CENTRAL SCIENTIFIC COMPANY

OPERATING INSTRUCTIONS

Complete Optical Bench Set
No. 31023

1. Introduction

Our Complete Optical Bench Set contains everything students need to perform a variety of precise optical experiments in the classroom. The included 120cm-long graduated bench securely holds optical devices such as light sources, lenses, and other accessories. Students can easily adjust the positions of optical devices using the included carriers, which won't tip even when the guide rails are inclined. All the accessories are easy to mount and adjust.

Because the experimental possibilities are many, we've included just a few basic experiments. For example, students learn how to find the focal lengths of concave and convex lenses. Using the photometer and candles, they'll learn that the light's intensity decreases with the square of the distance between these objects.

2. Description

The Complete Optical Bench Set contains the following pieces of equipment (see figure 1):

1. 120cm-long graduated bench
2. 6 carriers
3. photometer
4. graduated ground-glass screen
5. image-formation object
6. 2 electric sockets
7. single- and 4-pronged candle holders
8. 2 lens/mirror holders
9. 5-hole diaphram
10. parallax bar (pointer?)
11. 2 convex lenses
12. 1 concave lens
13. 1 plane mirror

Figure 1

The 120cm-long precision-made bench has a scale with millimeter graduations. Two metal support feet with set screws are used to level the bench of a flat surface. The sides of the bench provide guide rails for the 6 included carriers, which hold accessories. Each carrier has one set screw for attaching it to the bench, and a second set screw and socket for attaching an accessory. The index window on each carrier has a marker that indicates its exact position on the scale.

The photometer, graduated screen, image-formation object, electric sockets, candle holders, diaphram, and parallax bar all have metal rods for mounting them onto the carriers. The photometer consists of a housing with a light window, an opaque internal barrier, a split paraffin block, and a viewing window (see figure 2). The photometer detects any difference in the intensity of the light falling on opposite sides of the bench.

Figure 2

The electric sockets have on/off switches and plugs for connecting them to standard AC wall outlets. The lens/mirror holders have adjustable blocks and set screws for securing the concave and convex lenses and the plane mirror. The 5-hole diaphram has holes of 5 different diameters and a small peg for rotating the diaphram to the desired setting. The parallax bar consists of one large rod with a hole and a set screw and one small rod.

3. Setup and Operation

Place the optical bench on its 2 metal support feet on a flat surface. Turn the leveling screws on the feet until the bench is horizontal. To attach a carrier, slide it over the guide rails at one end of the bench so the index marker is over the top of the scale. To secure the carrier in position, tighten its lower set screw. Experiments can also be performed on an inclined surface.

To attach an accessory to the carrier, such as the photometer, insert the accessory's mounting rod into the carrier's socket. Tighten the carrier's upper set screw to secure the accessory. To put a lens or the plane mirror into a lens/mirror holder, loosen the screws behind both blocks on the holder. Slide the blocks apart and place the lens or mirror between them. Close the blocks around the object and tighten the screws so they firmly grip the object.

To assemble the parallax bar, insert the smaller rod halfway through the hole in the larger rod. Tighten the set screw. Mount the parallax bar onto the bench using a carrier. To use a pronged candle holder, push the bottom of a candle onto a prong to secure it. Mount the candle holder onto the bench using a carrier.

Before connecting an electrical socket, be sure it's unplugged. Mount the socket on the bench using a carrier. Screw a light bulb into the socket, plug the cord into a standard AC wall outlet, and press the on/off switch to illuminate the bulb. To use the 5-hole diaphram, mount it on the bench using a carrier. Turn the small silver peg to rotate the diaphram until you can see through the desired hole.

Although optical bench experiments don't require a dark room, you should use the photometer to determine whether the light falling on opposite sides of the bench has the same intensity. After attaching the photometer to the bench, look through the viewing window to compare the amounts of light penetrating both halves of the paraffin block. If the light is equal on both sides, you won't detect any difference between the two halves of the circle. If the light is not equal, the two halves will appear different shades. Adjust the lighting until the circle appears to be one shade.

The pointer (parallax bar?) is used to align equipment on the optical bench (and to find the distance between its surfaces?) To align two lenses on the bench, insert the pointer into a carrier. Slide the pointer next to the first lens holder. Adjust the height of the pointer so it reaches the center of the lens. Lock the pointer at that height using the carrier's upper set screw. Slide the pointer down the bench next to the second lens holder. Lock the second lens holder in place so the top of the pointer again reaches the center of the lens.

A. Convex Lens Experiment

This simple experiment teaches students how to accurately measure the focal length **f** of a convex lens. When the parallel beam emitted from the light source penetrates a convex lens, the interval **f** equals the focal length of the lens (see figure 3).

Figure 3

To measure the focal length of a convex lens, attach an electric socket to a carrier at one end of the optical bench (see figure 4). Be sure the socket is unplugged before proceeding. Screw a light bulb into the socket and plug the cord into a standard AC wall outlet. Attach the image-formation object screen to the bench a few centimeters in front of the light bulb. Secure a convex lens into a lens/ mirror holder and attach the lens holder to the bench at a distance **a** from the light source (see figure 4). Attach the graduated ground-glass screen to the bench at a distance **b** from the lens. Turn on the light source.

Figure 4

Measure the intervals **a** and **b** in centimeters, and graph the results as shown in figure. 5. Note that all the light rays converge at point **F**, which is the focal point of the convex lens.

Figure 5

B. Parallax Experiment

A parallax is the apparent change in the relative orientations of objects when viewed from different positions. For example, this optical phenomenon occurs when you try to read an instrument's scale. Because the observer's eye and the pointer on the instrument's scale are not in a line perpendicular to the plane of the scale, a small reading error occurs (parallax). This brief experiment show students how to determine the focal length of a convex lens using the parallax effect.

Attach the single-pronged candle holder to a carrier at one end of the optical bench. Attach a convex lens to one lens/mirror holder and the plane mirror to the second holder. Attach the holders to the bench as shown in figure 6. (You can see the inverted reflection on the screen from the left side?). Slide the convex lens along the optical bench until you find a position without parallax between point **P** and point **Q**. At this point, the interval between the candle stand and the convex lens equals the focal length **f** of the lens.

Figure 6

C. Concave Lens Experiment

This simple experiment teaches students how to accurately measure the focal length **f** of a concave lens (shape). Place a black box (or screen?) on one side of the optical bench (see figure 7); this step makes observing the light rays easier. (use incense stick?) Place a light source at one end of the bench. Attach a concave lens to a lens/mirror holder and attach the holder to the bench using a carrier. Turn on the light source. Note that the parallel beam emitted from the light source diverges at point **A** (by way of the concave lens?). Point **A** is called the (nothingness?) point. The interval (cm) between point **A** and the concave lens equals the focal length **f** of the lens.

Figure 7

D. Light Intensity Experiment

This experiment teaches students that the intensity of light decreases with the square of the distance between the light source and an object. Attach the photometer to the optical bench between the single-pronged and the 4-pronged candle holders, as shown in figure 8. Push a candle onto the single-pronged holder and two candles onto the 4-pronged holder. Light one candle on each holder. Move the photometer to a position where the light intensity on both sides of it is equal.

Figure 8

Light the second candle on the 4-pronged holder. Leaving the photometer and the single-pronged holder in the same positions, slide the 4-pronged holder along the bench to a distance **b**, where the photometer again indicates equal illumination on both sides. Repeat this step using 3 candles and then 4 candles. Record and graph the distances (cm) vs. the number of candles using the graph shown in figure 9. When choosing your initial distance **b**, be sure to allow enough for room on the optical bench for subsequent measurements.

Figure 9

Remove the photometer and the 4-pronged candle holder from the bench. Using the single candle as a light source, attach the 5-hole diaphram at a distance **a** form the candle. Attach the graduated ground-glass screen at a distance **b** from the candle (see figure 10).

Figure 10

Measure the height of the projected image on the graduated screen. Calculate the area **S** of the projected image. Keeping distance **a** constant, calculate this area for several different distances between the graduated screen and the 5-hole diaphram (distance **b**). Graph the area **S** vs. the distance **b**, as shown in figure 11.

Figure 11

4. Maintenance

The Complete Optical Bench Set requires no special maintenance. Handle the lenses and the plane mirror carefully to avoid scratching them, and always unplug the electrical sockets after use. If you experience any problems with this apparatus or need more information abour operating it, contact Central Scientific Company. Please do not return any equipment until we have sent you written authorization.

5. Accessories

Description	Catalog No.
Light Bulbs?	?

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