614-0122 (50-080) Optical Bench, 1 m Deluxe

Description:
Lenses exist in both nature and technology. Lenses are made of transparent material and their index of refraction is different from the surrounding medium (e.g., air). Examples of lenses are the eye, glass, etc. Light rays are bent or refracted when they pass from one material to another. When light rays pass from air into a convex lens and back out again they are bent toward the focal point. Images are formed when light rays cross or appear to cross. There are two types of images, real and virtual. Real images are formed after the light rays have passed through the lens and have passed through the focal point. They are inverted and can be projected on a screen. Virtual images are located on the same side of the lens as the object and are viewed by looking through the lens at the object which appears to be a different size than it actually is. A virtual image for a convex lens is erect, larger than the object and is located where light rays only appear to cross.

How to Teach with Optical Bench, 1 m Deluxe:
Concepts Taught: Focal Length
Curriculum Fit: Lenses; images; optics
Grades 6-8 and up.

Additional Materials Needed:
- **615-4010** Battery Holder 4 D-cell OR 6V DC power supply (for use with included lamp)
- D cell batteries

Experiment 1: Measurement of the Focal Length of a Converging Lens by the Conjugate Foci Method

Note: Experiment should be performed in a dim or dark room.

1. Set up the optical bench on a flat surface.
2. Place three black sliders on the optical bench track.
3. Mount the 45 mm convex lens, the white screen and the light source on three of the slide rods on three of the pedestal ends.
4. Place the screen as close as possible to one end of the optical bench (~96 cm) and the lamp as close as possible to the other end (~1 cm). The lens should be located on the slider in between the screen and the light source.
5. Attach the ends of the wire leads to the battery holder so that the light source is operational.
6. There are two places in which the lens can be placed in order to form an image on the white screen. One of the images will be small and bright while the other image is large and dim. Find these two places and record the values below.

   Large and dim = ____ (cm)
   Small and bright = ____ (cm)

7. Use the following equation to determine the focal length:

   $$f = \left(\frac{L^2 - d^2}{4L}\right)$$

   L = distance between object (light source) and screen
   d = distance between two different lens positions (dim and bright)

Experiment 2: Measurement of the Focal Length of a Diverging Lens

Note: Experiment should be performed in a dim or dark room.

In this part of the experiment, a real image will be used as a virtual object. A concave lens cannot form a real image of an object, and there is no way to determine its focal distance directly. However, by using a converging lens in conjunction with a diverging lens we are able to calculate the focal length of the diverging lens.

1. Place the lamp at some position, O_c (~1 cm). Connect the lamp to the battery holder, so that it's operational. The lamp will remain stationary throughout the experiment.

2. Place the screen at a position at the other end of the optical bench (~96 cm). Record position below.

   Screen = ____ (cm)
3. The convex lens (45 mm) should be placed in between the lamp and the screen. Starting at the lamp, slide the convex lens toward the screen until it forms a large and dim image on the white screen. Record the position of the convex lens, $I_{convex.}$ This image serves as the virtual object for the next part of the experiment.

   I_{convex} = ____ (cm)

4. Place the diverging lens (35 mm concave lens) next to I_{convex}, and in between the convex lens and the location where the image was formed on the screen.
5. Move the concave lens away from the convex lens, toward the screen, in order to form a clear image on the white screen. Record the position, $I_{concave}$, of the concave lens. Calculate the image distance below.

   q = Screen position (cm) – $I_{concave}$ (cm)

   q = ____ (cm)

6. The focal length of a thin lens is given by:

   $$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

   p = object distance (i.e., $I_{concave}$ (cm) – I_{convex} (cm))

   f = ____ (cm)

Note: Many more creative optics experiments can be fashioned using the materials provided with this kit.

Warranty and Parts:
We replace all defective or missing parts free of charge. Additional replacement parts may be ordered toll-free. We accept MasterCard, Visa, checks and School P.O.s. All products warranted to be free from defect for 90 days. Does not apply to accident, misuse or normal wear and tear. Intended for children 13 years of age and up. This item is not a toy. It may contain small parts that can be choking hazards. Adult supervision is required.