

## Basic Optics System

OS-8515C

- ▶ Geometric and Ray Optics
- ▶ Concave and Convex Lenses
- ▶ Concave/Convex Mirror

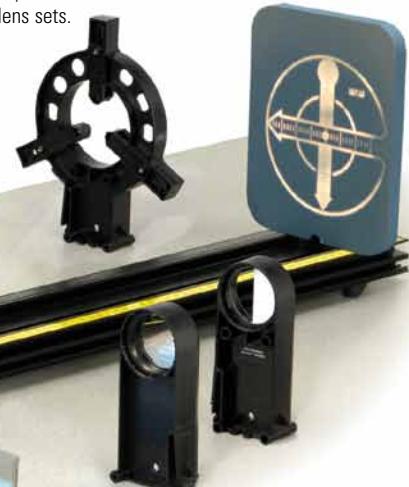
PASCO's Basic Optics System is easy-to-use, affordable, and ruggedly designed. Large 50 mm diameter optics components are mounted in protective holders that snap directly onto the aluminum track, and are easy to slide and position. Built-in metric tape makes measurements of image and object distances quick and accurate for both lenses and mirrors. The versatile Light Source doubles as a table-top ray box, for studies in reflection, refraction, color addition, and Snell's Law. All the components (except the track) fit in the included custom foam storage box.



**Four 50 mm diameter Lenses**  
+100, +200, +250, -150 mm lenses are mounted in protective holders.

**Adjustable Lens Holder**  
Use your own lenses (from 19 mm to 75 mm in diameter) or choose from our lens sets.

**Viewing Screen**  
White plastic screen snaps into the optics bench and the position of the screen can be read directly on the bench scale.



### Concave/Convex Mirror

50 mm diameter plastic mirror with reflective surface on both sides. Includes "half-screen" upon which the image is focused.

### Ray Optics Kit

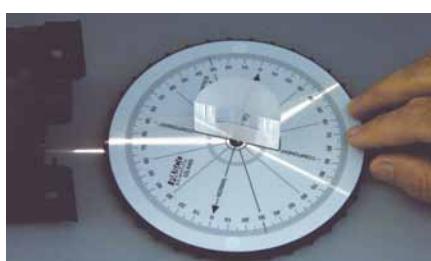
Concave/convex lenses, concave/convex/plane mirrors, acrylic rhomboid for prism spreading of white light and refraction experiments, hollow lens for teaching the lensmaker's equation. Includes storage tray which can also be used as a water tank for the hollow lens.

### Optics Bench (1.2 m)

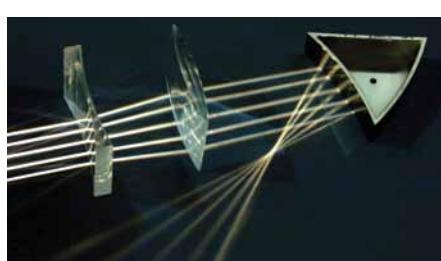
The lenses, mirrors, light source, and screen snap into this rugged aluminum extrusion. The metric tape makes position measurements easy.

### Ray Table

Two-piece construction allows the table to be rotated for studying Snell's Law or the Law of Reflection. Includes D-shaped acrylic lens.



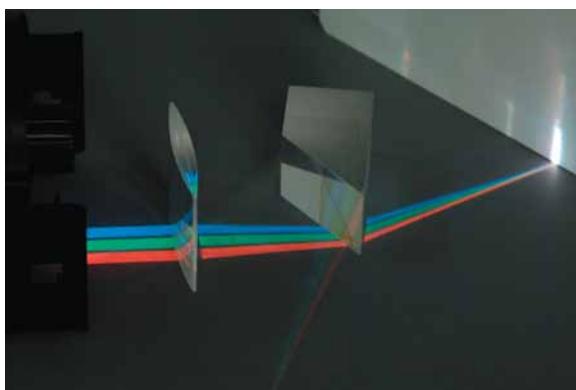
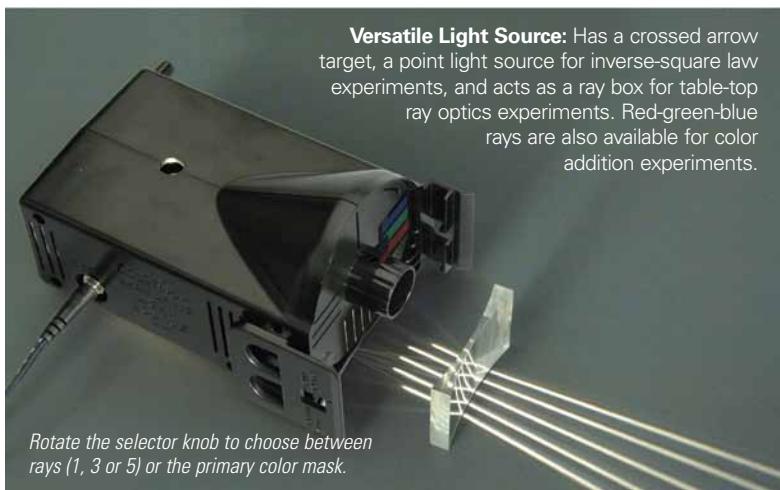
Ray Table in use showing both the Reflected and Refracted rays.



Components from the Ray Optics Kit showing Refraction and Reflection.



Light Source: Has a lighted crossed arrow target with metric scale for focusing images through lenses or using with the concave mirror.



## Basic Optics System Experiments Included:

- |                              |   |  |
|------------------------------|---|--|
| 1. Color Addition            | 7. Hollow Lens                                    | 13. Focal Length and Magnification of a Concave Mirror |
| 2. Prism                     | 8. Lensmaker's Equation                           | 14. Virtual Images                                     |
| 3. Reflection                | 9. Apparent Depth                                 | 15. Telescope  |
| 4. Snell's Law               | 10. Reversibility                                 | 16. Microscope   |
| 5. Total Internal Reflection | 11. Dispersion                                    | 17. Shadows  |
| 6. Convex and Concave Lenses | 12. Focal Length and Magnification of a Thin Lens |  |

## Basic Optics System Storage Box:

All components (except the track) fit in the custom foam box. There are additional slots for accessory lenses. (See page 308)



### Includes:

- 1.2 m Optics Bench
- Basic Optics Light Source
- 50 mm diameter Glass Lenses in Holder  
+100 mm, -150 mm, +200 mm, +250 mm
- Adjustable Lens Holder
- Concave/Convex Mirror with Screen
- Ray Optics Kit
- Ray Table with D-shaped Lens
- Viewing Screen
- Storage Box

### Order Information:

Basic Optic System ..... OS-8515C

## Basic Optics Components and Accessories:

### System Components

pg 306-307



### Lens Sets

pg 308



### System Accessories

pg 309-311



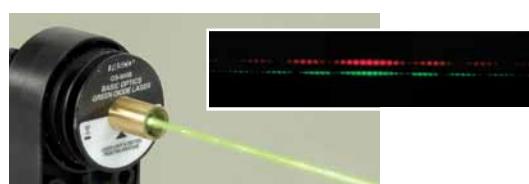
### Human Eye Model

pg 312-313



### Diffraction

pg 314-317



### Dynamics Track Optics

pg 319



### Basic Optics Light Source

OS-8470

- ▶ One, Three or Five Parallel Rays
- ▶ Three Primary Color Source
- ▶ Crossed Arrow Object and Point Source

The Basic Optics Light Source is an excellent source for a variety of optics experiments. A single 10-watt quartz-halogen bulb provides bright, easy-to-see illumination without a lot of heat. By turning the box to a different side, it becomes a:

- 1. Crossed Arrow Object with Metric Scale.** Ideal for showing images, focal point and magnification.
- 2. Bright Point Source.** The very small filament of the halogen bulb provides an excellent point source for experimenting with shadows or the Inverse Square Law.
- 3. Three Primary Colors Source.** The red, green and blue filters provide 3 rays of light which are easily combined with a lens for color mixing.
- 4. 1, 3 or 5 Ray Source.** Just rotate the knob on front of the light source to vary the number of rays produced.



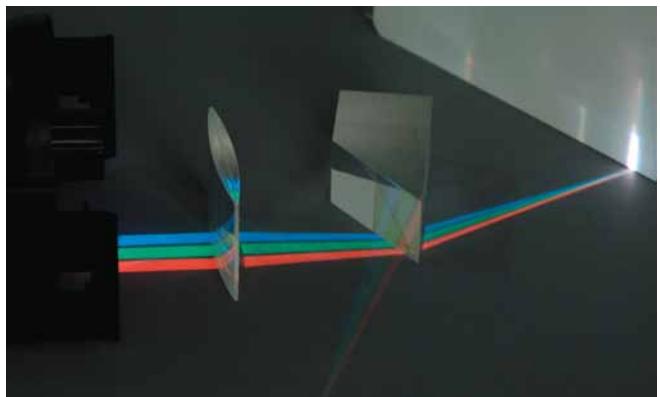
Use free standing or  
easily clip directly to  
Basic Optics Track.



The Basic Optics Light Source provides a point source and an extremely bright crossed arrow target.



Rotate the selector knob to choose between rays (1, 3 or 5) or the primary color mask.



The primary color mask allows experiments in color addition using components from Ray Optics Kit (OS-8516A).

#### Order Information:

Basic Optics Light Source ..... OS-8470

### Concave/Convex Mirror Accessory

OS-8457

- ▶ 50 mm Diameter
- ▶  $\pm 100$  mm Focal Length
- ▶ Plastic Mirror

This double-sided convex/concave plastic mirror is mounted in a lens holder for easy placement on the Basic Optics Track. The Accessory also includes a "half screen" that allows light to pass through on one side, and an opaque screen on the other half to focus the real image formed by the concave mirror.

#### Includes:

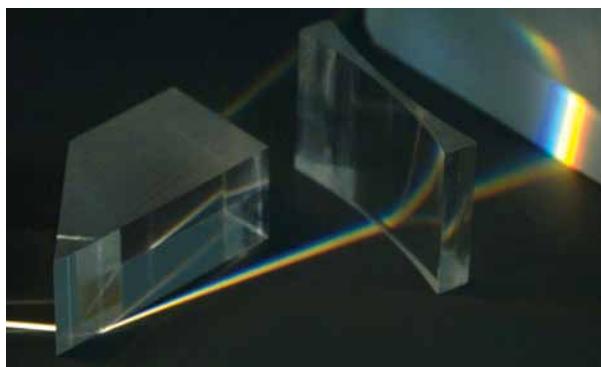
Concave/Convex Mirror  
Half Screen



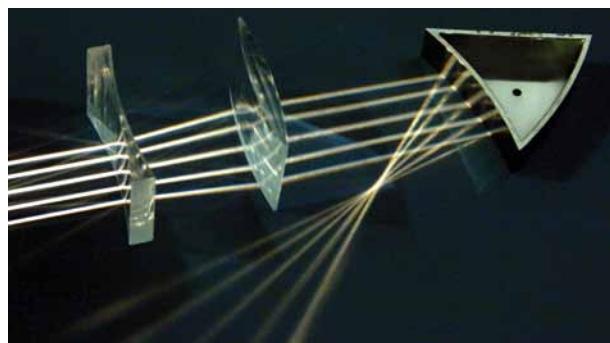
Order Information:  
Concave/Convex Mirror Accessory ..... OS-8457

## Ray Optics Kit

OS-8516A



Rhomboid acting as a prism to separate white light.



Ray Optics Kit includes two lenses and a three-sided mirror.

### Includes:

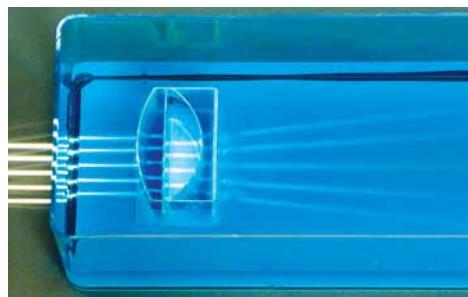
Double Convex Lens  
Double Concave Lens  
Rhomboid  
Eye Dropper

Triangular mirror accessory with concave, convex and plane reflective surfaces  
Hollow lens to fill with a liquid or use as an air lens.



The storage tray is used to create a "hollow" air filled convex lens.

Note that the rays diverge.



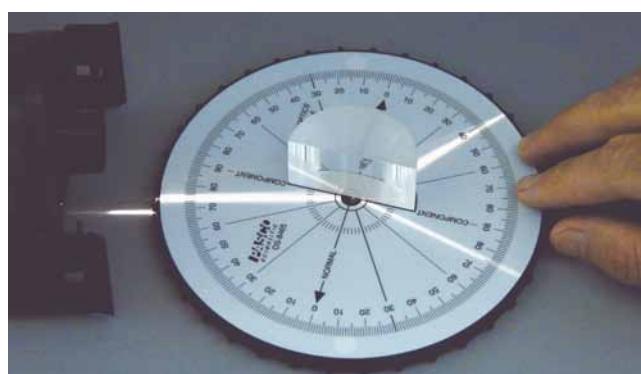
### Order Information:

**Ray Optics Kit.....OS-8516A**

## Ray Table

OS-8465

- ▶ Angle of Reflection
- ▶ Snell's Law
- ▶ Total Internal Reflection



The Ray Table provides an excellent viewing surface for ray optics. The table can be rotated about its axis to quickly change the incident angle of the ray. The resulting angles of reflection and refraction are easily measured directly off the polar grid printed on the table. The (included) acrylic cylindrical D lens simplifies the experiment by having the rays bend at only one surface. Investigate Snell's Law for both cases of rays either entering or leaving the acrylic.

### Includes:

Table  
D-shaped Lens

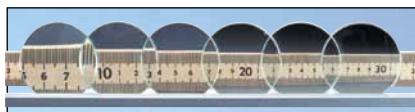


### Order Information:

**Ray Table.....OS-8465**

### Ground Glass Lenses (set of 6)

SE-9013



These precision ground glass lenses provide a useful range of focal lengths. Each lens has a 50 mm diameter – small enough for easy mounting, yet large enough for effective viewing. The set of six comes in a convenient storage box.

Focal Length	Description	Focal Length	Description
500 mm	concave convex	-167 mm	double concave
333 mm	plano convex	-333 mm	plano concave
167 mm	double convex	-500 mm	convex concave

**Order Information:**  
Ground Glass Lenses  
(set of 6) ..... SE-9013

### Lens Holder Set

OS-8522



These holders for the Basic Optics System are an excellent way to permanently mount 50 mm diameter lenses.

**Order Information:**  
Lens Holder Set (2 pack) ..... OS-8522

### Adjustable Lens Holder

OS-8474

The Adjustable Lens Holder for the Basic Optics System is designed for use with lenses and mirrors with diameters between 19 mm and 75 mm.

Place the lens or mirror in the holder and adjust the three arms to hold the component. A set screw in each adjustable arm ensures the mirror or lens will remain in place.

The holder snaps into the Basic Optics Track and is designed to position all mirrors and lenses at the same height as the rest of the Basic Optics System components.

**Order Information:**  
Adjustable Lens Holder ..... OS-8474

### General Quality Lens Sets

#### Geometric Lens Set

OS-8466A

This is a set of three unmounted 50 mm diameter glass lenses with focal lengths of +100 mm, +200 mm, and -150 mm.

These are the same lenses included in the Dynamics Track Optics Kit (OS-8471A) and the Beginning Optics System (OS-8459). They can be mounted in the Adjustable Lens Holder (OS-8474).

**Order Information:**  
Geometric Lens Set ..... OS-8466A

#### 50 mm Diameter Convex Class Sets

These class sets each contain six identical 50 mm diameter lenses made of polished glass with ground edges, and come in a wooden storage box.

**Order Information:**  
100 mm Focal Length  
Class Set ..... SE-7582  
200 mm Focal Length  
Class Set ..... SE-7583

#### 50 mm Diameter Lens Assortment

SE-7581

This set of six lenses is made of polished glass with ground edges, and comes in a wooden storage box.

Focal Length (mm)	Description	Focal Length (mm)	Description
+1000	double convex	-1000	double concave
+300	double convex	-200	double concave
+150	double convex	-150	double concave

**Order Information:**  
50 mm Diameter  
Lens Assortment ..... SE-7581

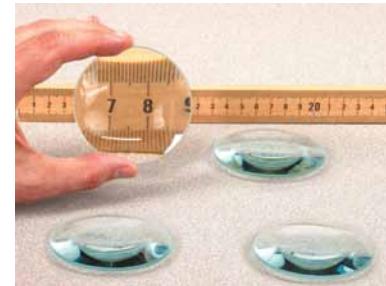


#### 75 mm Diameter Convex Class Set

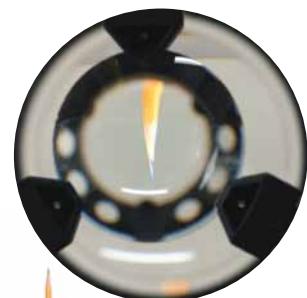
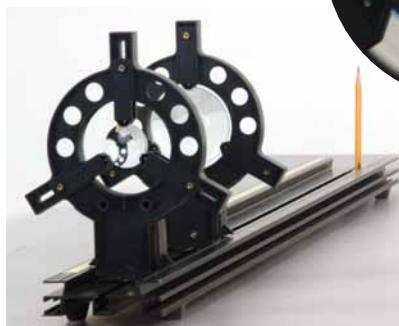
SE-7584

This class set contains four identical 75 mm diameter 200 mm focal length lenses made of polished glass with ground edges. Shipped in a cardboard box with thermoform packing.

**Order Information:**  
75 mm Diameter Class Set ..... SE-7584



Actual view through the lens of the magnified image of the pencil.



Build a telescope or microscope: Shown with 1.2 m Basic Optics Track OS-8508

## Lens Sets

### Basic Optics Geometric Lens Set (Set of 2)

(+200, +100 mm)

OS-8456

### Accessory Lens Set (Set of 2)

(+250, -150 mm)

OS-8519



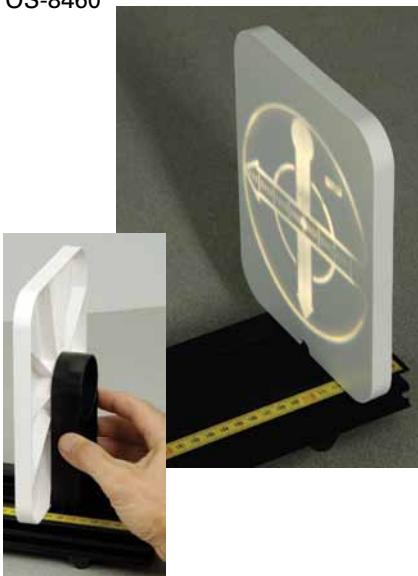
Each lens is mounted in a lens holder for protection and easy storage. The lens holder clips directly to the Basic Optics track.

#### *Order Information:*

Basic Optics Geometric Lens Set (set of 2) .....	OS-8456
Accessory Lens Set (set of 2) .....	OS-8519

### Basic Optics Viewing Screen

OS-8460



This white plastic screen is used with Basic Optics systems. The screen snaps into the optics bench and the position of the screen can be read directly on the bench scale. Also fits the Dynamics Track Optics Carriages (OS-8472 on page 319) for use with a Dynamics Track.

#### *Order Information:*

Basic Optics Viewing Screen .....	OS-8460
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### Concave Mirror Accessory

OS-8532



The OS-8532 Concave Mirror is made of glass and has a 50 mm focal length. Using the "crossed arrow" object of the light source, students will shine the light through the open section of the "half-screen" onto the concave mirror. The light rays will reflect off the mirror and form a partial image on the screen. Students can use the Lensmaker's Equation to verify the focal length of the mirror.

## Basic Optics Spares Kit

OS-8510

The Basic Optics Spares Kit includes many of the small parts which are sometimes lost after student use. Also includes two replacement bulbs for the Light Source. Suitable for all versions of the Basic Optics System (OS-8515).

All parts are organized in a plastic case for easy storage.

#### **Includes:**

- |  |   |
|--|---|
| 2 10W bulb for Basic Optics Light Source OS-8470 or OS-8517A   | 4 1/4-20 3/8" round steel thumbscrew                              |
| 8 6-32 1 1/2" screw for the Basic Optics Light Source OS-8517A | 6 6-32 5/8" round steel thumbscrew                                |
| 6 3/8" screw for optics accessories                            | 4 6-32 3/8" round steel thumbscrew                                |
| 4 3/8" brass thumbscrew for optics track brackets              | 4 4-40 5/16" round steel thumbscrew                               |
| 8 1/4-20 1/2" nylon thumbscrew                                 | 4 6-32 3/16" round steel thumbscrew                               |
| 20 1/4-20 square nut   | 6 Replacement rubber feet for optics bench                        |
| 6 nylon washers  | 15 replacement rubber feet for Basic Optics Light Source OS-8517A |
| 6 nylon washers  | 4 replacement screws for Basic Optics Light Source OS-8470        |
| 4 1/4-20 9/16" round steel thumbscrew                          | 1 Plastic Storage Box   |



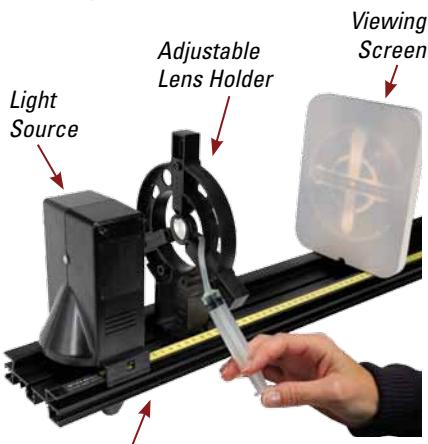
#### *Order Information:*

Spares Kit – Basic Optics ..... OS-8510

### Adjustable Focal Length Lens

OS-8494

Use the syringe to adjust the amount of water in the lens. Changing the curvature of the clear flexible membranes changes the focal length of the lens.



**Use the Adjustable Focal Length Lens with your Basic Optics System**

See page 313 for use with Human Eye Model.



**Includes:**

Syringe  
Tubing  
Lenses (2)

#### Order Information:

Adjustable Focal Length Lens ..... OS-8494

Shown in use with:

Basic Optics System ..... OS-8515C p. 304



### Aperture Accessories

OS-8524

#### Aperture Disk

Simulate the compound lens system of a camera using the Aperture Disk. Simply snap the disk onto one face of a lens. The disk offers six different f-number settings for controlling the amount of light that reaches the viewing screen.



The f-number is designated as  $f/\#$ , where  $\#$  equals the focal length of the lens,  $f$ , divided by the diameter of the aperture,  $D$ . (Example uses a +100 mm lens.)

<i>f</i> -Number	Aperture Diameter (mm)
<i>f</i> /4	25.0
<i>f</i> /5.6	17.7
<i>f</i> /8	12.5
<i>f</i> /11	8.8
<i>f</i> /16	6.3
<i>f</i> /22	4.4

### Spherical Aberration Attachments

Do the center and outside parts of a lens focus light differently? With the Spherical Aberration Attachments, students will be surprised by the answer. Simply snap the attachments onto a lens from the Basic Optics System and compare the image distance for each attachment.



The Peripheral Mask passes light through the center only.



The Center Mask passes light through an outside ring.



Peripheral Mask shown mounted on +250 mm lens.

**Includes:**

Syringe  
Tubing  
Lenses (2)

#### Order Information:

Adjustable Focal Length Lens ..... OS-8494

Shown in use with:

Basic Optics System ..... OS-8515C p. 304

**Includes:**

Aperture Disk and Holder  
Spherical Aberration Attachments

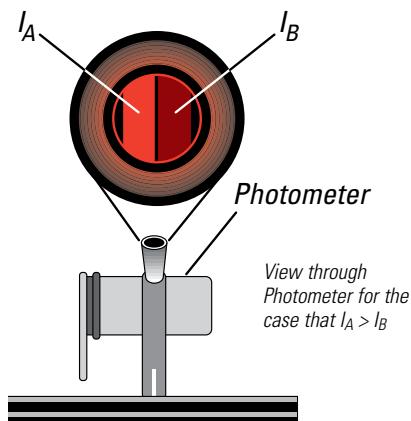
#### Order Information:

Aperture Accessories ..... OS-8524

### Photometer

OS-8520

PASCO's Photometer is an easily understood, nonelectronic device that allows students to measure relative light intensities. By looking through the eyepiece, students can see if the two fluorescent disks, each receiving light from an opposite side of the photometer, are equal in intensity. Students can verify the Inverse Square Law.



View through Photometer for the case that  $I_A > I_B$

#### Includes:

Photometer  
Set of polarizers and an accessory holder  
Disk of neutral density filters—  
25, 50, 75 and 100% transmittance

#### Order Information:

Photometer ..... OS-8520

### Polarizer Set

OS-8473

This accessory set includes two polarizer disks and an optics holder. Rotate the polarizers relative to one another to view the effect on light intensity.



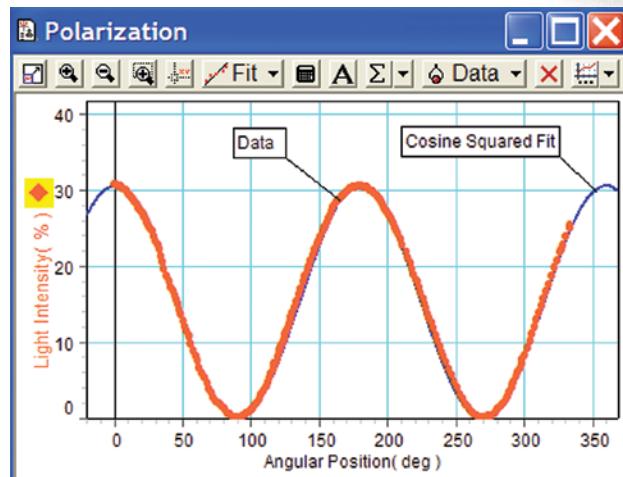
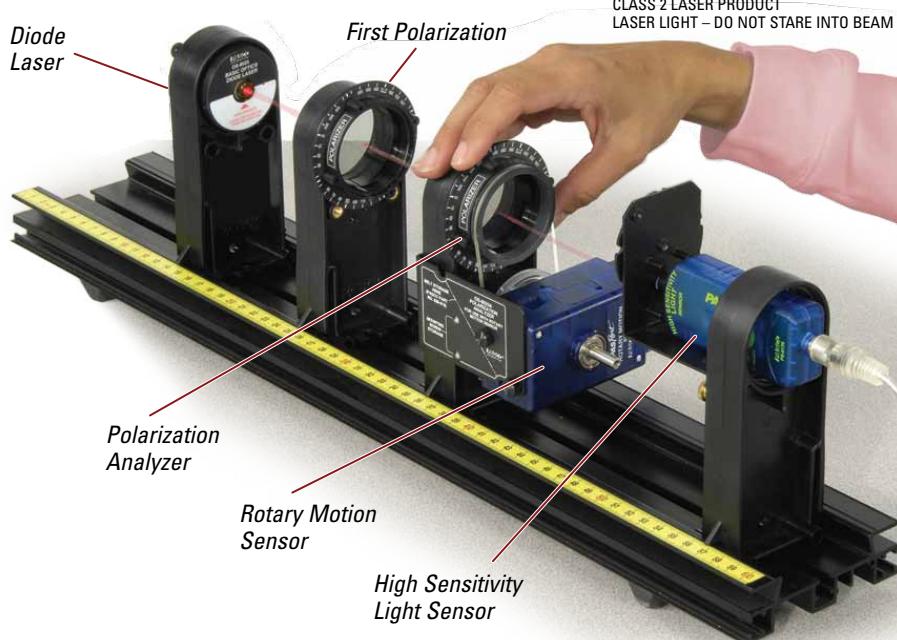
#### Order Information:

Polarizer Set ..... OS-8473

## Polarization Analyzer

OS-8533A

Students can confirm Malus' Law of Polarization by using the Polarization Analyzer with the Basic Optics System. All components mount directly to PASCO's OS-8515B Basic Optics Bench. The Rotary Motion Sensor is used to measure the angle between the two polarizing disks. The Light Sensor measures the intensity of light which passes through both polarizers.



Shown with OS-8541,  
60 cm track.

As the polarizer is rotated, the intensity of the light varies as the square of the cosine of the angle between the two polarizers.

See page 394 for complete experiment.

### Includes:

- Polarizer Disks (2)
- Polarizer Holder
- Aperture Bracket
- Accessory Holder with Mounting Bracket
- Accessory Holder for Aperture Bracket
- Retarder Disk



### Order Information:

**Polarization Analyzer** ..... OS-8533A

Required for use with PASPORT:

Rotary Motion Sensor ..... PS-2120 p. 26

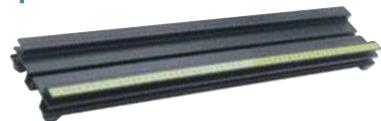
Light/High Sensitivity Sensor ..... PS-2176 p. 46

Basic Optics System ..... OS-8515C p. 304

Diode Laser ..... OS-8525A p. 316

PASPORT Interface ..... p. 10-23

## Optics Benches



### 60 cm Optics Bench

OS-8541

The short optical bench is for experiments such as polarization and spectrophotometry.

### 120 cm Optics Bench

OS-8508

This optics bench is used for lens and mirror experiments, inverse-square law, and diffraction/interference experiments. If you want a bench longer than 120 cm, use the Optics Bench Connectors (OS-8538) shown below.

### Order Information:

**60 cm Optics Bench** ..... OS-8541

**120 cm Optics Bench** ..... OS-8508

## Optics Bench Rod Clamps

OS-8479

Rod Clamps are used to elevate Basic Optics benches to match the height of various light sources.



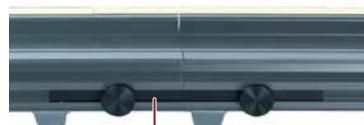
**Includes:**  
Two Rod Clamps

### Order Information:

**Optics Bench Rod Clamps** ..... OS-8479

## Optics Bench Connectors

OS-8538



**Optics Bench Connector**

The OS-8538 Connectors slide into the T-slot to couple two Basic Optics Benches together. Includes two connectors.

### Order Information:

**Optics Bench Connectors** ..... OS-8538

## Human Eye Model

OS-8477

- ▶ Classic Eye Model at an Affordable Price
- ▶ 3-dimensional Working Model of the Human Eye

### Features

**Working Model of the Human Eye:** Two lenses are used to form images on the retina. Sealed tank holds water to simulate the vitreous humor. Size and orientation of the illuminated object can be easily measured.

#### Study the Optics of Normal Vision and

**Vision Correction:** Use the included plastic lenses to create images for normal vision, far-sightedness, near-sightedness and astigmatism. Additional lenses are placed in front of the eye to correct for vision problems.

#### Fixed Corneal Lens and Interchangeable

**Crystalline Lens:** The crystalline lens is surrounded by water (vitreous humor). By changing the crystalline lens, the eye can focus on both near and far objects.

**Movable Retina:** Three positions to demonstrate near-sightedness, far-sightedness and normal vision.

**Variable Pupil Size:** Students can observe the change in brightness and clarity of the image as the pupil size is reduced.



The Eye Model can image any illuminated picture, or use with the Basic Optics System and Eye Model Bracket shown on page 313.

#### Includes:

Molded Plastic Eyeball  
Plastic Lenses (2 sets of 6)  
Pupil Aperture  
Retina Screen  
Optics Caliper (1)  
Experiment Manual  
Included



#### Order Information:

**Human Eye Model** ..... OS-8477

##### Recommended:

Basic Optics Light Source	OS-8470	p. 306
Human Eye Replacement Set (includes lenses, screen and pupil)	OS-8476	
Optics Caliper (set of 5)	OS-8468	p. 313

### Specifications

**Focal Lengths in Air of Plastic Lenses:** +62 mm (+16d), +120 mm (+8.3d), +400 mm (+2.5d), -1000 mm (-1.0d), -128 mm (-7.8d) cylindrical, +307 mm (+3.26d) cylindrical

**Corneal Lens Focal Length in Air:** +140 mm (+7.1d)

**Dimensions:** 15 cm x 17 cm x 10 cm high

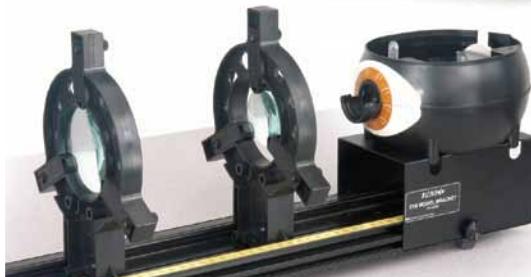
## Eye Model Bracket

OS-8469



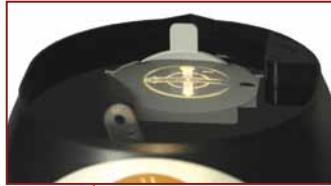
### Built-in scale

Simplifies distance measurements on the optics track.



Eye Model and Bracket shown with a telescope made using two Adjustable Lens Holders (OS-8474) and accessory lenses (see page 309). Students can see the image through the telescope with their own eyes, and then place the Eye Model on the track and see the same image projected on the retina screen.

Image on  
retina screen of  
crossed-arrow  
target



The OS-8469 Bracket allows the Human Eye Model (OS-8477) to be used with the Basic Optics System (OS-8515). The bracket holds the Eye Model securely on the track at the correct optical height.

The illuminated crossed-arrow target on the Basic Optics Light Source makes the perfect object. Easily measure object and image distances, as well as the size of the object and image for calculations of magnification.

### Includes:

- Bracket
- Two 1/4-20 thumb screws with nuts



### Order Information:

<b>Eye Model Bracket.....</b>	<b>OS-8469</b>
<i>Shown in use with</i>	
Basic Optics System.....	OS-8515C

Human Eye Model..... OS-8477

## Optics Caliper

OS-8468

### ► Glow in the Dark Tips

### ► Waterproof

This lightweight plastic caliper is perfect for measuring images in the dark. Simply span the object and then use a scale to measure the distance. For approximate measurements, use the built-in cm scale on the calipers.



The tips of the caliper glow in the dark: Activate with an incandescent or UV lamp.



Use the Optics Caliper to measure image sizes in the Human Eye Model. Glow-in-the-dark tips activated using a UV light source.

### Order Information:

<b>Optics Caliper</b>	
<b>(Set of 5).....</b>	<b>OS-8468</b>

Recommended:  
UV Light Source..... SE-7228 p. 334

## Adjustable Focal Length Lens

OS-8494



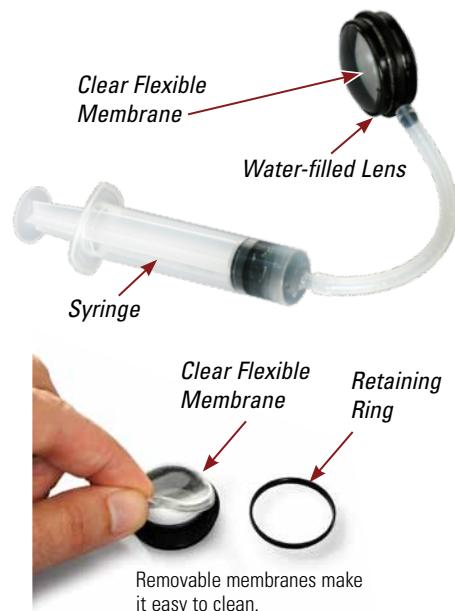
Use the syringe to adjust the amount of water in the lens. Changing the curvature of the clear flexible membranes changes the focal length of the lens.



### Demonstrate accommodation:

Show how the eye lens changes focal length by changing its surface curvature.

See page 304 for use with Basic Optics System.



### Includes:

- Syringe
- Tubing
- Lenses (2)



### Order Information:

<b>Adjustable Focal Length Lens.....</b>	<b>OS-8494</b>
<i>Shown in use with:</i>	

Human Eye Model..... OS-8477 p. 312

## Sensor-Based Diffraction System

OS-8452 with Optics Bench

OS-8455A without Optics Bench

► Single-Slit Diffraction

► Double-Slit Interference

► Real-Time Intensity Graphs

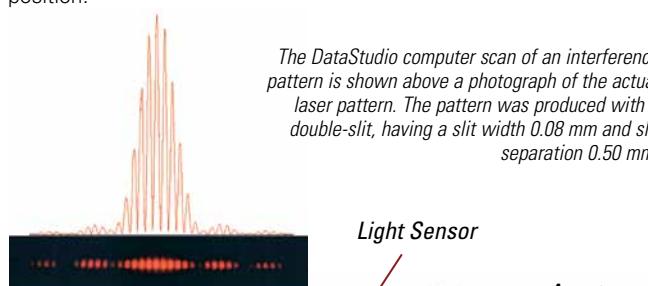


The Sensor-Based Diffraction System enables students to scan many diffraction and interference patterns during one lab period. They can study the differences caused by changing the slit width, slit separation, and number of slits. And, with the addition of the Green Diode Laser, they can study the difference caused by changing the wavelength.

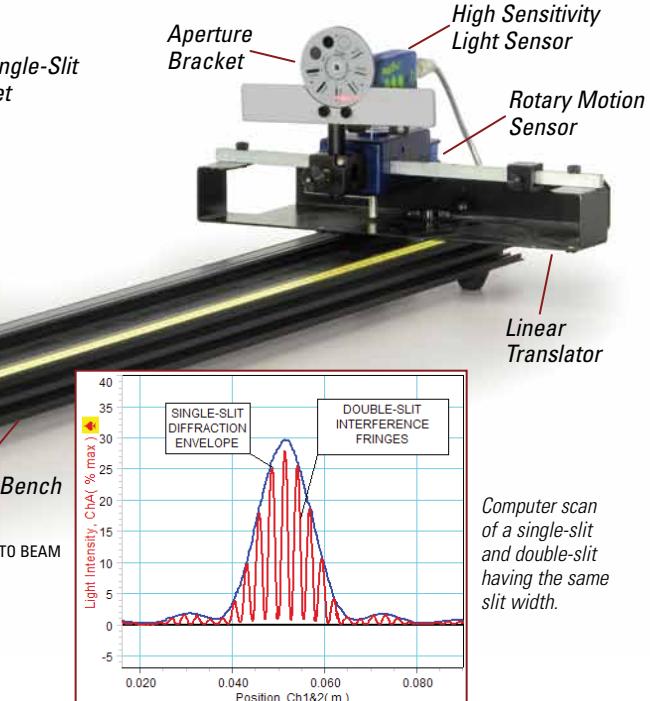
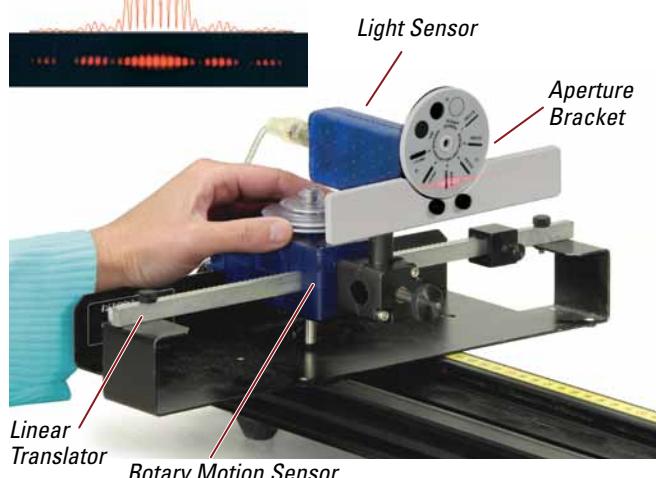
### How It Works

#### Scanning with the Linear Translator

In this unique scanning system, the diffraction pattern is scanned using a light sensor attached to a Rotary Motion Sensor. As the wheel on the Rotary Motion Sensor is rotated by hand, the Rotary Motion Sensor moves along a gear rack (called the Linear Translator). Students make the association between the diffraction pattern they see and the real-time graph of the light intensity versus position.



*The DataStudio computer scan of an interference pattern is shown above a photograph of the actual laser pattern. The pattern was produced with a double-slit, having a slit width 0.08 mm and slit separation 0.50 mm.*



#### Easy Laser Alignment

The laser beam can be aimed through the slits using two thumb screws. Once the beam is aligned, either the laser or the slits can be removed from the optics bench and returned to the bench without re-aligning the beam.



#### Change slits in the dark without re-aligning everything.

The slit wheels eliminate the frustration of trying to change the slits in a darkened room. Simply rotate to the next positive click to lock a different slit into position. The alignment of the disk only has to be done once; thereafter all the slits on that wheel will be in alignment.

#### Includes:

Red Diode Laser	OS-8525A
Diffraction Slits	OS-8453
Linear Translator	OS-8535
Aperture Bracket	OS-8534A
Optics Bench	OS-8508



#### Order Information:

**Sensor-Based Diffraction** ..... OS-8452

Also Available without Optics Bench:

**NEW Sensor-Based Diffraction Kit** ..... OS-8455A

Required for use with ScienceWorkshop:

Light Sensor ..... CI-6504A

Rotary Motion Sensor ..... CI-6538

ScienceWorkshop Interface ..... p. 68-72

Required for use with PASPORT:

High Sensitivity Light Sensor ..... PS-2176

Rotary Motion Sensor ..... PS-2120

PASPORT Interface ..... p. 10-23

Recommended:

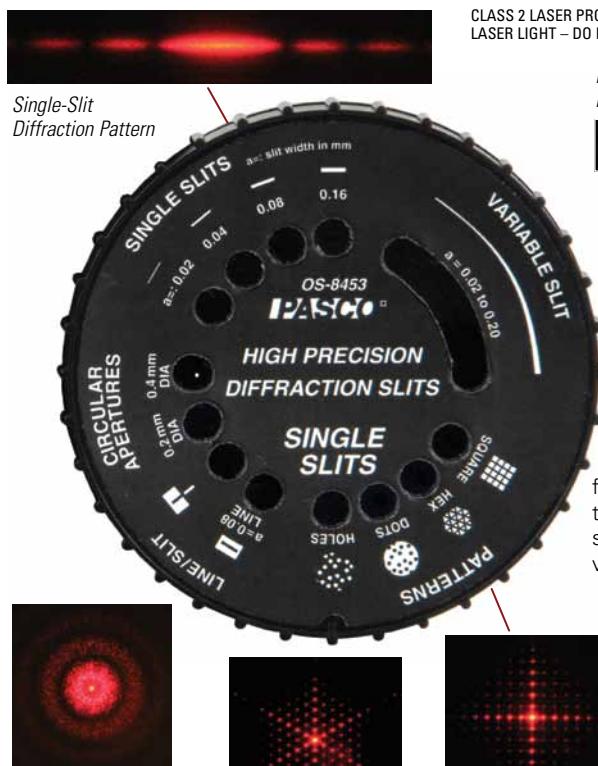
Green Diode Laser ..... OS-8458 p. 316

## High Precision Diffraction Slits

OS-8453

- Vacuum Deposited Chromium on Glass
- Single-Slit and Double-Slit Wheels

OS-8453 includes two slit wheels with holders designed to match the height of the slits to the height of the diode laser. All components clip directly to the Optics Bench from the OS-8515C Basic Optics System. The slit wheels eliminate the frustration of trying to change the slits in a darkened room. To change the slit being illuminated by the laser, the slit wheel is simply rotated to the next positive click to lock another slit into position.



The Circular Diffraction pattern has the same dimensions for both the dots and the holes.

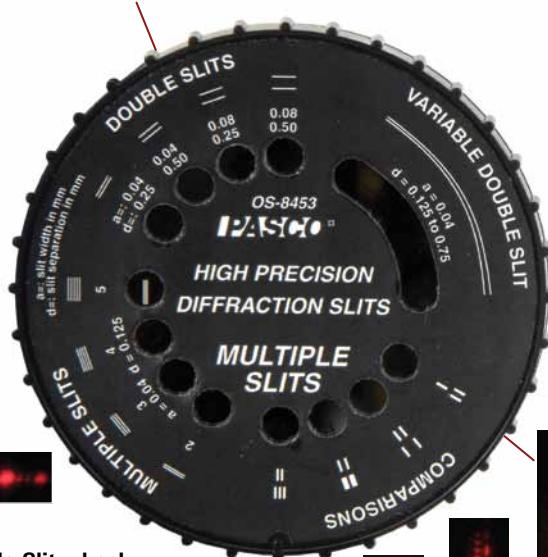
The diffraction geometry represents the structure of the Square and Hex pattern.

CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM

Four Slit Diffraction Pattern

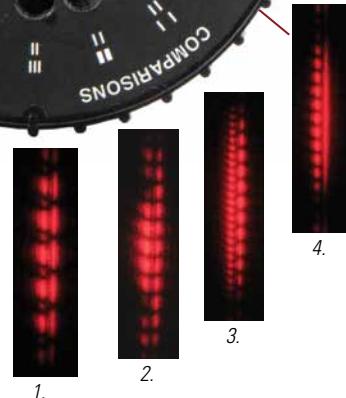


Double-Slit Diffraction Pattern



### The Multiple-Slit wheel

includes four double slits, a set of four multiple slits having the same slit width and separation (2, 3, 4, and 5 slits), four slit comparisons, and a variable double slit.



**The Single-Slit wheel** includes four single slits of different widths, two circular apertures, one line/slit comparison, one opaque line, a variable width slit and four patterns.

The comparisons have two slits illuminated by the same laser beam, so that the patterns can be viewed side by side.

1. Two slit and three slit comparison
2. Different slit widths
3. Different slit separation
4. Single slit and Double slit



Simply rotate the wheel to select the desired slit. Each position locks into place making it easy to use, even in the dark.

## Green Diode Laser OS-8458



CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM

Add a second wavelength with the new Green Laser.



Order Information:

Green Diode Laser

OS-8458

### Includes:

Single-Slit Wheel with holder  
Multiple Slit-Wheel with holder

### Order Information:

High Precision Diffraction Slits ..... OS-8453

Recommended:

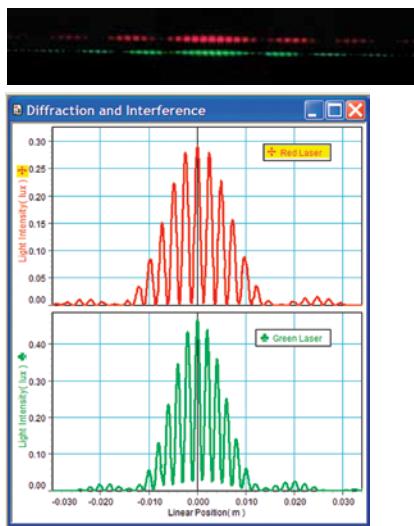
Basic Optics System.

OS-8515C p. 304

## Diode Laser – Basic Optics

OS-8525A (Red)

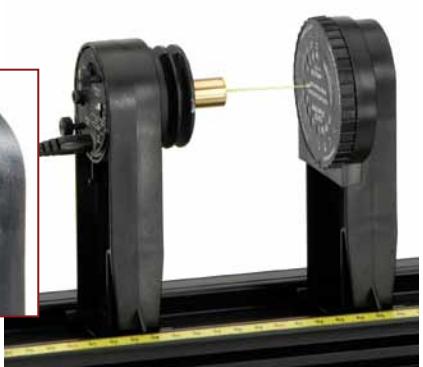
OS-8458 (Green)



These unique diode lasers take the frustration out of aligning the laser beam with the diffraction slits because the horizontal and vertical positions of the beam can be adjusted by turning the thumb screws on the back of the laser.

With the addition of the new Green Diode Laser, you can demonstrate the effect of changing wavelength on the diffraction and interference patterns. At left, a red laser beam was passed through a double slit. Then the Red Diode Laser was replaced by the Green Diode Laser by simply pulling the Red Laser off the optics track and clipping the Green Laser into its place. The recorded patterns from red and green lasers show clearly that the longer wavelength (red) is spread out more than the green.

## Green Laser



### Specifications

**Output Power:** <1 mW

**Wavelength:** 650 nm (OS-8525A)

532 nm (OS-8458)

**Power Supply:** 9-V adapter (included)

#### Order Information:

Diode Laser – Red ..... OS-8525A

Diode Laser – Green ..... OS-8458

## Linear Translator

OS-8535



The Linear Translator transforms

a Rotary Motion Sensor into a linear motion device. The toothed rack of the Linear Translator fits into the slot in the side of the Rotary Motion Sensor. As the Rotary Motion Sensor pulley is rotated by hand, the Rotary Motion Sensor moves along the rack.

See page 314 for more information.

### Specifications

#### Resolution for Rotary Motion Sensor:

0.055 mm (CI-6538)

0.020 mm (PS-2120)

**Maximum Travel:** 20 cm

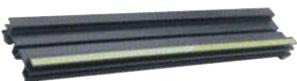
Rotary Motion Sensors Not Included

#### Order Information:

Linear Translator ..... OS-8535

## Optics Bench (120 cm)

OS-8508



This is the optics bench included in the OS-8515C Basic Optics system.

#### Order Information:

Optics Bench (120 cm) ..... OS-8508

## Aperture Bracket

OS-8534B

The Aperture Bracket acts as a mask for a light sensor. The wheel is rotated to select different size slits, defining the spatial resolution. Narrow slits are used to scan diffraction patterns having fine detail. Wider slits are used to let in more light when scanning dimmer patterns. The diffuser selection is used for inverse square law experiments.



#### Includes:

Aperture Bracket  
with Screen

Metal Handle

Accessory Holder



Rotate the wheel to select the aperture.

### Specifications

**Six Slits:** From 0.1 mm to 1.5 mm width

**Open Aperture:** No reduction in intensity

**Screen Aperture:** 10% transmittance

**Diffuser**

#### Order Information:

Aperture Bracket ..... OS-8534B

Replacement Part:

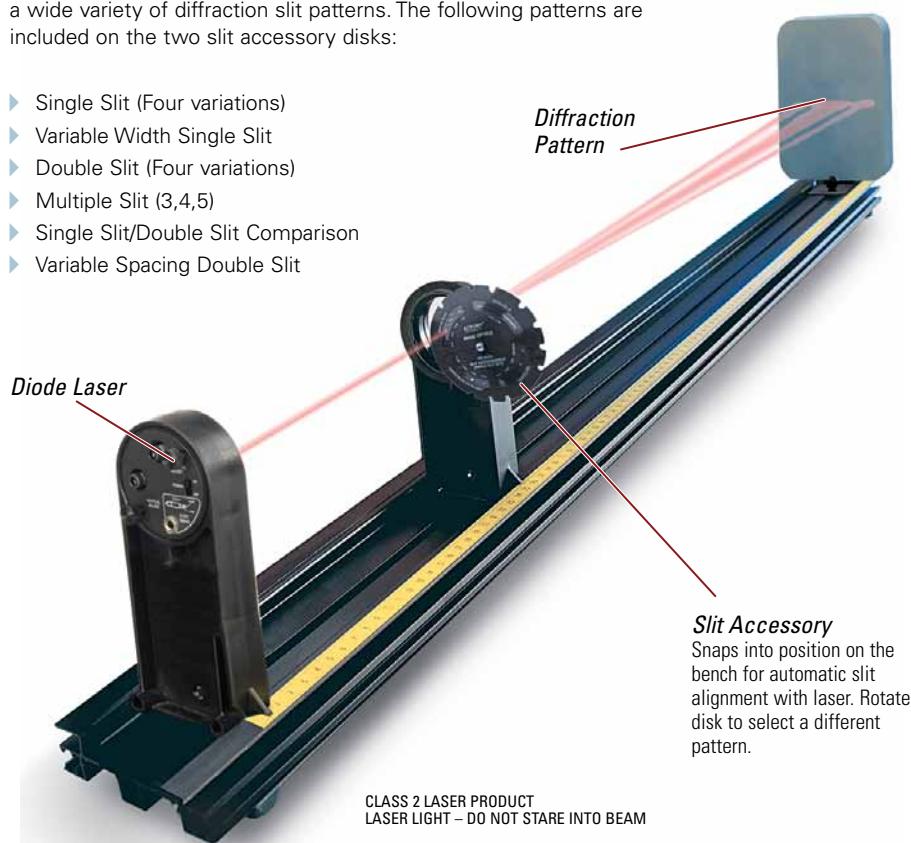
Aperture Bracket Handle ..... OS-8451

## Diffraction Optics Kit

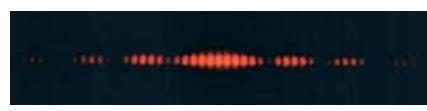
OS-8531

Add this kit to the Basic Optics System to allow the investigation of a wide variety of diffraction slit patterns. The following patterns are included on the two slit accessory disks:

- ▶ Single Slit (Four variations)
- ▶ Variable Width Single Slit
- ▶ Double Slit (Four variations)
- ▶ Multiple Slit (3,4,5)
- ▶ Single Slit/Double Slit Comparison
- ▶ Variable Spacing Double Slit



Single Slit Pattern ( $a = 0.04 \text{ mm}$ )



Double Slit Pattern ( $a = 0.08 \text{ mm}$ ,  $b = 0.05 \text{ mm}$ )



4-Slit Pattern ( $a = 0.04 \text{ mm}$ ,  $d = 0.125 \text{ mm}$ )



### Includes:

Diode Laser (OS-8525)  
Slit Accessories (OS-8523)



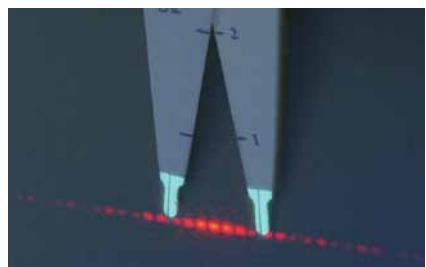
### Order Information:

Diffraction Optics Kit ..... OS-8531

## Optics Caliper

OS-8468

This light-weight plastic caliper is perfect for measuring interference and diffraction patterns in the dark. Glow-in-the-dark tips are activated using an incandescent or UV lamp. See page 313 for more information.



### Order Information:

Optics Caliper  
(Set of 5) ..... OS-8468

Recommended:

UV Light Source ..... SE-7228 p. 334

## Slit Accessories – Basic Optics

OS-8523

Two Slit Accessory disks offer a variety of single and multiple slits for diffraction experiments. The two accessory disks come mounted to lens holders. Just rotate the disk for a wide range of diffraction patterns. The slit patterns automatically align with the laser. Includes User's Guide with experiments.

Slit wheels are constructed using a photographic process.

**Single-slit Disk**— Four single slits, two circular apertures, one line/slit comparison, four two-dimensional diffraction patterns, variable-width slit (0.02-0.20 mm), one opaque line.

**Multiple-slit Disk**— Four double slits, four multiple slits (2, 3, 4 or 5 slits), four single/double-slit comparisons, variable double-slit (slit separation 0.125-0.75 mm).



### Order Information:

Slit Accessories – Basic Optics ..... OS-8523

## PASCO Optics Systems

### Basic Optics System

OS-8515C

### Basic Optics System II

OS-8546B

### Computer-Based Optics System II

OS-8548B

These optics systems provide a wide range of optics laboratories from the very basics of ray tracing to quantitative measurement of blackbody radiation.



### Computer-based Optics System II OS-8548B

#### Computer-based Optics System II OS-8548B

#### Basic Optics System II OS-8546B

#### Basic Optics System OS-8515C

#### Page

### Basic Optics System (OS-8515C)

Includes the lenses and mirrors required for geometrical and ray box optics. Experiment manual and storage box included.

### Basic Optics System II (OS-8546B)

Adds to the Basic Optics System a wider assortment of lenses and mirrors plus components for polarization, interference and diffraction.

### Computer-Based Optics System II (OS-8548B)

Adds to the Basic Optics System II a wider assortment of lenses and mirrors plus components for prism and grating spectrophotometers.

Additionally the sensors to allow a computer to record and analyze data from diffraction, interference, polarization and Inverse-Square Law experiments are included.

#### Order Information:

**Basic Optics System** ..... OS-8515C

**Basic Optics System II** ..... OS-8546B

**Computer-Based  
Optics System II** ..... OS-8548B

\*14. Not included with OS-8548B.

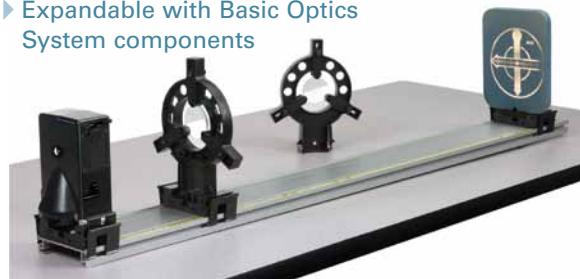
**NOTE:** The computer-based systems include the necessary sensors for the experiments but not the necessary Science Workshop Interface (500 or 750). See pages 68-72.

# Entry Optics Systems

## Dynamics Track Optics Kit

OS-8471A

- ▶ Makes your Dynamics Track into an optical bench
- ▶ Use with 1.2 or 2.2 meter Dynamics Tracks and PAstrack
- ▶ Expandable with Basic Optics System components



The PASCO Dynamics Track Optics Kit includes specially designed slides (carriages) that snap on the dynamics track. PASCO Basic Optics components attach directly to the carriage for positioning anywhere on the track.

Choose from a wide range of optics components to expand your system. *See pages 306-317 for more components.*

### Dynamics Track Optics Kit Includes:

Basic Optics Light Source



Two Adjustable

Lens/Mirror Holders

+100 mm, +200 mm,

and -150 mm Focal Length Lenses

Viewing Screen

Three Optics Carriages

#### **Order Information:**

**Dynamics Track Optics Kit** ..... **OS-8471A**
*Required:*

Dynamics Track 1.2 m ..... ME-6953

*or*

Dynamics Track 2.2 m ..... ME-9779

*or*

PAstrack ..... ME-6960

## Dynamics Track Optics Carriage

OS-8472

The Dynamics Track Optics Carriages are designed to snap onto the PASCO Dynamics Track. Basic Optics components attach directly to the carriages for positioning anywhere on the track.

#### **Includes:**

Carriages  
(3)

#### **Order Information:**

**Dynamics Track Optics Carriage** ..... **OS-8472**

## Beginning Optics System

OS-8459

- ▶ New lab manual with five experiments
- ▶ Expandable with Basic Optics System components
- ▶ The most affordable optics system with a metal bench



This economical system has everything needed to do the five included experiments.

It is a good start for studying optics and can be expanded using the components of the Basic Optics System (see pages 306-317).

### Included Experiments

1. Focal Length and Magnification of a Thin Lens
2. Telescope
3. Microscope
4. Shadows
5. Virtual Images

#### **Includes:**

Basic Optics Light Source  
(Point, Luminous Object, Rays, and Primary Colors);

Two Adjustable Lens/  
Mirror Holders

Geometric Lens Set (+100 mm,  
+200 mm, and -150 mm focal  
length lenses)

Viewing Screen

1.2m Optics Bench

Lab Manual

#### **Order Information:**

**Beginning Optics System** ..... **OS-8459**

## Geometric Optics Kit

OS-8518



#### **The Geometric Optics Kit Includes:**

Optics Bench

Two Lenses in Holders: +100/+200 mm

Viewing Screen

#### **Order Information:**

**Geometric Optics Kit** ..... **OS-8518**

**NEW**  
**Lab Manual**  
**with**  
**Experiments**

## Introductory Optics System

OS-8500

- ▶ Complete and Comprehensive System
- ▶ 22 Experiments— From Basic Ray Optics to Multiple-Slit Diffraction
- ▶ Easy Setup— Magnetic Mounting

### High-Intensity Light Source

The special line filament makes images and diffraction lines bright and sharp. Features a built-in power supply and a knob for adjusting the filament position.



### Rotating Ray Table

Table mounts magnetically on the bench, at a slight angle, for bright, sharp rays. Measurements are easy: there's a polar grid on one side of the table and both a polar and rectangular grid on the other.

### Diffraction Scale, Grating and Slits

The system includes a diffraction grating and diffraction plate with 10 diffraction apertures (single, double and multiple slits, plus random and ordered arrays).



### Full Range of Components

Includes a parallel ray lens, slit mask, universal mirror and other components needed for a full range of optics experiments.

**Color Filters**  
Investigate color mixing.

### Ground Glass Lenses and Mirror

Produce sharp images and mount in recessed plastic holders for protection.



### A Comprehensive and Self-Contained Optics System

This Introductory Optics System includes both a ray table and an optics bench. It includes everything needed for a complete course in introductory optics. It will take students through reflection, thin-lens theory, color theory, polarization, interference, diffraction and optical instruments. The manual includes 22 quantitative experiments.

### Designed for the Introductory Lab

In many ways, the requirements for a good introductory system are even more stringent than for more advanced equipment. The equipment must be easy-to-use and durable, and the experiments must be substantive, yet conceptually straight-forward.

With these requirements in mind, we incorporated the following features into our Introductory Optics System:

### Features

**Magnetic Mounting:** Components mount magnetically to the optics bench and ray table, yet are easily aligned and repositioned.

**Fully-Illustrated Manual:** The 22 copy-ready experiments provide a thorough and orderly introduction to both elementary and more advanced optics experiments.

**Full Range of Components:** No improvising or buying additional equipment.

**Built-In Scales:** Built-in scales are convenient and provide accurate results.

### 70 cm Optics Bench

This tough aluminum bench has two built-in metric scales, one on each side, and magnetic pads for attaching the light source, component holders and ray optics table.

### Calibrated Polarizers

Two polarizers rotate through 360° in 2° increments.



### Calibrated Variable Aperture

Investigate the relationship between aperture and depth of field.



### Typical Experiments

With Teacher's Guide and Sample Data.

1. Introduction to Ray Optics
2. The Law of Reflection
3. Image Formation in a Plane Mirror
4. The Law of Refraction
5. Optical Reversibility
6. Dispersion and Total Internal Reflection
7. Converging Lens— Image and Object Relationships
8. Light and Color
9. Two-Slit Interference
10. Polarization
11. Image Formation: Concave Mirrors
12. Image Formation: Spherical Mirrors
13. Image Formation: Cylindrical Lenses
14. Spherical Lenses: Spherical and Chromatic Aberration, Aperture Size, Depth of Field
15. The Diffraction Grating
16. Single-Slit Diffraction
17. General Diffraction
18. Introduction to Optical Instruments
19. The Projector
20. The Magnifier
21. The Telescope
22. The Compound Microscope

### Order Information:

Introductory  
Optics System.....OS-8500



The OS-8500 Introductory Optics System comes in a fitted box for convenient storage.

### Component List for Introductory Optics System

Each system contains a complete set of the following components:

Optics bench—70 cm extruded aluminum bench with magnetic surface

Incandescent light source—high-intensity; built-in power supply

Instruction and experiment manual—with 22 experiments

The following components are included and can be purchased separately

#### Product #

Diffraction Set—Introductory Optics OS-8480

Diffraction plate (ten patterns)—single slits, double slits, multiple slits, crossed slits and circular apertures

Diffraction grating

Diffraction scale—for measuring maxima and minima

Color Filter Set—Introductory Optics OS-8481

Color filters—red, green and blue

Polarizer Set—Introductory Optics OS-8482

Polarizers (two)—with degree scales

Mirror Set—Introductory Optics OS-8483

Mirror—front surface, concave (50 mm F.L.)

Mirror—three-sided (plane, concave, and convex)

Slit Set—Introductory Optics OS-8484

Slit plate and mask—for producing up to seven rays

Variable aperture—for investigating depth of field

Virtual image locators (two)

Screen/Target Set—Introductory Optics OS-8485

Crossed arrow target—for determining image orientation

and magnification

Viewing screen—with metric scale for measuring images

Virtual image locator

Rotating Base Set—Introductory Optics OS-8486

Ray Table—degree scale, mm grid and component holder

Component Set—Introductory Optics OS-8487

Component holders (three)—attach magnetically to the bench

75 mm Lens—Introductory Optics OS-8488

Spherical lens—ground glass, mounted in plastic carrier for protection (75 mm F.L.)

150 mm Lens—Introductory Optics OS-8489

Spherical lens—ground glass, mounted in plastic carrier for protection (150 mm F.L.)

150 mm Lens OS-8490

Spherical lens—ground glass, mounted in plastic carrier for protection (150 mm F.L.)

Parallel Ray Lens—Introductory Optics OS-8491

Parallel ray lens—for producing parallel rays for ray tracing

Cylindrical Lens—Introductory Optics OS-8492

Cylindrical lens—for ray tracing

## Lenses and Mirrors



These ground-glass lenses and silver coated front-surface glass mirrors are mounted in recessed plastic holders to protect the optical surfaces.

#### Order Information:

**Double Concave (-22 mm).....OS-9131**

**Double Convex (+18 mm).....OS-9132**

**Double Convex (+48 mm).....OS-9133**

**Double Convex (+127 mm).....OS-9134**

**Plano Convex (+252 mm).....OS-9135**

**Mirror, Flat—Advanced Optics.....OS-9136**

**Concave Mirror (-25mm)—Advanced Optics.....OS-9137**

## Diode Laser – Intro. Optics

OS-8528A

Support bracket automatically aligns laser with Introductory Optics or Advanced Optics components.



CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM

This versatile, inexpensive Diode Laser can be placed on the Introductory Optics bench. The metal stand adheres to the magnetic strip and automatically aligns the laser beam with each system's diffraction accessories. Easy set-up makes it ideal for diffraction or other general laser experiments.

## Specifications

**Output Power:** <5 mW

**Wavelength:** 650 nm

**Power Supply:** 9 VDC, 500 mA adapter (included)

#### Order Information:

**Diode Laser – Intro. Optics.....OS-8528A**

## Component Carrier

OS-9107



Mounts magnetically to the Optics Bench and components mount magnetically to the carrier. The aperture is 22 mm x 22 mm.

#### Order Information:

**Component Carrier—Advanced Optics.....OS-9107**

## Electroformed Diffraction Slits



These slits are extremely sharp ( $\pm 5$  micron tolerance), producing diffraction patterns superior to those produced by traditional film emulsion slits. Four slides are available, each providing four patterns.

#### Order Information:

**Complete Slit Set—Advanced Optics.....OS-9165**

Four slides.

Slide 1–4 single slits: widths 0.02, 0.04, 0.08, 0.16 mm.....OS-8461

Slide 2–4 sets of double slits: slit widths 0.04 and 0.08 mm; slit spacing 0.25 and 0.5 mm.....OS-8462

Slide 3–4 sets of multiple slits: 2, 3, 4, 5 slits; all widths 0.04 mm, all spaced 0.125 mm.....OS-8463

Slide 4–Apertures: 2 circular apertures 0.04, 0.08 mm dia.; 1 array of triangular apertures (equilateral); 1 array of square apertures.....OS-8464

**Single/Double Slits—Advanced Optics.....OS-9179**

Slides 1 and 2 only.

## High Precision Diffraction Slits – Intro. Optics

OS-8454



The two sets of interference slits fit the Introductory Optics bench. Perfect for use with the OS-8528A Diode Laser. Just rotate the disk for a wide range of diffraction patterns. The slit patterns automatically align with the laser.

## Single-slit Disk

4 single slits

- 2 circular apertures

- 1 line/slit comparison

- 4 two-dimensional diffracton patterns

- variable-width slit

(0.02–0.20 mm)

- 1 opaque line

## Multiple-slit Disk

4 double slits

- 4 multiple slits

(2, 3, 4 or 5 slits)

- 4 slit comparisons

- variable double slit

(slit separation 0.125–0.75 mm)

See page 315 for more details.

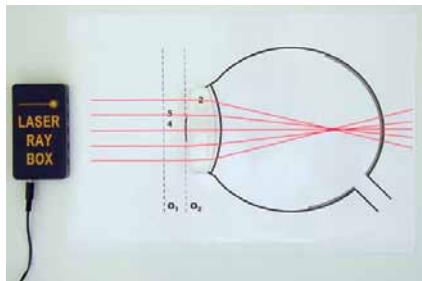
#### Order Information:

**High Precision Diffraction Slits – Intro. Optics.....OS-8454**

### Ray Optics Laser System

SE-8506

- ▶ No Need to Dim the Lights
- ▶ Wide Variety of Optical Components
- ▶ Templates Simulate Real-World Optical Devices



The laser rays are focused in front of the retina by the myopic lens used with the human eye template.

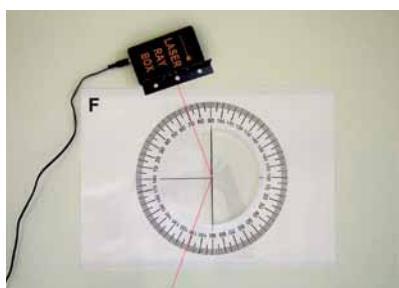
This demonstrations optics set uses a Laser Ray Box which has bright, well-defined rays because it uses lasers rather than an incandescent light source. The Laser Ray Box projects five parallel laser beams onto any flat surface. It contains five 1 mW diode lasers (wavelength 635 nm). The laser beams are spread out into clearly visible lines by cylindrical lenses inside the box.

The ray box has a magnetic back for mounting on any steel board. The unit is powered by an included AC adapter.

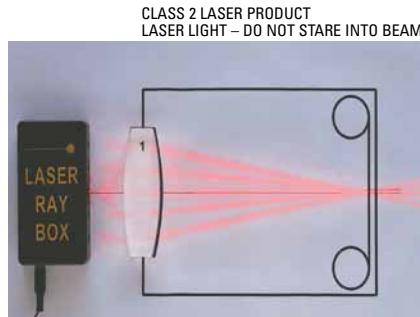
This exceptional optics set includes six magnetically-backed templates that have guidelines showing where to put components to perform different demonstrations, including:

- ▶ Modeling the human eye and eyeglasses
- ▶ How a camera works
- ▶ Two types of telescopes
- ▶ Spherical aberration
- ▶ Refraction and reflection

Each component has a magnetic backing for mounting on any steel board.



The included protractor template can be used to demonstrate refraction.



The laser rays are redirected by the converging lens and focused on the "film" of the camera template.



#### Includes:

- Laser Ray Box
- Laser Ray Mask
- Double-convex lenses (4)
- Double-concave lens
- Plano-concave lens
- "D" lenses (4.5 cm and 7.5 cm radius) (2)
- Plane, convex and concave mirrors
- Right-angle prism
- Rectangle (6 cm x 10 cm)
- Optical Fiber (2 cm x 20 cm)
- Templates (6)
- Steel white board (56.5 cm x 41.5 cm)
- Most components are 10 cm tall and 1.7 cm thick.

#### Specifications for Laser Ray Box

**Dimensions:** 11 cm x 6 cm x 2 cm

**Laser Ray Separation:** 1.8 cm

**Power Adapter:** 3 VDC, 300 mA (included)

**Wavelength:** 635 nm

#### Order Information:

Ray Optics Laser System .....	SE-8506
Laser Ray Box (only) .....	SE-8505

### Lens Plus Set

SE-7578



Add this additional lens set to extend the use of the Ray Optics Laser System or Laser Ray Box. Components were chosen to demonstrate the effect of both positive and negative optical devices.

#### Includes:

- Biconcave Air Lens
- Biconcave Glass Lens
- Biconvex Air Lens
- Biconvex Glass Lens
- Optical Air Prism
- Equilateral Optical Glass Prism
- Rectangular Optical Glass Prism (2 piece)
- Square Glass Planar Parallel Plate
- Rectangular Glass Planar Parallel Plate (2 piece)
- Planar Mirror (2 piece)

#### Order Information:

Lens Plus Set .....	SE-7578
---------------------	---------

### "Visible Ray" Optics Set

SE-9767



Students can see the light rays as they pass through these unique 20 mm thick acrylic components. Refraction and internal reflection are easily observed.

Each set comes in a convenient case and includes:

Double Convex lens: 50 mm focal length

Double Concave lens: 50 mm focal length

Plano-Convex lens: 100 mm focal length

Prism: 120°, 90°, 90°, 60°

#### Order Information:

Visible Ray Optics Set .....	SE-9767
------------------------------	---------

# Blackboard Optics Systems

## Basic Magnetic System

SE-9193

- ▶ Versatile Magnetic System
- ▶ Magnetic Mounting
- ▶ Large Components

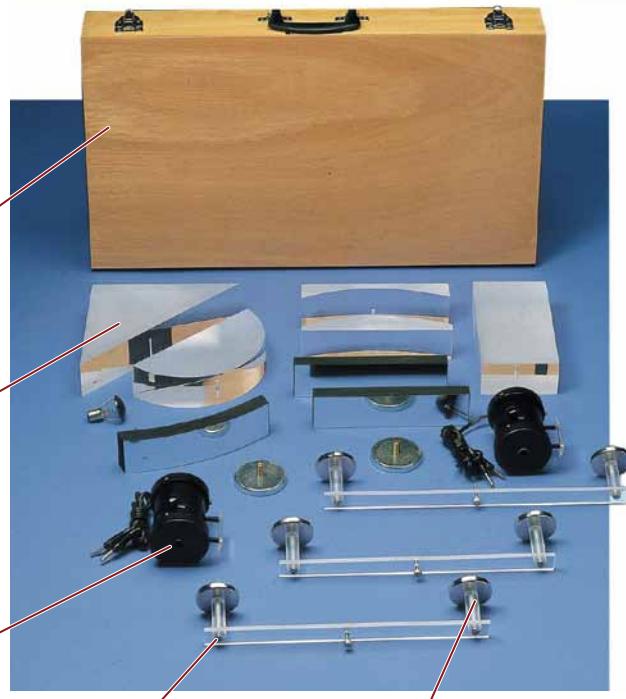
With this unique system, optics diagrams are transformed into working demonstrations. All components and light sources mount right on the blackboard. Instead of ray diagrams, students observe the interactions of actual light rays.

### Systems Available

Basic Blackboard Optics Systems include:

- Ray projector (2)
- Holder for projector (2)
- Clamping bar, 13-inch (2)
- Clamping bar, 15-inch (1)
- Plano-convex lens (1)
- Plano-concave lens (1)
- Semi-circular lens (1)
- Rectangular block (1)
- Prism, right angle (1)
- Plane mirror (2)
- Curved mirror, double (1)
- Projector lamp, spare (1)
- Cushioned storage cabinet (1)

**Note:** A power supply, such as the SE-9197 AC Transformer, is required and must be ordered separately. See Order Information on this page.



**Carrying Case**  
The basic system stores neatly in the included hardwood carrying case.

**Large Acrylic Components**  
(5 cm thick and 20 cm high)  
Durable and easy to use.

**High-intensity Light Sources**  
For clearly visible rays, both inside and outside the components. Adjust the sliding apertures for thin rays of light or divergent cones.

**Versatile Mounting Brackets**  
Components can be rotated without moving the brackets.

**Magnetic Mounting**  
Magnetic mounting for steel-backed blackboards.

### The Blackboard Optics Accessories include: (not shown)

- Multiple-ray projector w/spare lamp
- Two prisms: flint glass, equilateral
- Projection screen w/holder
- Replica grating w/holder  
(6000 lines/cm)
- Color filters (3) and polarizers (2)
- Double slit
- Three lenses: plano-convex (2); plano-concave

### The Blackboard Optics System with Accessories includes:

- Basic Blackboard Optics System
- Blackboard Optics Accessories



## Demons

### Basic System primary demonstrations:

#### Reflection

- Law of Reflection
- Virtual Images
- Focal Lengths
- Real Images

#### Refraction

- Law of Refraction
- Rectangular Block
- Critical Angle
- Total Internal Reflection
- Reversing Prism
- Angle of Minimum Deviation

#### Lenses

- Focal Lengths
- Virtual Images
- Thick Lens Optics

### Basic System with Accessories additional demonstrations:

#### Advanced

- Focal Lengths: Double Convex and Double Concave Lens
- Real Image Formation: Double Convex Lens
- Nearsighted/Farsighted
- The Telescope
- The Microscope
- Spherical Aberration
- Dispersion: Prisms and Gratings
- Two Slit Interference

### Order Information:

Basic Blackboard Optics System: Magnetic Mount	SE-9193
Blackboard Optics Accessories: Magnetic Mount	SE-9195
Blackboard Optics System with Accessories: Magnetic Mount	SE-9198
<i>Required:</i>	
(for Blackboard Optics)	
AC Transformer (110V version only)	SE-9197
<i>or</i> Equivalent supply providing up to 100 watts at 12 VAC	
<i>Replacement Bulbs:</i>	
for Single Ray Projector (12 V, 35 W)	SE-9406A
for Multiple Ray Projector (12 V, 55 W)	SE-9407
<i>Note:</i> Blackboard not included.	

### Ray Box

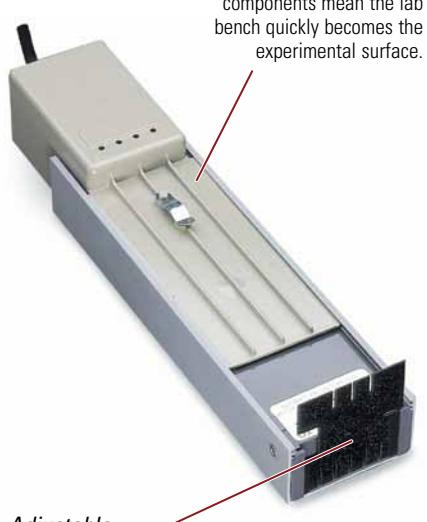
SE-9474

- ▶ Bright, Sharp Ray Optics
- ▶ One, Three or Five Parallel, Convergent or Divergent Rays
- ▶ Rugged and Reliable

The Ray Box is the standard light source for ray optics experiments. It is easy to use, extremely durable and the rays are bright enough to be seen clearly, even in a relatively bright room.

Just plug it in, turn it on and rotate the adjustable screen to produce one, three or five pencil-thin rays, or a single wide beam. A sheet of white paper makes a great experimental surface. The rays are clearly visible, and both rays and component positions can be traced onto the paper.

The included manual describes 15 basic experiments that can be performed using the Ray Box, Ray Box Component Set, Ray Box Color Filter Set and a prism.



#### Adjustable Ray Slits

Quickly adjust the number of rays to fit the experiment.

#### Order Information:

**Ray Box** ..... SE-9474

### Ray Box Component Set

SE-9476



#### Includes:

Two lenses —  
double concave and  
double convex  
  
Three mirrors — flat, concave and convex  
  
Cushioned plastic storage case

#### Order Information:

**Ray Box Color Component Set** ..... SE-9476

### Ray Box Color Filter Set

SE-9475



#### Includes:

Amber Lucite™ filter w/stand  
White Plexiglas® filter w/stand  
Slotted screens (2)  
Cellophane color filters  
(7.62 cm sq: red, blue, pink, purple, green, orange, yellow)  
Cushioned plastic storage box

#### Order Information:

**Ray Box Filter Set** ..... SE-9475

#### Recommended:

Equilateral Prism ..... SE-9021A p. 327

### Basic Optics Light Source

OS-8470



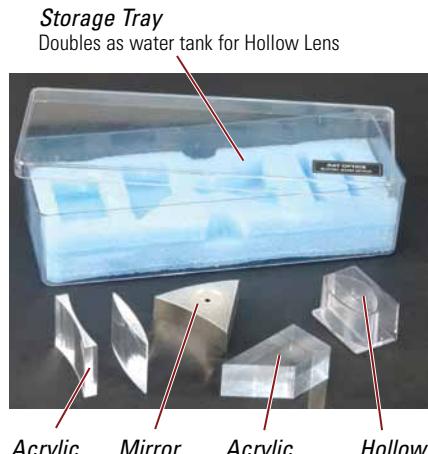
Rotate the selector knob to choose between rays (1, 3 or 5) or the primary color mask.

#### Order Information:

**Basic Optics Light Source** ..... OS-8470

### Ray Optics Kit

OS-8516A

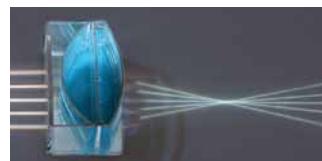


#### Order Information:

**Ray Optics Kit** ..... OS-8516A

### Hollow Lens

OS-8511



The Hollow Lens allows students to investigate the effect of different liquids on the index of refraction. In addition, students can fill only one or two of the compartments to experiment with compound lenses.

#### Order Information:

**Hollow Lens** ..... OS-8511

## Color Filters

SE-9360



Seven filters in glass-covered 35 mm slides. Colors include red, green, blue, magenta, peacock blue, yellow and purple.

Filters can be used in projectors and ray boxes and are excellent for color mixing and color perception demonstrations.

**Order Information:**

**Color Filters  
(set of 7)** ..... SE-9360

## Polarizing Sheets (2 pack)

OS-9477



Two large polarizing sheets for easily visible classroom demonstrations. Show how the intensity of transmitted light varies with the angle between the two sheets, or investigate stress patterns by viewing plastic objects (not included) between crossed polarizers.

Two 23 x 25 cm sheets included.

**Order Information:**

**Polarizing Sheets  
(2 pack)** ..... OS-9477

## Polarizer

OS-9109

**Order Information:**

**Calibrated Polarizer—  
Advanced Optics** ..... OS-9109  
(HN-32) calibrated in 2 degree increments

## Basic Diffraction Grating Set

SE-9357

**For Qualitative Demonstrations**

Three diffraction gratings on a single slide: 100, 300 and 600 lines/mm.

By looking at spectral light sources, students can study the relationship between line spacing and angle of diffraction. The low cost means each student can use one during lecture demonstrations.

**Order Information:**

**Basic Diffraction  
Grating Set** ..... SE-9357

## Diffraction Gratings

SE-9361



This set of four glass-mounted diffraction replicas are excellent for introductory student work. Four line spacings are provided: 80, 100, 300 and 600 lines/mm. Excellent for quantitatively studying the relation between line spacing, angle of diffraction and wavelength.

Each grating is 21 x 35 mm.

**Order Information:**

**Diffraction Gratings  
(set of 4)** ..... SE-9361

## Optics Bench Couplers

OS-9142



Connect two Optics Benches together for a two meter long bench. The couplers keep the benches in alignment.

**Order Information:**

**Optics Bench Couplers  
(2 pack) – Advanced Optics** ..... OS-9142

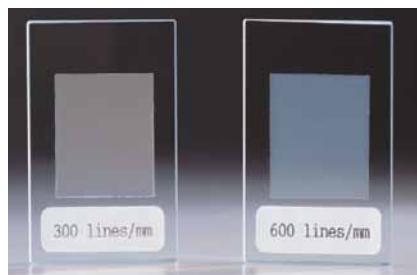
## High-Quality Gratings

300 lines/mm

SE-9359

600 lines/mm

SE-9358



The 300 lines/mm replica grating is strongly blazed in the first through fifth orders, while the 600 lines/mm grating is strongly blazed in the first order. They have excellent resolving power and produce bright, sharp spectral lines for spectrometer labs or for projecting spectra in lecture demonstrations.

**Order Information:**

**High-Quality Gratings**  
300 lines ..... SE-9359  
600 lines ..... SE-9358

## Digital Light Meter

SE-9087A



This handheld Digital Light Meter measures light intensity from 0-50,000 lux in three ranges (2000; 20,000; 50,000 from 1 lux). A precision selenium photovoltaic cell is built-in, providing high accuracy (to 5%) and a fast sampling time (0.4 seconds). To measure light intensities, turn the switch to the desired range, then read the result on the large digital display (13 mm high digits). Zero adjustment is automatic, and the display lets students know if the intensity exceeds the range setting. Read the result in lux or in foot-candles (0 to 5000 Fc). In addition to the digital readout, the meter provides an analog output that can be used to drive a strip chart recorder or other voltage measuring device. Powered by 9-volt battery (included).

**Order Information:**

**Digital Light Meter** ..... SE-9087A

### Demonstration Mirrors



Convex Mirror  
(SE-7574)

Virtual and real images are formed with these large, curved mirrors.



Concave Mirror  
SE-7573

### Convex Mirror

SE-7574

Extra large mirrors are a great way to teach students about image formation. Watch the amazement on their faces as they observe a real image hanging in space before their eyes (produced by the concave mirror). Use the convex mirror to demonstrate why they are used for security purposes in many retail establishments.

**Order Information:**

Demonstration Convex Mirror ..... SE-7574

### Concave Mirror

SE-7573

The mirrors combine large size and a sturdy stand for ease of use during demonstrations. Each silver-backed, non-aluminized mirror measures 60 cm in diameter with a 75 cm focal length. Unique clamp on stand allows mirror to be adjusted to any angle.

**Order Information:**

Demonstration Concave Mirror ..... SE-7573

### Large Corner Reflector Set

SE-8810

Classic demonstration to teach students about reflection: Do mirrors really reverse the image? Two mirrors are held at 90° by a rigid base. Set also includes a third mirror which when placed over the base, creates a corner reflector. A cork base is also included for ray tracing.



**Includes:**

Sturdy base, three mirrors and a cork base for tracing.

**Order Information:**

Large Corner Reflector Set ..... SE-8810

### Reflect View

SE-8699

The Reflect View is a unique plane mirror that is both reflective and transparent. By placing an object on one side of the "mirror," students can locate the position of the virtual image by looking through the "mirror." This position will coincide with the location where the reflected light rays from the object appear to converge. Students will better understand virtual image formation and location after using the Reflect View.



*The reflection of the yellow car appears to be behind the mirror next to the blue car.*

**Includes:**

Four reflect view mirrors (9 cm X 15 cm)

Cars not included

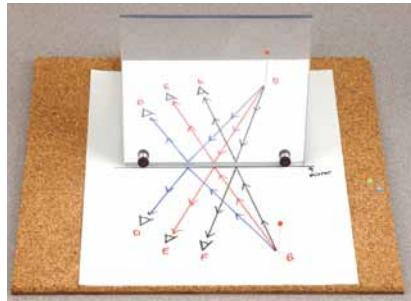
**Order Information:**

Reflect View (4 pack) ..... SE-8699

## Discover Reflection Kit

SE-8803

The Discover Reflection Kit includes everything to perform a variety of reflection experiments. The plane mirror is plastic to avoid the chipping which accompanies glass mirrors and the sturdy stand holds the mirror perpendicular to the surface. The corkboard provides a reusable surface for inserting pins during experiments.



### Law of Reflection

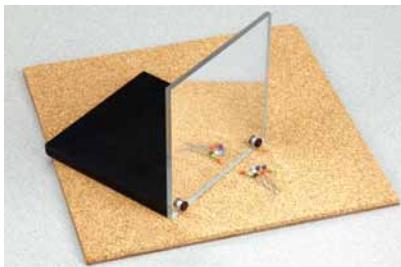
Students place a pin in the corkboard and view the image of the pin. Light rays are drawn from the pin to the mirror and finally to the position of their eye. This is repeated for several different viewing positions. For each reflected light ray, a normal line is drawn at the surface of the mirror. Students use a protractor to measure the angle of incidence and angle of reflection to determine that they are always equal.

### Includes:

Plane mirror with stand (15 cm x 15 cm)

Corkboard (22 cm x 28 cm)

Colored pins



### Order Information:

**Discover Reflection Kit** ..... SE-8803

## Plane Mirror (2 pack)

SE-8804

These mirrors are excellent for many reflection demonstrations. The mirrors are constructed of plastic to avoid chipping on the edges.

Each mirror measures 15 cm x 15 cm.



### Includes:

Unassembled Mirrors (2)

Wrench



### Order Information:

**Plane Mirror (2 pack)** ..... SE-8804

## Dioxide Glass

SE-8719



**Intrigue your students:** What special property of Dioxide Glass causes it to invert blue letters (GLASS) while not effecting red letters (DIOXIDE)? Of course, it is a trick of symmetry. Dioxide Glass is actually an acrylic rod which acts as a lens and both words are inverted in the image. Includes acrylic rod with stand and printed card.

### Order Information:

**Dioxide Glass** ..... SE-8719

## Prisms

These prisms are made of high quality optical glass.

**Equilateral Prism:** 30 x 30 mm sides; 50 mm long

**Right Angle Prism:** 23 x 32 mm sides; 50 mm long

**Equilateral**  
SE-9021A



**Right Angle**  
SE-9022A



### Order Information:

**Equilateral Prism** ..... SE-9021A

**Right Angle Prism** ..... SE-9022A

## Achromatic Prism Pair

SE-9333



A beam of white light can be broken up into its constituent colors, and the colored light can be recombined to produce the original white beam of light. Use these prisms to demonstrate dispersion, to show that white light is actually a mixture of colored lights.

### Specifications

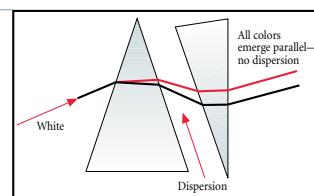
**Material:** Optical glass

**Shape:** Isosceles

**Length:** 45 mm (long side)

**Angles:** 20°, 80°, 80° for one, and

40°, 70°, 70° for the other



### Order Information:

**Achromatic Prism Pair** ..... SE-9333

# Educational Spectrophotometer

## Educational Spectrophotometer Accessory Kit

OS-8537

## Educational Spectrophotometer System

OS-8539

- ▶ Analyze and Graph Spectral Lines
- ▶ Explore Relationship Between Angle, Wavelength and Intensity
- ▶ Versatile and Inexpensive

PASCO's Educational Spectrophotometer teaches basic optical principles and allows quantitative measurements rivaling those of more expensive units.

When the Spectrophotometer is used with DataStudio, students can explore the relationship between angle, wavelength and intensity and graph the spectral lines from discharge tubes. Lines from mercury,

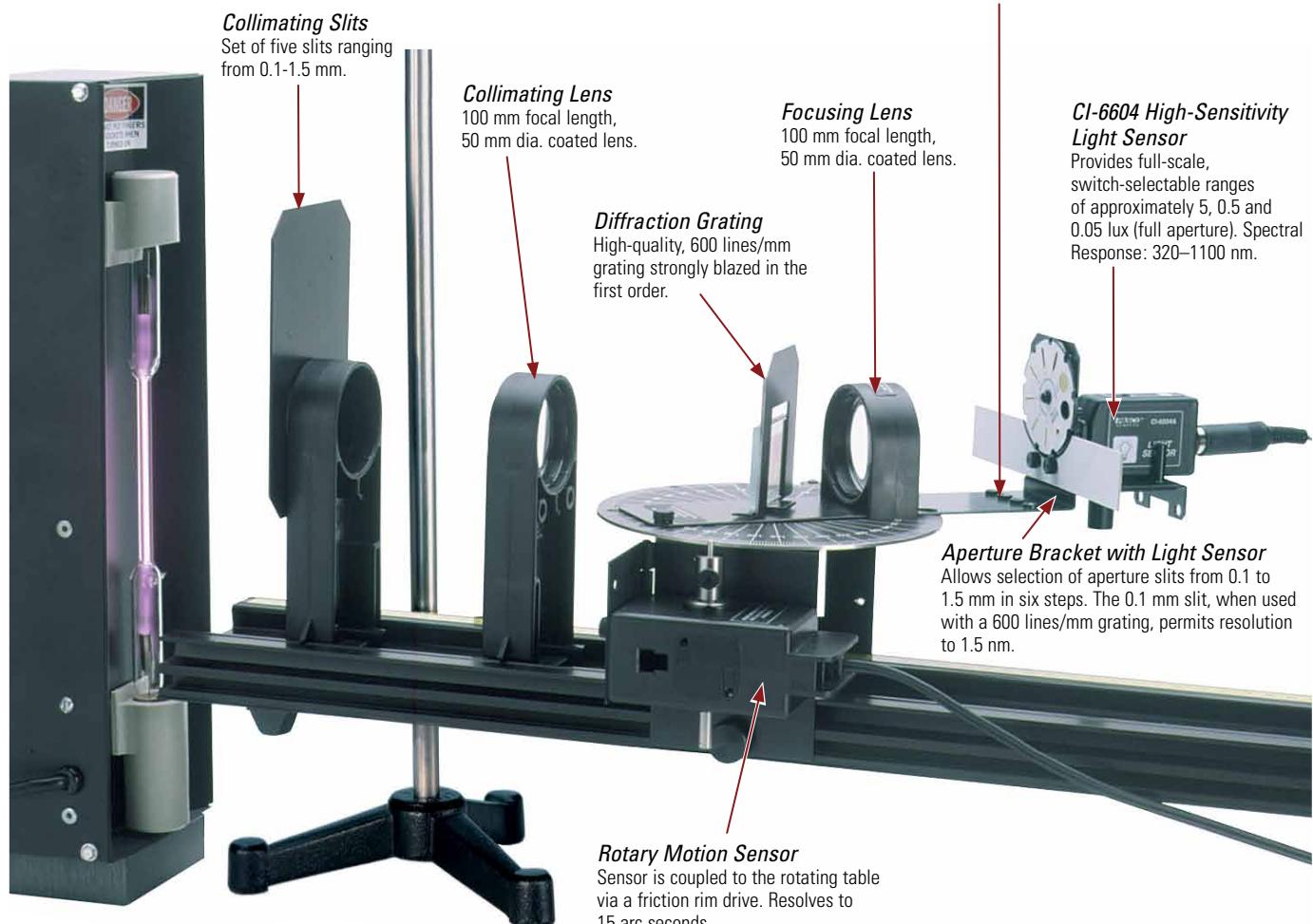
sodium, helium, neon, krypton and argon can be plotted—even the lines of the Balmer series in hydrogen can be detected.

Students can also analyze the transmission characteristics of filters, chemical solutions and even the absorption spectrum of a leaf. Few instruments can be used to teach so many aspects of science.

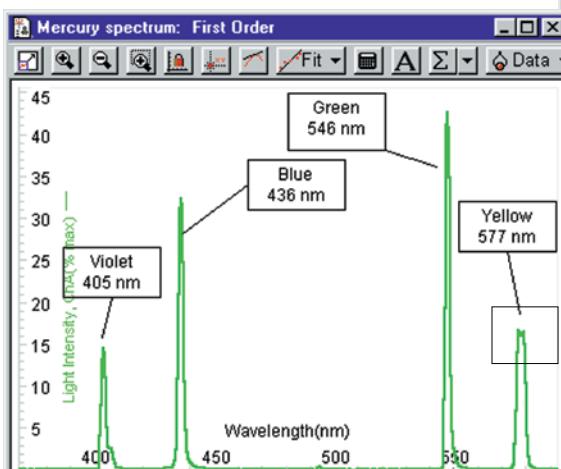


### **Rotating Light Sensor Arm and Table**

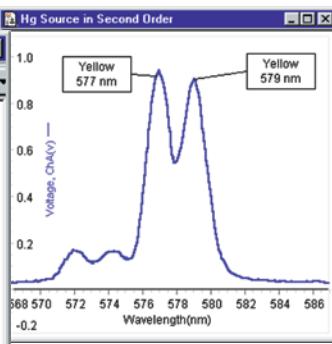
The arm can rotate 360 degrees. As the arm rotates, the edge of the circular table drives the Rotary Motion Sensor. The arm angle can be resolved to 15 seconds of arc.



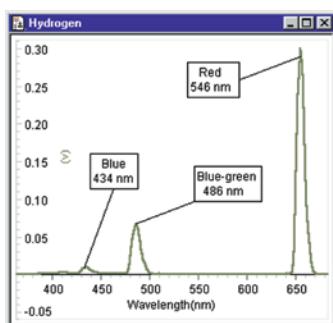
## Typical Spectrum Graphs



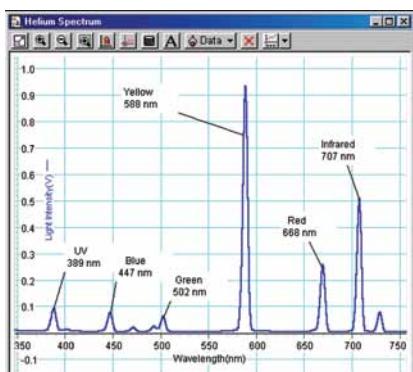
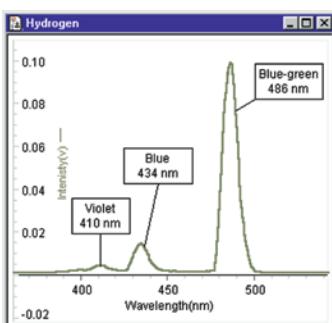
Mercury Spectrum in the First Order



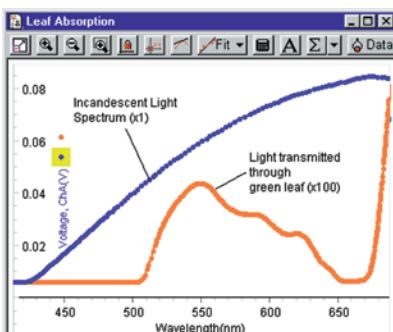
Mercury Spectrum in the Second Order



The left graph shows three lines of the Balmer series for hydrogen. A second scan, with a 10X increase in sensitivity, shows an additional line in the violet (410 nm).



Helium Spectrum



Incandescent light transmitted through a green leaf.

Note: The open design of this spectrophotometer accessory is ideal for education. It is not intended for industrial or research applications.

### Order Information:

**Educational Spectrophotometer System** ..... OS-8539

Required for use with ScienceWorkshop:

ScienceWorkshop 500 or

750 Interface ..... p. 68-72

Spectral Sources ..... p. 333

For adjusting height of optics bench to your light source:

Large Rod Stand (2) ..... ME-8735 p. 212

45 cm Rod (2) ..... ME-8736 p. 212

## Educational Spectrophotometer Components

Teachers that already own a PASCO Interface and the OS-8515C Basic Optics System should purchase the OS-8537 Accessory Kit and any additional equipment needed from the list below.



### The Spectrophotometer Accessory Kit includes:

1. Spectrophotometer Table
2. Rotating Arm
3. Collimating Slits and Lens
4. Focusing Lens
5. Diffraction Grating and Holder
6. Optics Bench Rod Clamps (2) (ME-9836, see page 116)

### The Spectrophotometer System includes:

- 1-6 above and 7-10 below.
7. Optics Bench (60 cm)
  8. CI-6538 Rotary Motion Sensor
  9. CI-6604 High-Sensitivity Light Sensor
  10. OS-8534 Aperture Bracket

### Order Information:

**Educational Spectrophotometer Accessory Kit** ..... OS-8537

Required for use with ScienceWorkshop:

Basic Optics System ..... OS-8515C p. 304

ScienceWorkshop 500 or 750 Interface ..... p. 68-72

Spectral Sources ..... p. 333

Rotary Motion Sensor ..... CI-6538 p. 74

High-Sensitivity Light Sensor ..... CI-6604 p. 78

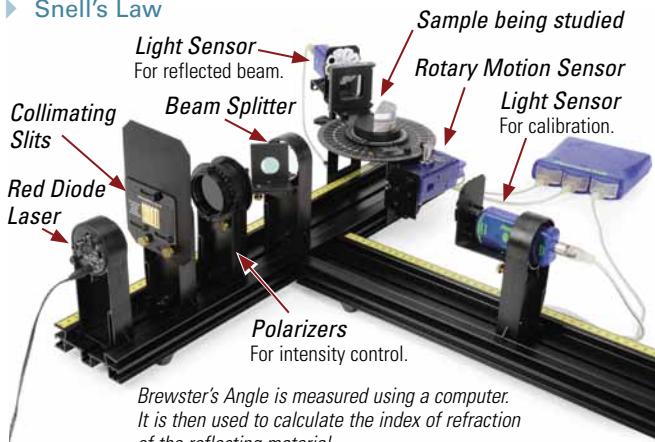
Aperture Bracket ..... OS-8534A p. 316



## Brewster's Angle Accessory

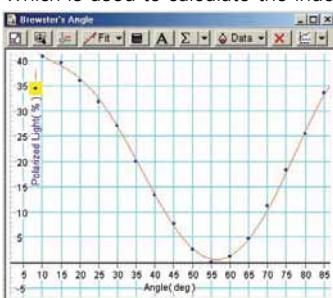
OS-8170A

- ▶ Polarization by Reflection
- ▶ Brewster's Angle
- ▶ Fresnel's Law of Reflection
- ▶ Snell's Law



When light reflects off a nonconducting material, the reflected light is partially polarized. The amount of polarization depends on the incident angle and the index of refraction of the reflecting material. The incident angle that gives maximum polarization is called Brewster's Angle.

Light from a diode laser (wavelength = 650 nm) is reflected off the flat side of an acrylic semi-circular lens. The reflected light passes through a polarizer and is detected by a Light Sensor. The angle of incidence is measured by a Rotary Motion Sensor mounted on the Spectrophotometer table. The intensity of the reflected polarized light versus incident angle is graphed to determine the angle at which the light intensity is a minimum. This is Brewster's Angle, which is used to calculate the index of refraction of acrylic.



Developed using original ideas from P.J. Ouseph, Professor of Physics at University of Louisville, KY: *Polarization of Light by Reflection and the Brewster Angle* by P.J. Ouseph, Kevin Driver, and John Conklin, Am. J. Phys. 69, 1166 (2001).

The intensity (% of total reflected) of the reflected polarized light as a function of the incident angle. See Brewster's Angle Experiment on page 395.

### Includes:

Acrylic semi-circular lens  
Lens platform  
Polarizers (2) with holder  
Analyzing polarizer  
Beam splitter



### Order Information:

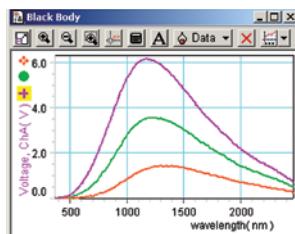
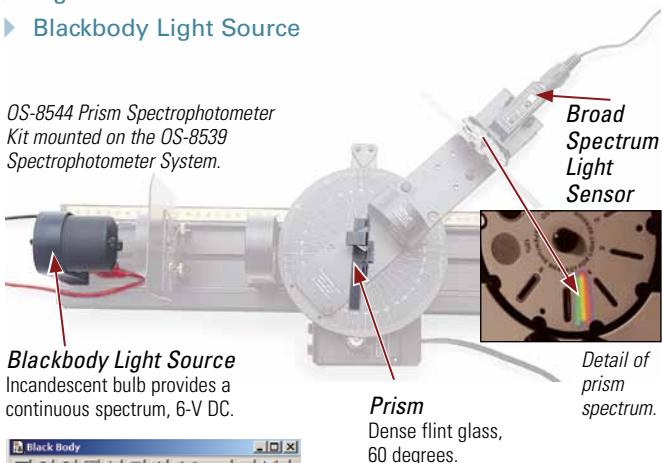
Brewster's Angle Accessory	OS-8170A
Beam Splitter (only)	OS-8171
<i>Required:</i>	
Spectrophotometer Accessory Kit	OS-8537
Optics Bench (60 cm) (2)	OS-8541
Aperture Bracket (2)	OS-8534A
Red Diode Laser	OS-8525A
<i>Required for use with ScienceWorkshop:</i>	
High Sensitivity Light Sensor (2)	CI-6604
Rotary Motion Sensor	CI-6538
<i>Required for use with PASPORT:</i>	
High Sensitivity Light Sensor (2)	PS-2176
Rotary Motion Sensor	PS-2120

## Prism Spectrophotometer Kit

OS-8544

- ▶ High-Quality Prism
- ▶ Light Sensor Senses Into Infrared
- ▶ Blackbody Light Source

OS-8544 Prism Spectrophotometer Kit mounted on the OS-8539 Spectrophotometer System.



The classic textbook diagram of the intensity versus wavelength blackbody curves can be produced with real data. In this graph, the peak wavelength in the blackbody curve shifts as the source temperature is lowered.

One of the basic phenomena that led to the development of quantum mechanics was the spectral curve seen from a blackbody. Using this prism spectrophotometer, students can scan the spectrum of a blackbody, plot the intensity versus wavelength and change the temperature of the blackbody to see the shift in the peak wavelength.

This spectrophotometer uses a prism to disperse the light instead of a diffraction grating. This allows the infrared to be seen without overlapping the second order visible spectral lines. The Infrared Sensor has a linear response to all wavelengths within its range, so the actual intensity of the light in the blackbody spectrum is detected and there is no need to calibrate the intensity. Designed to be used with the OS-8539 Spectrophotometer System described on pages 328-329. See Blackbody Radiation Experiment on page 389.

### Includes:

Prism, Mount and IR Filter (OS-8543)  
Blackbody Light Source (OS-8542)  
DataStudio Experiment Setup CD

### Order Information:

**Prism Spectrophotometer Kit.....OS-8544**

*OR components of the system may be ordered separately:*

Blackbody Light Source.....OS-8542  
Mounted Prism.....OS-8543

*Required for use with ScienceWorkshop:*

Broad Spectrum Light Sensor.....CI-6630 p. 78

Spectrophotometer System.....OS-8539 p. 328

Power Supply (18V DC, 5A).....SE-9720A p. 279

or *ScienceWorkshop 750*  
Interface and Power Amplifier.....p. 68-72

*Replacement Supplies:*

Replacement Bulbs (10 pack).....SE-8509

## Student Spectrometer

SP-9268A

- ▶ Wide Aperture Optics
- ▶ Precision Vernier— Resolves 1 Minute of Arc
- ▶ Durable and Precise

### *Collimator*

High-quality, large-aperture optics with a 6 mm long slit of adjustable width. The collimator can be independently focused, leveled and aligned.



### *Precision Ground Bearings*

The main bearings are ground as a single unit, so the movement is exceptionally smooth with virtually no backlash. This is essential for precise positioning.



### *Dense Flint Glass Prism with holder*

Chemists use it to determine the constituents of molecules, astronomers use it to determine the constituents of stars and physicists use it to investigate the structure of the atom—not bad for an instrument for which few people can name the inventor (David Alter, with some important later enhancements by Joseph von Fraunhofer).

PASCO offers this high-quality spectrometer that allows students to perform accurate prism and grating spectrometry. High-quality, large-aperture optics produce sharp spectral images, while precision machining allows for precise rotation and accurate measurement.

The Student Spectrometer is most popular in upper division labs, where precision and durability are equally important.

### *Custom Prism/Grating Table*

Threaded holes and engraved reference lines for accurate component placement.



### *Telescope*

High-quality, large-aperture optics plus a 15x Ramsden eyepiece with a crosshair graticule. The telescope can be independently focused and aligned.

### *Durable Construction*

Heavy aluminum castings provide a stable base for delicate measurements and ensure long-term durability.

## Features

**Resolution to 1 Minute of Arc:** The 127 mm diameter, precision-engraved degree plate is complemented by two precision-engraved verniers, one on each side of the instrument for convenient reading.

**Wider Aperture Optics:** 32 mm wide apertures on the telescope and collimator provide more light for brighter and sharper images.

**Rack and Pinion Focusing:** On both the telescope and the collimator. Focusing is easier and more precise.

**Rotatable Table:** For greater flexibility in measurements. Turn the table by hand for coarse adjustments. Use the fine lead screw for delicate adjustments.



The Vernier Scale resolves angle measurements within 1 minute of arc.

### *Order Information:*

**Student Spectrometer** ..... SP-9268A

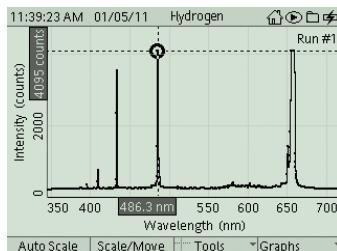
*Recommended:* Spectral Light Sources ..... p. 332-333

## Emission Spectrometer System for Xplorer GLX

PS-2635

- Uses Ocean Optics™ Red Tide Spectrometer

Spectrum of Hydrogen as seen on the Xplorer GLX screen. The Smart Cursor can be used to measure the wavelengths of the peaks.



Light from a Hydrogen tube is sampled using the fiber optics cable connected to the Ocean Optics Spectrometer. The Spectrometer is plugged into the USB port on the Xplorer GLX.



The Xplorer GLX controls the Ocean Optics Red Tide Spectrometer which detects the spectrum using a 2048 pixel CCD linear array. The Xplorer GLX does a full sweep in less than 1 second. See page 16 for the Absorption Spectrometer System.

### Specifications

**Range:** VIS-NIR, 350-1000 nm

**Optical Resolution:** 2 nm

### Includes:

Ocean Optics Red Tide Spectrometer

Fiber Optics Cable, USB Cable

License key for Ocean Optics GLX feature set

### Order Information:

**Emission Spectrometer System for Xplorer GLX** ..... PS-2635

**Required:**  
Xplorer GLX ..... PS-2002 p. 10

## Spectroscope SE-8688

The rugged, Stainless Steel design of this spectroscope means durability. Turn the dial to adjust the slit width and slide the eyepiece back and forth to focus the spectrum.

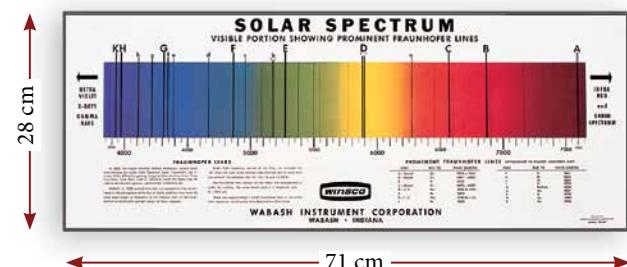


### Order Information:

**Spectroscope** ..... SE-8688

## Solar Spectrum Chart

SE-7338



This Solar Spectrum Chart highlights the visible portion of the spectrum showing prominent Fraunhofer lines. Includes a historical background of solar absorption spectra.

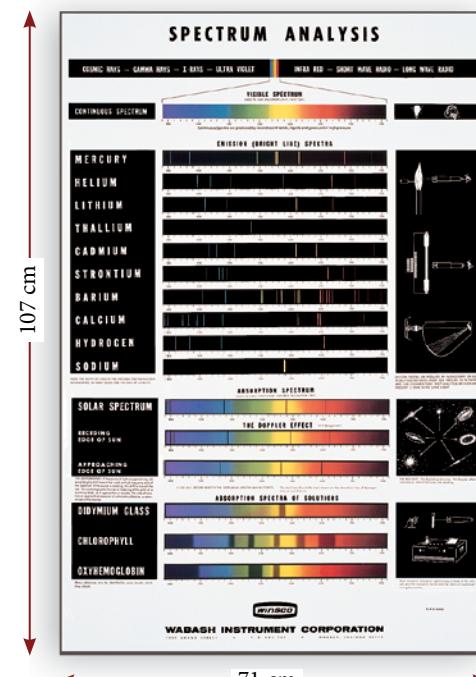
### Order Information:

**Solar Spectrum Chart** ..... SE-7338

## Spectrum Chart

SE-7336

The continuous nature of the electromagnetic spectrum is often difficult for students to understand. The Spectrum Chart clearly displays all of the regions of the spectrum, from cosmic rays to long-wave radio. Complete with full-color enumerated examples, the Spectrum Chart visually displays emission or bright line and absorption spectra.



### Order Information:

**Spectrum Chart** ..... SE-7336

## Sodium Light Source

OS-9287B

- ▶ Long Lamp Life
- ▶ Rugged and Reliable
- ▶ Can be Used by Two Groups Simultaneously

This Low-Pressure Sodium Light Source has an output intensity of approximately six candela/cm<sup>2</sup>, with better than 99.5% of the visible output concentrated in the 5889 and 5895 angstrom spectral lines. Slight impurities (1% neon and argon) are added to the sodium gas to improve operating efficiency. Lamps provide 10,000+ hours of trouble-free operation. The light ports are 3.2 cm in diameter and are 22.5 cm high.

This light source is supplied fully operational with built-in power supply, housing and lamp. Operating voltage is 115/220 VAC, 50/60 Hz.



### Order Information:

**Low-Pressure Sodium Light Source** ..... OS-9287B

### Replacement Supplies:

Replacement Lamp - Sodium Light Source  
(for OS-9287B only) ..... 526-034

## Osram® Spectral Lamps

The PASCO SF-9288 Spectral Lamp Power Supply and Lamp Mount are designed for use with Osram® 9-pin DIN spectral lamps. A variety of spectral lamps are available. Changing spectral lamps is easy, so a single power supply and lamp mount is required to power any one of the Osram® lamps.



### Order Information:

**Spectral Lamp Power Supply and Mount** ..... SF-9288

**Mercury Spectral Lamp** ..... SF-9282

**Sodium Spectral Lamp** ..... SF-9289

**Cadmium Spectral Lamp** ..... SF-9290

**Helium Spectral Lamp** ..... SF-9291

**Neon Spectral Lamp** ..... SF-9292

## Spectral Tube Power Supply and Mount

SE-9460

This system is easy-to-use and inexpensive, with a variety of safety features that make it suitable for beginning labs. Mount any of the eight different spectral tubes into the power supply and turn it on. The 26 cm long tubes are capillary-thin over the middle 10 cm, providing sharp, bright spectra.

### Features

**Student Safety:** The tubes mount from the front of the supply and snap into molded sockets that fully enclose the conductive ends. The all-metal case is electrically grounded.

**Spectral Tube Safety:** A current limiting transformer protects the tubes. A protective shield also helps safeguard the tubes, while blocking unwanted ambient light for clear viewing.

**Power Requirements:** 115/220 VAC, 50/60 Hz.

SE-9460  
Power Supply and Mount



### Order Information:

**Spectral Tube Power Supply** ..... SE-9460

## Spectral Tubes

- ▶ Argon
- ▶ Krypton
- ▶ Carbon Dioxide
- ▶ Mercury
- ▶ Helium
- ▶ Neon
- ▶ Hydrogen
- ▶ Water Vapor



These spectral tubes are designed for use in the SE-9460 Spectral Tube Power Supply and Mount.

### Order Information:

#### Spectral Tubes:

**Argon** ..... SE-9463

**Carbon Dioxide** ..... SE-9464

**Helium** ..... SE-9462

**Hydrogen** ..... SE-9461

**Krypton** ..... SE-9465

**Mercury** ..... SE-9466

**Neon** ..... SE-9467

**Water Vapor** ..... SE-9468

## Light and Optics – UV Light Source

### UV Beads

SE-8796



Before (left) and after (right) being exposed to UV Light.

UV-Sensitive beads are pale while indoors, but change color instantly when exposed to UV radiation. Each bead is created with a pigment which changes color as the UV energy is absorbed. As the UV radiation is removed, the beads will return to their pale white color. This process can be repeated many thousands of times.

Each package includes over 200 beads.

#### Order Information:

UV Beads ..... SE-8796

### UV Filters

SE-8797

This set of two plastic discs look identical, however one disc absorbs ultraviolet radiation (UVA and UVB) while the other doesn't. Use the discs with UV Beads (SE-8796) or our UV Sensors (see pages 47 and 78).



A UV Light Source illuminates the UV beads under two types of filters.

#### Includes:

Two Filters



#### Order Information:

UV Filters ..... SE-8797



### Glow String (2 pack)

SE-8690

This stretchy "string" glows in the dark after being exposed to light. Use it to demonstrate wave motion, including resonance and standing wave patterns. Two rolls are included, totaling over 15 meters of string.



Glow String forming a standing wave using PASCO's String Vibrator WA-9857, Sine Wave Generator WA-9867 and a UV Light Source SE-7228.

#### Order Information:

Glow String (2 pack) ..... SE-8690



### Red Laser Pointer

SE-9716B



- ▶ Push-Button Switch
- ▶ Inexpensive

CLASS IIIa LASER PRODUCT  
LASER RADIATION – AVOID DIRECT EYE EXPOSURE

This Red Diode Laser Pointer is an inexpensive, easy-to-use light beam for a multitude of demonstrations and experiments in optics.

#### Specifications

**Source:** Laser diode  
**Power:** 5 mW max. (class IIIa)  
**Wavelength:** 645 nm (red)  
**Beam Dia.:** Approx. 8 mm at 5 meters  
**Beam Visibility:** Up to 50 m  
**Battery:** Alkaline AAA (2 included)  
**Battery Life:** Approx. 1 1/2 hours continuous  
**Dimensions:** 143 mm x 12.7 mm

#### Order Information:

Laser Pointer ..... SE-9716B

### Diode Laser – Intro. Optics

OS-8528A



This diode laser adheres to the magnetic strip on the Introductory Optics Bench. CLASS 2 LASER PRODUCT LASER LIGHT – DO NOT STARE INTO BEAM

#### Specifications

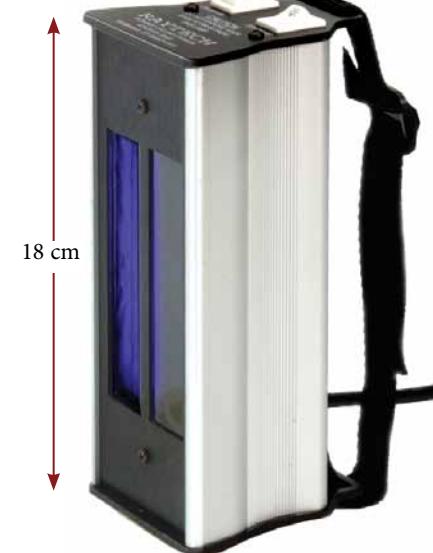
**Output Power:** <5 mW  
**Wavelength:** 650 nm  
**Power Supply:** 9 VDC, 500 mA adapter (included)

#### Order Information:

Diode Laser – Intro. Optics ..... OS-8528A

### UV Light Source

SE-7228



This compact, easy-to-use ultraviolet lamp is ideal for educational use. Two independent lamps are included in one unit. The lamp includes two switches allowing the shortwave and longwave UV to be turned on individually.

Each wavelength produces 4 Watts.

Each lamp window 10 cm X 2.4 cm.

#### Order Information:

UV Light Source ..... SE-7228

### Diode Laser – Basic Optics

OS-8525A (Red)

OS-8458 (Green)



These diode lasers fit on the Basic Optics Benches (OS-8505 and OS-8541) and the Dynamics Track Optics Carriage (OS-8472).

CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM

#### Specifications

**Output Power:** <1 mW  
**Wavelength:** 650 nm (OS-8525A)  
532 nm (OS-8458)  
**Power Supply:** 9-V adapter (included)

#### Order Information:

Diode Laser – Red ..... OS-8525A

Diode Laser – Green ..... OS-8458

## X-Y Adjustable Diode Laser

OS-8526A

This versatile, inexpensive Diode Laser is designed to mount on a rod stand. The laser assembly can rotate 360 degrees. Easy set-up makes it perfect for refraction investigations or other general laser experiments.



CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM



*Two knobs allow independent adjustment of horizontal and vertical alignment of the laser beam.*

### Specifications

**Output Power:** <1 mW

**Wavelength:** 650 nm

**Power Supply:** 9 VDC, 500 mA adapter (included)

#### Order Information:

**X-Y Adjustable Diode Laser** ..... OS-8526A

## Green Laser Pointer

SE-8805

- ▶ Push Button Switch
- ▶ Brilliant Color

CLASS IIIa LASER PRODUCT  
LASER RADIATION – AVOID DIRECT EYE EXPOSURE



Use this green diode laser for a wide variety of optics demonstrations and experiments.

### Specifications

**Source:** Laser Diode

**Power:** 5 mW max (class IIIa)

**Wavelength:** 632 nm

**Beam Dia:** Approx. 15 mm at 10 meters

**Beam Visibility:** 500 meters

**Battery:** Alkaline "AAA" (2 included)

**Dimensions:** 151 mm x 13.5 mm

#### Order Information:

**Green Laser Pointer** ..... SE-8805

## Mini Laser w/Bracket

OS-8514



*Shown  
mounted on a  
PASCO Laser  
Alignment Bench.  
(see below)*

CLASS II LASER PRODUCT  
LASER RADIATION – DO NOT STARE INTO BEAM OR  
VIEW DIRECTLY WITH OPTICAL INSTRUMENTS

This 0.5 mW Helium Neon Laser is ideal for use with the PASCO Advanced Optics System. It includes a mounting bracket that attaches to the PASCO magnetic optics bench and permits adjustment of the laser beam in the X and Y Axes.

The aperture has a 15.8 mm (5/8") receptacle for mounting beam spreaders or spatial filters. An AC adapter is included but the unit can be powered with any power source providing 0.7 A at 12 VDC.

### Specifications

**Output:** 0.5 mW min.

**Wavelength:** 632.8 nm

**Polarization:** Random

**Power:** 115/220 VAC, 50/60 Hz

#### Order Information:

**Mini Laser –  
with Bracket** ..... OS-8514

## Mini Laser w/o Bracket

SE-9367



CLASS II LASER PRODUCT  
LASER RADIATION – DO NOT STARE INTO BEAM OR  
VIEW DIRECTLY WITH OPTICAL INSTRUMENTS

#### Order Information:

**Mini Laser –  
without Bracket** ..... SE-9367

## Laser Alignment Bench

OS-9172



This Laser Alignment Bench connects to the Optics Bench with the included couplers. It leaves the full one-meter length of the Optics Bench free for experimental work.

#### Order Information:

**Laser Alignment Bench** ..... OS-9172

## Modulated Laser (1.5 mW)

SE-9449

- ▶ Higher Power
- ▶ Durable
- ▶ Modulated

This Helium Neon laser has two advantages over the other lasers:

1. **1.5 mW:** The extra power makes laser experiments and demonstrations brighter (and often easier). Especially useful for holography. A shorter exposure time can be used to minimize problems with vibrations.
2. **Modulation:** Connect a microphone or TV camera to this laser, and students can transmit voice or video signals through the laser beam to a distant receiver. Or use this laser as a laser stroboscope for timing.

**Note:** Additional equipment, not available from PASCO, is required for laser communication experiments.



CLASS IIIa LASER PRODUCT  
LASER RADIATION – DO NOT STARE INTO BEAM

### Specifications

**Wavelength:** 632.8 nm

**Modulation Range:** 85-100% of full power

**Input Signal Frequency:** 50 Hz-600 kHz ( $\pm 3$  dB); video signals of higher bandwidth may also be accepted

**Audio:** Miniature phone jack accepts audio input signals at 100 mV peak-to-peak and 60 k $\Omega$  impedance

**Video:** BNC connector accepts video input signals at 1 V peak-to-peak and 8 k $\Omega$  impedance

**Transmission Range:** Effective up to several hundred feet; with a good collimator and detector, transmissions up to several thousand feet are possible

**Video:** Black and white TV can be transmitted, but the bandwidth is not broad enough to produce the full resolution of commercial TV

**Power:** 115 VAC, 60 Hz (not available in 220 V)

#### Order Information:

**1.5 mW Modulated Laser** ..... SE-9449

## Introductory Michelson Interferometer

OS-8501

- ▶ Micrometer-Controlled Mirror Movement
- ▶ Precision, Front-Surface Optics
- ▶ Good Quality, Low Price

This Introductory Michelson Interferometer is a precision interferometer for the introductory lab. It's easier to use, more compact and less expensive than PASCO's advanced interferometer (see page 337). It's capable of measuring the wavelength of monochromatic light with an accuracy of better than 5%. The Michelson Interferometer can also be used for making precise measurements of the index of refraction of air.

### Features

#### Smooth Mirror Movement:

Uses a taut-band mirror movement similar to PASCO's more expensive interferometer, providing smooth movement with minimal backlash.

#### Built-in Micrometer:

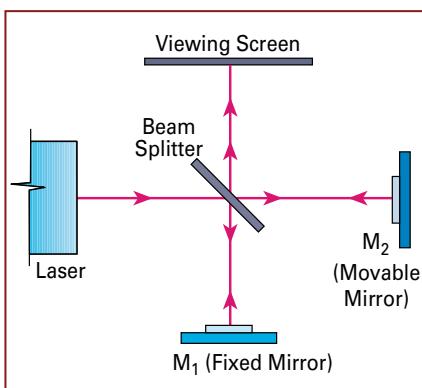
Measures mirror movement to a fraction of a micron.

#### Easy Setup:

Especially easy with a laser and a PASCO Optics Bench. If a laser is unavailable, a spectral light source can be used.

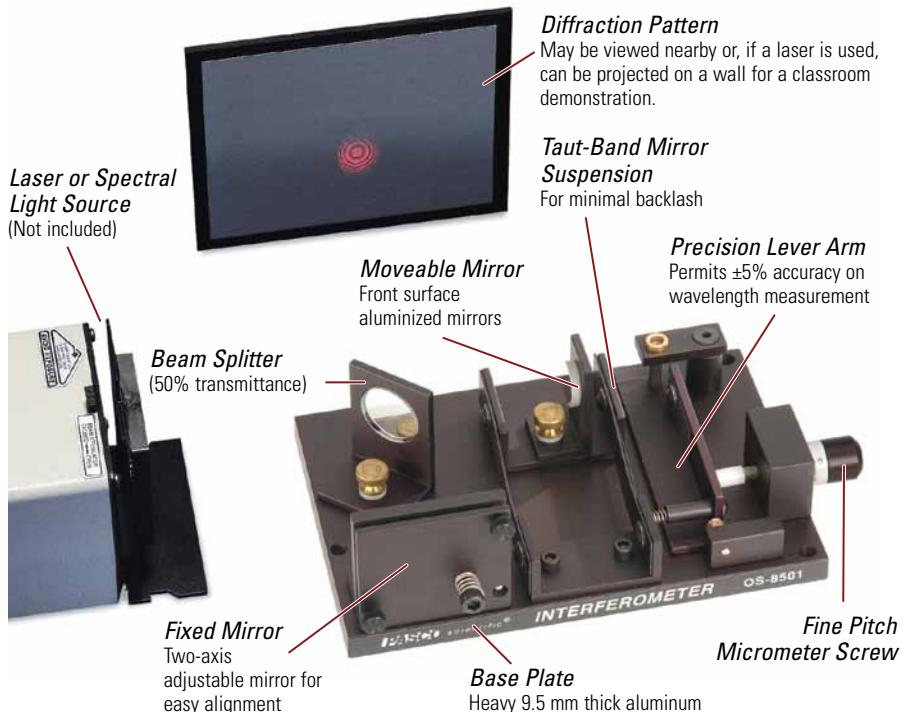
#### Complete Manual:

Manual includes illustrated set-up instructions, a detailed discussion of basic Michelson interferometry plus two copy-ready experiments (measure the wavelength of monochromatic light, and measure the index of refraction of air).



Beam-splitting schematic for a basic Michelson Interferometer.

The Introductory Michelson Interferometer provides precision interferometry at an economical price (laser and screen not included).



### Optics Bench

**Note:** While the interferometer is designed to be used with the Optics Bench of the OS-8500 Introductory Optics System, or the OS-9103 Optics Bench of the Advanced Optics System, it can also be used without the PASCO Optics Bench.

#### Includes:

- Michelson Interferometer
- Gas Cell
- Collimating Lens (18.4 mm focal length)
- Lens Holder
- Storage Case
- Manual

#### Order Information:

**Introductory Michelson Interferometer** ..... OS-8501

**Recommended:**  
Mini Laser w/Bracket ..... OS-8514 p. 335

Hand Operated Vacuum Pump w/Gauge ..... OS-8502

## Hand Operated Vacuum Pump

OS-8502



Shown above: OS-8502 Hand Operated Vacuum Pump with Gauge (required for measuring the index of refraction of air using the Introductory Michelson Interferometer).

#### Order Information:

**Hand Operated Vacuum Pump** ..... OS-8502

## Precision Interferometer

OS-9255A

- ▶ Three Modes: Michelson, Fabry-Perot, Twyman-Green
- ▶ Large Precision Optics
- ▶ 5 kg Machined Aluminum Base

No study of interferometry should overlook the historical importance of the Michelson interferometer. Yet in the laboratory, the Fabry-Perot and Twyman-Green interferometers can be more important tools; the first for high-resolution spectroscopy, the second for testing and producing optical components with aberrations that can be measured in fractions of a wavelength.

The PASCO Interferometer is a high-precision, movable-mirror interferometer that can be used to perform Michelson, Fabry-Perot and Twyman-Green interferometry. Mirrors are attached with thumbscrews, so it's easy to set up and change configurations.

The PASCO Interferometer can be ordered in a variety of systems. The OS-9255A Basic Interferometer can be operated in either the Michelson or Fabry-Perot modes. The Complete Interferometer Systems also contain components for the Twyman-Green mode and a vacuum pump for the refractive index of air experiment. The Systems Component List shows the contents of each system.

### Features

**Stable:** The massive (5 kg) base is machined from a single block of aluminum ensuring extremely stable optics.

**Smooth Mirror Movement:** With the taut-band suspension system, there's no starting or stopping friction and virtually no backlash (less than 0.5 micron).

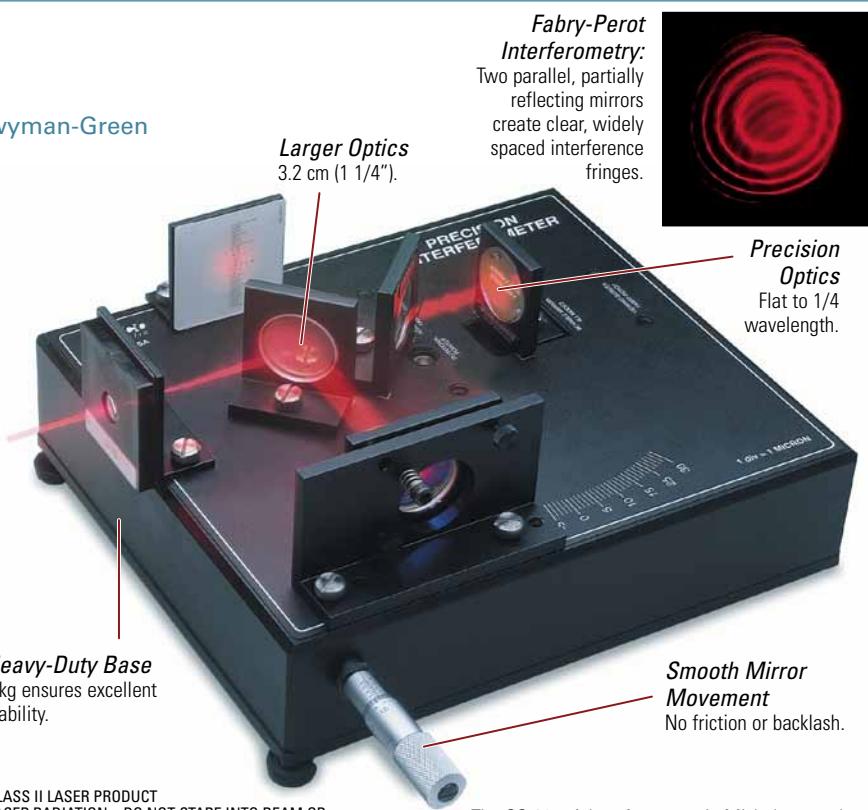
**Precise Measurements:** Mirror control is extremely fine— one micron per division of the micrometer head. The mirrors and beam-splitter are flat to 1/4 wavelength to ensure uniform interference patterns.

**Larger Optics:** The 3.2 cm (1 1/4") diameter optics in the PASCO Interferometer produce larger and sharper interference patterns for better experimental results.

**Complete:** The Basic Interferometer includes everything necessary to perform basic Michelson and Fabry-Perot interferometry.

### Order Information:

Complete Interferometer System	OS-9258B
Complete Interferometer System (no laser)	OS-9257A
Precision Interferometer	OS-9255A
Interferometer Accessories Kit	OS-9256A



The OS-9255A Interferometer in Michelson mode.

### Add the Accessories Kit (included in the Complete Interferometer) to:

Demonstrate that cross-polarized beams will not interfere

Measure lens irregularities in Twyman-Green Mode

Measure the indices of refraction for air and glass. The indices of refraction for user-supplied materials can also be measured.

*Note: The fitted case will hold all components and accessories except the 5 kg base, which must be stored separately.*

A. OS-9258B	Complete Interferometer System with Laser	C. OS-9255A	Precision Interferometer		
B. OS-9257A	Complete Interferometer System without Laser	D. OS-9256A	Interferometer Accessories Kit		
Part Number	Systems Component List	A	B	C	D
003-06412	Machined base— 5 kg	1	1	1	
003-03957	Three-point adjustable mirror	1	1	1	
003-03956	Mounted beam-splitter	1	1	1	
003-03955	Mounted movable mirror	1	1	1	
003-05161	Accessory mounts	3	3	2	1
OS-9138	Viewing screen— Advanced Optics	1	1	1	
OS-9120	Diffuser— Advanced Optics	1	1	1	
OS-9132	Double Convex lens (18 mm)— Advanced Optics	1	1	1	
003-03958	Compensator lens	1	1	1	
650-05178	Fitted case	1	1	1	
OS-8502	Vacuum pump with gauge	1	1		1
003-05162	Gas cell	1	1		1
OS-9109	Calibrated Polarizer— Advanced Optics	2	2		2
OS-9128	Glass plate— Advanced Optics	1	1		1
003-05160	Rotating component holder	1	1		1
OS-9133/OS-9132	Twyman-Green lenses	2	2		2
OS-8514	Mini laser with bracket— Advanced Optics	1			
OS-9172	Laser alignment bench— Advanced Optics	1			
012-05187	Instruction manual	1	1	1	

# Microwave Optics

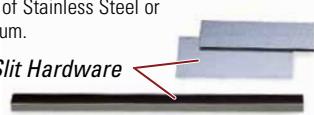
## Basic System

WA-9314B

### Durable Construction

Parts are made of Stainless Steel or die-cast aluminum.

### Diffraction Slit Hardware



### Ethafoam® Prism with Styrene Pellets

Used for refraction of microwaves.

### Rotating Mounts

The transmitter and receiver rotate through a full 360°.

### Gunn Diode Transmitter

A stable, low-voltage source of linearly polarized microwaves (10.5 GHz; 15 mW).

## The Microwave Optics Advantage

The large 3 cm wavelength makes it easy to understand and visualize electromagnetic wave interactions. Interference and diffraction slits are several centimeters wide, and polarizers are slotted sheets of Stainless Steel.

## How It Works

The heart of the Microwave Optics System is the Gunn Diode Transmitter and receiver. The transmitter is a low voltage source of linearly polarized microwaves (10.5 GHz; 15 mW). The receiver can detect and measure the intensity of the microwaves at various positions beyond the transmitter. The receiver has a built-in amplifier as well as a variable sensitivity scale, ensuring accurate data for even the lowest intensity measurements.

## Advanced System

WA-9316

### Magnetic Mounting

All components mount magnetically.

### 18 cm High Mounts

Minimize tabletop reflections.

## The WA-9314B Basic Microwave Optics System includes:

Gunn Diode Transmitter with mounting stand

Receiver with built-in amplifier and mounting stand

Goniometer with fixed and rotatable arms and degree scale

Fixed-arm assembly for interferometer experiments

Component holders: two standard, one rotating

Rotating table

Reflectors: two full reflectors (metal), two partial reflectors (wood)

Polarizers (two)

Diffraction slit hardware

Prism (Ethafoam) with styrene pellets

AC adapter

Laboratory manual with 12 experiments

## The WA-9316 Advanced Microwave Optics System includes:

WA-9314B Basic Microwave Optics System

WA-9315 Microwave Accessory Package

### Order Information:

**Basic Microwave Optics System** ..... WA-9314B

**Advanced Microwave Optics System** ..... WA-9316

### Recommended:

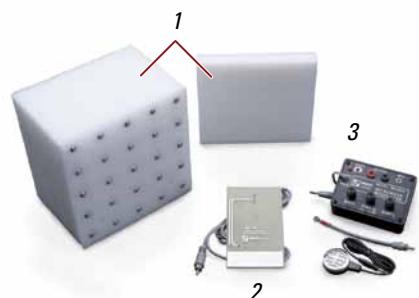
*The microwave transmitter and receiver assemblies may be purchased separately:*

Microwave Transmitter ..... WA-9801

Microwave Receiver ..... WA-9800

Microwave Mounting Stand (two needed) ..... WA-9802

## Microwave Accessories



### 1. WA-9315 Microwave Accessory Package (included in the WA-9316 Advanced System)

Includes a polyethylene panel for measuring Brewster's angle and a simulated crystal for Bragg diffraction experiments. The crystal is a cubic lattice of 100 metal spheres in a 5 x 5 x 4 array, mounted in plastic foam.

### 2. WA-9319 Microwave Detector Probe

Investigate the nodes and antinodes in standing wave patterns with this microwave probe. It plugs directly into the receiver.

### 3. WA-9318 Microwave Transmitter Modulator

Modulate a microwave signal to demonstrate microwave communication. Includes a built-in signal generator (0.4 to 4 kHz) as well as a microphone for voice and music modulation. The signal can be detected with the microwave receiver, but an oscilloscope is needed to view the signal, or an amplifier and speaker to hear it.

### Order Information:

**Microwave Accessory Package** ..... WA-9315

**Microwave Detector Probe** ..... WA-9319

**Microwave Transmitter Module** ..... WA-9318

*Required for Transmitter Modulator:*

Audio Amplifier ..... Open Speaker ..... WA-9900 p. 296

20 MHz Dual Trace Oscilloscope ..... SB-9591A p. 282

## Fiber Optics Communication Kit

SE-8794

- ▶ Demonstrate Light Propagation in Optical Fibers
- ▶ Transmit and Receive Optical Data
- ▶ Includes Experiment Manual



This kit has transmitter and receiver boards and several modules to connect to these boards to transfer optical data through fiber optics cables. The modules included are: analog transmitter and receiver, digital transmitter and receiver, transmitter set with microphone, receiver set with amplifier and speaker, a frequency generator, RS232 signal converter receiver and transmitter. The kit also includes a special holder for the optical fibers, special emery cloths for preparation of the fibers, multimeter, equipment for Tyndall's light guiding experiment, force plates, bending cylinders, jacketed and not jacketed fibers, power sources, and a user's guide. Also included is a Windows CD user guide and video tutorials.

### **Order Information:**

**Fiber Optics Communication Kit** ..... SE-8794

## Red Laser Pointer

SE-9716B



- ▶ Push-Button Switch
- ▶ Inexpensive

CLASS IIIa LASER PRODUCT  
LASER RADIATION – AVOID DIRECT EYE EXPOSURE

This Red Diode Laser Pointer is an inexpensive, easy-to-use light beam for a multitude of demonstrations and experiments in optics.

### **Specifications**

**Source:** Laser diode  
**Power:** 5 mW max. (class IIIa)  
**Wavelength:** 645 nm (red)  
**Beam Dia.:** Approx. 8 mm at 5 meters  
**Beam Visibility:** Up to 50 m  
**Battery:** Alkaline AAA (2 included)  
**Battery Life:** Approx. 1 1/2 hours continuous  
**Dimensions:** 143 mm x 12.7 mm

### **Order Information:**

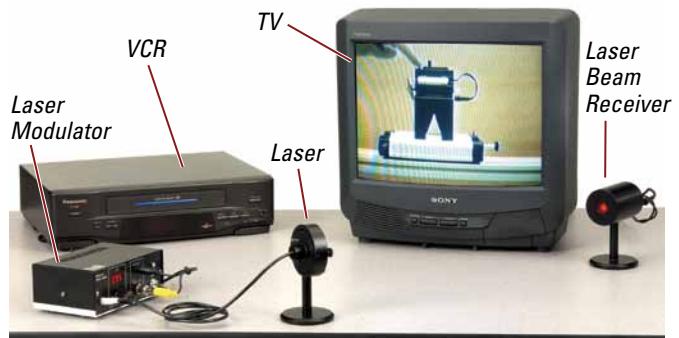
**Laser Pointer** ..... SE-9716B

## Laser Communication Kit

SE-8793

- ▶ Transmit Both Audio and Video over Laser Beam
- ▶ Transmit Voice using Microphone
- ▶ Laser Included

A laser is modulated by a microphone, audio oscillator, or video player. The modulated beam is received on the other side of the room and the signal emitted out of a speaker or television.



**Both Video & Audio:** A video tape is played to modulate the laser beam and the laser signal is received and displayed on a television set.



*Speak into a microphone and your words are transmitted over the laser beam to the speakers.*

CLASS 2 LASER PRODUCT  
LASER LIGHT – DO NOT STARE INTO BEAM

### **Included:**

Laser Transmitter (Diode Laser 635 nm, 1 mW)  
 Laser Receiver  
 Microphone  
 Speaker  
 Adjustable Transmitter Holder  
 Adjustable Receiver Holder  
 Power Source:  
 230VAC/110VAC or 12VDC  
 Compact Plastic Case



### **Order Information:**

**Laser Communication Kit** ..... SE-8793