6. Once you have determined the refractive index of the acrylic, you can confirm Snell's Law by calculating the angle of refraction using a different angle of incidence than the one you used in step 4 to predict the path the laser before actually shining the beam through the shape.

7. Locate your refraction tank (**#6**) to use place of your semi-circle shape. This tank can be filled with any fluid in order to measure its refractive index. When empty, it can be used to test the refractive index of air.

8. Repeat steps 4 through 7 using your refraction tank filled with the fluid of your choosing.

Snell's Law

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

- n_1 = Refractive Index (1)
- n_2 = Refractive Index (2)
- θ_1 = Angle of Incidence
- θ_2 = Angle of Refraction