Optical bench

1060510

CE

- Rail (120cm)
- Incandescent Light source: Halogen Lamp (20 W) with automatic cooling fan system.

- Power Source for Light Source， output 12V DC
- Diode laser, 0.5mW, operated by 2 AAA battery
- Lens on stand, set of 4 (+50, +100, +150 and -100)
- Slit Accessory
- Polarization Sheet, pair on stand
- Viewing Screen
- Diffraction Grating sheet on stand, 750 lines
- Color filter, plastic sheet on stand, set of 3: Red, Green and Blue
- Prism, Equilateral on stand with adjustable handle
- Primary Color source, named ‘COLOR MIXER’
- Power Source for Color Mixer output 5V DC
- “F” Shaped Screen

Easy to Use, higher quality extruded Aluminum made bench with steel ‘Rail’ equipped with rugged bearing system. components securely hold on stand rigid and perpendicular are smoothly to slide above the bench

. build-in side scale obvious indicates the object position in metric given quick and accurate results,

This product offers your students the basic optical experiments:

Telescope, Microscope, Refraction, Color, Image Formation, light and color, Prisms, Snell’s Law, （Index 0） Lensmaker’s Equation （index1）, Apparent Depth （index 2）

In addition, this product also to be used for some advanced experiments like:

Diffraction and Interference optics with Slits and Diffraction Grating sheet by laser source to capture real time diffraction patten

Polarization Analysis for Malus' Law of polarization （Index 4）

Precise Color adds and mix

Index 0：、Snell's Law, also known as the Law of Refraction, is an equation that relates the angle of the incident light and the angle of the transmitted light at the interface of two different mediums. Snell's Law can be applied to all materials, in all phases of matter. Most people are familiar with Snell's Law because of the apparent shortening of their legs that is observed when standing in water. Another commonly recognized example of refraction in a material is diamonds. The many facets of the cut diamond combined with a high index of refraction give diamonds the brilliance that they are known for. Snell's Law is especially important for optical devices, such as fiber optics. Snell's Law states that the ratio of the sine of the angles of incidence and transmission is equal to the ratio of the refractive index of the materials at the interface.

Speed of Light and Index of Refraction

Refraction occurs because the speed of the light changes when it passes into a new medium. The speed of light in a medium is given by the following equation:

$c=nv(1)(1)c=nv$

where n is the refractive index of the material and c is the speed of light in a vacuum. The refractive index can also be determined from the permittivity and permeability of the material. Therefore it is possible to know the optical properties of the material from the electrical properties of the material. Using these properties, the index of refraction is given by the following equation:

$n=cv=\varepsilon\mu\varepsilon0\mu0----\sqrt{}=\varepsilon r\mu r----\sqrt{}(2)(2)n=cv=\varepsilon\mu\varepsilon0\mu0=\varepsilon r\mu r$

where ε_r and μ_r are the permativity and permeability of the material respectively. Table 1 lists the index of refraction for some common materials.

Material Index		
GLASS		1.5
WATER		1.33
DIAMOND		2.42
VEGETABLE OIL		1.47
POLYCARBONATE PLASTIC		1.6

Snell's Law

Snell's law relates the sines of the angles of incidence and transmission to the index of refraction for each material:

sinθ1sinθ2=n2n1(3)(3)sinθ1sinθ2=n2n1

It should be noted that the angles are measured from the normal line at the interface (Figure 1).

Figure 11: Refraction at the interface between two materials (Wikipedia)

Additionally, because the index of refraction is related to the speed of light in the material, the following equation is also true:

sinθ1sinθ2=v1v2(4)(4)sinθ1sinθ2=v1v2

As light crosses the boundary between two different materials, the light will be refracted either at a greater angle or a smaller angle depending on the relative refractive indecies of each material. If the index of refraction for the second material is greater than the first material, then the light will be refracted to a smaller angle.

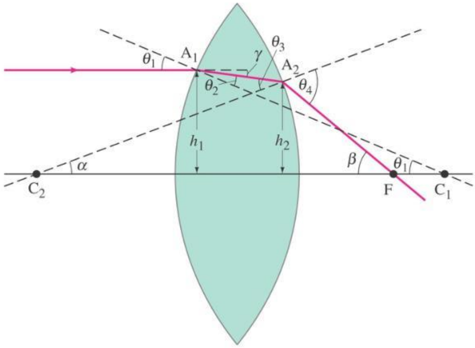
index 1: *The lensmaker's equation relates the focal length of a simple lens with the spherical curvature of its two faces:* $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2} + \frac{(n-1)\,d}{n\,R_1\,R_2}\right)$*,*
where R_1 *and* R_2 *represent the radii of curvature of the lens surfaces closest to the light source (on the left) and the object (on the right). The sign of* R_i *is determined by the location of the center of curvature along the optic axis*

with the origin at the center of the lens. Thus for a doubly convex lens, R_1 *is positive while* R_2 *is negative.,*

Lensmaker's Equation

This useful equation relates the radii of curvature of the two lens surfaces, and the index of refraction, to the focal length:

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right).$$



Index 2 Apparent depth and real depth - definition Real Depth is actual distance of an object beneath the surface, as would be measured by submerging a perfect ruler along with it. Apparent depth in a medium is the depth of an object in a denser medium as seen from the rarer medium. Its value is smaller than the real depth.
Also, what causes apparent depth? Apparent Depth and Distortion This effect is due to the refraction of light rays as they traverse the boundary between water and air. In the following graphic, the chest appears to be closer to the surface than it is.
In this way, what is real apparent depth?
The apparent depth is the distance of the virtual image, I from the surface of the water. The real depth is the distance of the real object, O from the surface of the water.
What is the formula for apparent depth?
real depthapparent depth=hh'=tanθ'tanθ=n. For water, n is about 43 , so that the apparent depth is about 34 of the real depth.

Index 4 : Light is an electromagnetic wave, which propagates as a transverse wave, with both the electric and magnetic fields oscillating perpendicularly to the direction of propagation. Natural light (e.g., sunlight) is unpolarized and vibrates in a multitude of directions. However, this light can be polarized by applying a filter, known as a polarizer. When a second filter is used in the path of the now polarized light, it is called an analyzer. Malus' law states that the intensity of plane-polarized light passing through an analyzer varies as the square of the cosine of the angle between the transmission axes of the polarizer and analyzer.
Malus' law has been named after Étienne-Louis Malus, who was a French engineer, physicist, and mathematician. Malus had published his work on the polarization of light in 1809.

Malus' Law Formula

Consider a beam of light that is polarized after passing through the polarizer, and its [electric field] oscillates in one plane. The axis of the polarizer lies on this plane. Let this beam be incident on an analyzer whose axis makes an angle Ø with the axis of the polarizer. The component of the electric field E in the direction of the analyzer axis is given by,

$E = E_o \cos Ø$

Where, E_o is the amplitude of the electric field vector.

This equation gives the displacement of the electric field vector after passing through the analyzer. Since the intensity I of the polarized beam is proportional to the square of the electric field, therefore,

$I \propto E^2$

$I = I_o \cos^2 Ø$

This equation is the Malus' law.

Note that,

When Ø = 0° (or 180°), $I = I_o \cos^2 0° = I_o$. This condition implies that the intensity of light transmitted by the analyzer is maximum when the transmission axes of the analyzer and the polarizer are parallel to each other.

When Ø = 90°, $I = I_o \cos^2 90° = 0$. This condition implies that the intensity of light transmitted by the analyzer is minimum when the transmission axes of the analyzer and the polarizer are perpendicular to each other.