Optics Expansion Kit

(Order Code OEK)

The Vernier Optics Expansion Kit (OEK) is a set of lenses, holders, a light source, a sensor holder, and a screen for use with the Vernier Track. The required Track is available separately or as a part of the Vernier Dynamics System. Students can perform basic optics experiments with this equipment. Some typical experiments done with the system include

- Thin lens image formation from a converging lens
- Thin lens equation
- Image formation by a convex lens
- Focal length measurement
- Simple telescope construction
- Microscope
- Inverse-square law of light intensity from a point source

The OEK requires the addition of a Vernier Light Sensor, an interface, and a data-collection application for performing the inverse-square experiment. Appropriate interfaces include the Vernier LabPro® interface, the Vernier Go!®Link, and the Texas Instruments CBL 2™. Appropriate software includes Logger ***Pro***® for computers, EasyData™ and DataMate for calculators, and Data Pro for Palm OS.

What is included with the Optics Expansion Kit?

The Optics Expansion Kit is shipped in one box containing the following parts:

2 Lens holders with bases
Light source with power supply
Screen with base
Light sensor holder
100 mm focal length double convex lens
200 mm focal length double convex lens
–150 mm focal length double concave lens

Note: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications.

Common Base Units

The lens holders, screen holder, light source and light sensor holder all make use similar base units. The base unit consists of a hollow post and a flat carriage. The base unit has fiducial marks to locate the center line of a screen or lens held by the base. In the case of the light source, either the pointer or the front edge of the base is used as a fiducial mark, depending on the choice of point source or luminous source.

Lens Holder Assembly

The lens holders will accommodate most 50 mm (two inch nominal) diameter lenses. To insert a lens, loosen the thumbscrews, and insert the lens in the grooves. Tighten the thumbscrew with some tension on the springs. Store unused lenses in envelopes to avoid scratching. The base units for the lenses have the post centered on the carriage.

Screen Holder Assembly

The screen is marked with a millimeter scale. The base for the screen has the post off center so the screen may be positioned in the same plane as the pointer.

Light Source Assembly

The light source has two working sides. The open side permits an end-on view of the bulb filament. The end-on view presents the bulb as a point source for inverse-square law experiments. The end of the filament is located at position marked by the pointer on the base.

The other side serves as a luminous source for imaging experiments. The shape of the source can be used to determine size and orientation of images. The position of the luminous source corresponds to the edge of the base plate. The light source shares the same base as the lens holders.

Note: Use only the provided power supply with the light source.

Light Sensor Holder

The light sensor holder is used to position a Vernier Light Sensor for inverse-square law experiments. Other light sensors may also be used. When placing the light sensor in the holder, take care to position the sensor at a known location so it is easy to read the position of the sensor from the base unit.

The light sensor holder shares the same base as the lens holders.

Sample Experiments: Real Image Formation

The thin lens equation is

$$\frac{1}{f} = \frac{1}{i} + \frac{1}{o}$$

where f is the lens focal length, i is the image to lens distance, and o is the object to lens distance. Sign convention for f is positive for converging lenses, negative for diverging. The variable i is positive if the (real) image is in back of the lens, and negative if the (virtual) image is in front. The variable o is positive if the (real) object is in front of the lens, and negative if the (virtual) object is behind the lens.

This relationship can be verified using the Optics Expansion Kit. Place the light source near the end of the track, with the luminous source facing along the longer length of the track. Insert the 100 mm focal length lens into a holder, and place it 15 cm from the light source plane. Place the screen on the side of the lens opposite the light source. Where do you find a sharp image? Is it where you expect it using the thin lens equation?

The linear magnification *M* of a lens is

$$M = \frac{-i}{o} = \frac{h_i}{h_o}$$

where h_i is the image height, and h_o is the object height. Use a ruler to measure the height of the image and object. Does the linear you observe magnification match the prediction?

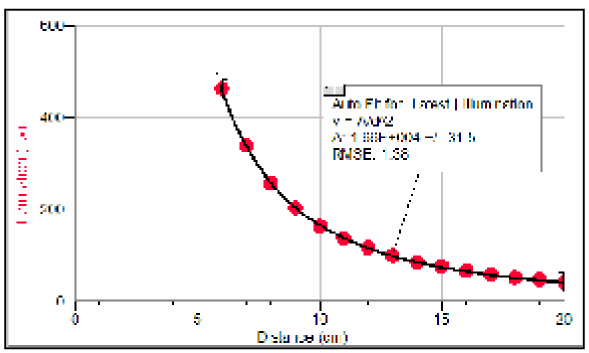
Sample Experiments: Inverse Square Law

This experiment requires a light sensor, interface, and associated software. In this example we will use Logger *Pro* software, a Go! Link, and a Vernier Light Sensor.

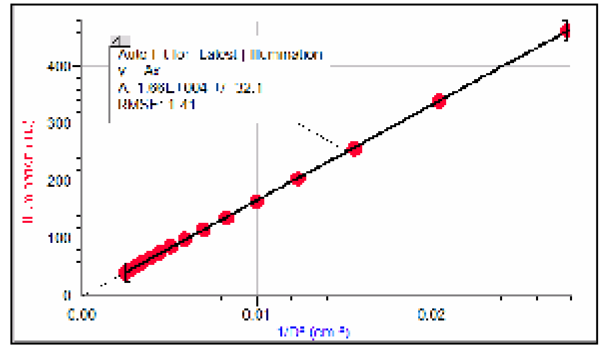
Position the light source so that the point source (open side) is facing down the length of the track. Read the position using the pointer arrow on the carriage for the light source.

Attach a light sensor to the light sensor holder. It is convenient to use the scale on the track to arrange the sensitive location on the sensor to be exactly 10 cm (or another convenient number depending on your sensor) from the center of the holder. Place the light sensor holder on the track, and align the height of the sensor to match the center of the light source, and so that the sensor is pointing directly at the light source.

Collect intensity data as a function of distance. Sample data with curve fits are shown in the following two graphs.



The light intensity follows the expected inverse-square relationship well. Another way to show this relationship is to graph light intensity *vs.* the inverse of the squared distances. The resulting graph should be a direct proportionality. The next graph shows this result.



The room was partially darkened during data collection. If there is substantial background light, both graphs would be shifted upward, and the fits would require an additive term.

Suggested Accessories

Vernier Dynamics System (VDS)
Vernier Light Sensor (LS-BTA)
Additional Track (TRACK)
Tracking joining kit (T2T-VDS)

Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. This warranty does not cover damage to the product caused by abuse or improper use.

Vernier

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